



**NTNU – Trondheim**  
Norwegian University of  
Science and Technology

An analysis of the relationship between approaches and technologies for information sharing and the competitive advantage obtained by SMEs.

**Alireza Eshaghzadeh**

Globalization

Submission date: June 2014

Supervisor: Luitzen de Boer, IØT

Co-supervisor: Godfrey Mugurusi, IØT

Norwegian University of Science and Technology  
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# MASTERKONTRAKT

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Studieprogram <b>Globalization</b>	Studieretning <b>Global Production Management</b>

## 3. Masteroppgave

Oppstartsdato <b>15. jan 2014</b>	Innleveringsfrist <b>01. des 2014</b>
Oppgavens (foreløpige) tittel <b>An analysis of the relationship between approaches and technologies for information sharing and the competitive advantage obtained by SME's.</b>	
Oppgavetekst/Problembeskrivelse In the specialization project, the student carried out a review of the literature on how Web-enabled ERP systems can aid SME's in gaining competitive advantage. In the thesis, this topic will be investigated using empirical data gathered in the International Manufacturing Strategy Survey (IMSS) project to which IØT also has contributed. By analyzing the data from the IMSS data, the student will consider to what extent various propositions developed in the project thesis can be validated. Based on the results of the analysis, revised propositions will be developed.	
Hovedveileder ved institutt <b>Professor Luitzen de Boer</b>	Medveileder(e) ved institutt <b>Godfrey Mugurusi</b>
Merknader	

#### 4. Emner som skal inngå i mastergraden

Toårige masterprogram og *masterdelen* av femårige masterprogram skal ha et *masterpensum* av emner på totalt 60 sp.

Emner av et omfang på minst 30 studiepoeng (sp) må være på masternivå; dvs. emner med 3000 i emnekodeprefikset (hvis det er realfagsemner). I tillegg må Ekspert i Team (EiT) inngå hvis det ikke eksplisitt er gitt fritak for EiT. Emner på 2000-nivå kan kun brukes i den grad fakultetet selv bestemmer. Emner på lavere nivå kan ikke brukes i mastergraden.

Emnene må være faglig relevant for masteroppgaven og skal velges i samråd med veileder.

Emner som skal inngå i masteroppgaven (totalt 60 sp):

	Emnekode	Emnenavn	Sp	Nivå	Semester
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					

#### 5. Ressursbehov

Angi *spesielle* ressursbehov knyttet til gjennomføring av masteroppgaven:

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## 6. Avtalevilkår

Kort tid etter at arbeidet med masteroppgaven er kommet i gang skal student og veileder lage en plan for gjennomføringen av arbeidet. Studenten har krav på ukentlig veiledning gjennom semesteret, men utover dette skal arbeidet utføres selvstendig. Hovedveileder skal være studentens faglige kontaktperson ved instituttet og bistå med råd og veiledning vedrørende den faglige siden ved masterstudiet.

Ved endringer av semestervis plan, må ny kontrakt signeres.

Den ansvarlige faglærer har ansvaret for at oppgaven er formulert og tilrettelagt slik at studenten skal kunne avslutte arbeidet og levere besvarelsen innen tidsfristen.

Hvis veileder blir fraværende en lengre periode p.g.a. forskningstermin, sykdom, reise etc., er instituttet ansvarlig for å oppnevne ny veileder hvis studenten ønsker det. Instituttet må ha en dialog med student og veileder om dette.

Avtalen forplikter både student og veileder(e) til å ta initiativ til veiledning. Studenten har hovedansvar for å ta kontakt første gang etter semesterstart. Hvis studenten ikke tar kontakt med institutt/veileder i løpet av et semester, plikter instituttet å kontakte studenten. Hvis instituttet ikke oppnår kontakt, resulterer det i at studenten ikke lenger har krav på veiledning og at veileder ikke lenger er forpliktet til å veilede studenten. Dette medfører at avtalen oppheves. Fakultetet kan i slike tilfeller avslutte studentens studierett ved programmet.

Dersom en av partene ikke på en tilfredsstillende måte overholder sine forpliktelser i henhold til denne avtalen, eller veiledningsforholdet blir problematisk, kan den andre part på dette grunnlag be om å bli løst fra veiledningsavtalen. Studenten kan da be om å få oppnevnt ny veileder. Slike saker må behandles i instituttets undervisningsutvalg, og instituttleder oppnevner ny veileder.

Besvarelsen skal leveres innen fastsatt fristen. Blir fristen ikke overholdt vil dette medføre stryk.

Studenten skal hvert semester gi veileder en skriftlig orientering om framdriften i mastergradsarbeidet.

Studenten plikter å registrere seg hvert semester innen gjeldende frister for registrering for at studentrettighetene skal opprettholdes. Registrering forutsetter at semesteravgiften er betalt.

## 7. Underskrift

**Hovedveileder:** Jeg erklærer herved at eventuelle spesielle ressursbehov er avklart med instituttet.

**Student:** Jeg erklærer herved at jeg har satt meg inn i gjeldende bestemmelser for mastergradsstudiet og at jeg oppfyller kravene for adgang til å påbegynne oppgaven, herunder eventuelle praksiskrav (sivilingeniør).

Partene er gjort kjent med avtalens vilkår, samt kapitlene i studiehåndboken om generelle regler og aktuell studieplan for masterstudiet.

15.01.2014  
Sted og dato

  
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Student

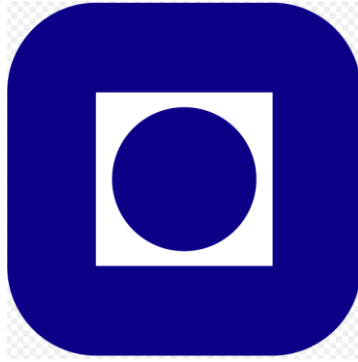
  
.....  
Hovedveileder

  
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Instituttleder

  
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Fakultetsrepresentant







**Norwegian University of Science and Technology**

**Department of Industrial Economics and Technology  
Management**

**Master of Global Production Management**

**An analysis of the relationship between approaches and  
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**Co-supervisor: Godfrey Mugurusi, IØT**

**Department of Industrial Economics and Technology Management, Trondheim, Norway**



## **Preface**

This master Thesis has been written as a part of my diploma at the department of Industrial Economics and Technology Management at Norwegian University of Science and Technology (NTNU), Trondheim, Norway. My specialization is within the disciplinary group of “Strategic Purchasing and Supply Management”. The thesis has been performed under supervision of Prof. Luitzen De Boer and co-supervision of Godfrey Mugurusi. In addition, International Manufacturing Strategy Survey (IMSS) and its data have applied to perform empirical study segment of Thesis. This thesis includes conceptual study and empirical study which has been conducted between January till June 2014.

Trondheim 10/06/2014

Alireza Eshaghzadeh



## **Acknowledgment**

Many people have contributed to the completion of this Thesis.

First of all, I thank my supervisor Professor Luitzen De Boer for his excellent support and guidance throughout the work. Luitzen provided the right mix of expertise, experience, criticism, encouragement and challenges.

I am also grateful to Godfrey Mugurusi for his invaluable support and inexhaustible patience. From beginning of the project he has been an infinite source of innovative ideas. Godfrey provided the precious and constructive comments which reinforce me to find the right direction swiftly. Furthermore, I thank Associate Professor Erlend Alfnes due to his significant help especially for opening the Purchasing and Logistics Management course for me and his fruitful lectures and labs on ERP & PLM course. I thank Torbjørn Netland for his help through providing survey data and empirical study for the Thesis.

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Finally I would like to offer my special thanks to my parents and my dear brother, Mohammadreza, for their generous support and constant encouragement throughout my whole life.



## **Abstract**

Gaining competitive advantage is a challenging task for Small and Medium sized Enterprises (SMEs). There is an ever-increasing interest toward the field of supply chain management and much attention has been deemed towards the importance of information sharing in gaining competitive advantage for SMEs. It is critical to take whole supply chain into consideration. Since both internal and external business processes are counted significant for SMEs. Integrating supply chain both internally and externally through information sharing can lead to increase supply chain performance and therefore competitive advantage. Technologies (e.g., ERP systems) are valuable resources for SMEs to enhance their supply chain performance by providing and sharing accurate information through whole supply chain. Therefore, information sharing has an undeniable place in SMEs' value chain as enabler of competitive advantage and technologies can facilitate sharing information.

This Thesis is basically about information sharing in supply chains which has considered two major problems and it is sought to offer appropriate solution to them. First to mitigate lack of information sharing in SMEs supply chain; second is to compensate lack of supply chain performance of SMEs and make use of opportunities to gain competitive advantage and dress threats. Mix research methods are applied to robustly answer main research question (Can SMEs enhance supply chain performance based on information sharing?) of this study through both analytical conceptual and empirical study.

Four major results have been obtained by this study. Two of them are associated with impact of information sharing through internal and external integration supply chain on enhancing supply chain performance and decreasing ROI. An important result is that information sharing through external integration does not lead to improve supply chain performance in term of cost. Third result indicates that technology can share information to enhance supply chain performance. Fourth result reveals that there is a high correlation between ROI and supply chain performance. The thesis concludes that information sharing has critical role in enhancing supply chain performance and the technologies will streamline the information sharing in a whole supply chain while the statistical study does not fully reap the benefits depicted by the literature. In order to fully benefit, IMSS is recommended to add specific questions about ROI and using technology (e.g., ERP).





## List of Acronym

APICS	American Production and Inventory Control Society
B2B	Business to Business
B2C	Business to customer
BRP	Business Process Reengineering
CAD	Computer Aided Design
CEO	Chief Executive Officer
CFA	Confirmatory Factor Analysis
CFI	Comparative Fit Index
CRM	Customer Relationship Management
Df	Degree of Freedom
EDI	Extranet Data Interchange
ERP	Enterprise Resource Planning
EU	Europe Union
GFI	Goodness of Fit Index
IO	Industrial Organization
IS	Information System
IT	Information Technology
KMO	Kaiser–Meyer–Olkin
NFI	Normed Fit Index
SAP	Systems Applications and Products
SCI	Supply Chain Integration
SCM	Supply Chain Management
SCP	Supply Chain Performance
SMEs	Small and Medium sized Enterprises
R&D	Research and Development
RMSEA	Root Mean Square of Approximation
ROI	Return on Investment
ROS	Return on Sales
VMI	Vendor Managed Inventory
WIP	Work in Progress



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# 1. Introduction

In today's competitive and turbulent market, manufacturing units highly need to create, share and replicate updated and required information (Nunes, 2006). In order to gain competitive advantage firms have concentrated more on supply chains and therefore managers have taken some initiatives into consideration to enhance their supply chain management (Lotfi & Sahran, 2013). A supply chain is connected by information flows, fiscal and material to the business partners (Fiala, 2005). Supply chain is collaboration from suppliers' suppliers to customers' customer and managing this collaboration is Supply chain Management (S. E. Fawcett & Magnan, 2002). The understanding and practicing of Supply Chain Management (SCM) are critical prerequisite for maintaining competitive place in the global race and improving profit through the companies (Tan & Keah Choon, 2002).

Information sharing is a key driver for any SCM system (Moberg, 2002) and it considered as a critical approach for the survival of enterprises and supply chains integration. Progression in communication technology and information in recent decades helps to apprehend information sharing better. Many scholars agree that information sharing is a key driver of effective and efficient supply chain by accelerating information flow, reducing the response time to customer's needs, enhancing coordination and collaboration and sharing the risks as well as the benefits. Thus, it can bring competitive advantage for organization in a long run (Li. Suhong, 2006).

The advantage of information sharing through a SCM has been vastly discussed by some researchers and scholars (Cachon & Fisher, 2000). Information sharing provides a SCM with a better coordination between supply chain processes to enable the material flow and minimizes inventory costs (Li. Suhong, 2006). According to (Jarrell, 1998) Information sharing leads to high levels of supply chain integration by enabling firms to make reliable delivery and introducing niche products to the market swiftly. Moreover, information sharing has gotten an essential role in supply chains to bring about efficiency by introducing long term cooperation and coordination which leads to competitive advantage (Lotfi & Sahran, 2013).

Competitive advantage is a widely discussed concept in practice and theory (Day & Wensley, 1988). Nevertheless, competitive advantage can be defined explicitly as a unique position improving company *vis-à-vis* its competitors (Hofer & Schendel, 1978). A firm has a competitive advantage when it is able to create more economic value (i.e. the difference between the perceived benefits and the economic cost of product) than rivals firm (Jay Barney, 2007). Moreover, it should be taken into consideration that the majority of researches in competitive advantage are carried out as experiences of large enterprises. There has been relatively little research performed in studying gaining competitive advantage in small and medium sized enterprises (SMEs) through approaches and technologies for information sharing.

SMEs are main employers and contributors to the market economy (E. Commission, 2010; McGibbon & Moutra, 2009). Meanwhile, they drive innovation and change significantly (Kelley, 2012). Based on these circumstances the SME sector has been seen as ‘‘decisive for the future prosperity of Europe’’ (E. Commission, 2008); see also (Robertson, 2003). SMEs driven Prosperity has also been actualized in china's phenomenal growth (Jun Li, 2003). SMEs competitiveness in a supply chain between suppliers and customers, business partners, relies on how effective and efficient the order and information is being handled among parties (Loh & Koh, 2004).

The major value of information sharing within a supply chain can be identified by the fact that achieved benefits are more important than the costs involved. Information systems investment is counted as such these costs which are charged by business partners for providing the information. Based on (Jingquan Li & Shaw, 2001), developments in technologies and approaches (e.g., Enterprise Resource Planning (ERP) and Web technologies) facilitates information sharing with dramatically reduced costs. ERP systems enhance alliances in the whole supply chain and utilize all capabilities of SMEs to improve their performances and competitive position. Information sharing has a considerable role in supply chains to match customer demands to marketplace anticipation. Broad utilization of advanced information technologies (e.g., Electronic Data Exchange (EDI)) has supported that a firm taken information sharing integration to enhance their performance (Jingquan Li & Shaw, 2001).

Through past two decades, both business managers and scholars have indicated considerable interest in understanding how information technologies (IT) assist to create competitive

advantage for a firm (Ganesh, 2008). Srinivasan and Dey (2014) mentioned that sharing accurate information without ERP system with supply chain partners is impossible. The most successful organization leverage their investment in technologies (ERP, e-business, and Web-enabled ERP) by implementing e-business solutions supported based on ERP systems. The ability of the enterprise to replicate information and communication with supply chain partners is made possible through technology (Srinivasan & Dey, 2014)

ERP systems are enterprise wide software packages providing fully integrated business processes through a common database and offering information visibility from various viewpoints (Stefanou, 2014). ERP systems codify and organize an enterprise's business data into an integrated database, and transform the data into useful information supporting business decisions (Seddon, 2010).

ERP systems, by seamlessly integrating business processes have the potential to improve business performance and gaining competitive advantage. Competitive pressures or willingness to gain customer service excellence have obliged SMEs to invest in ERP system recently (Stefanou, 2014). Taking into consideration that SMEs seek for competitive advantage in whole supply chain, communication technology can enhance SMEs performance regarding responsiveness toward business partners by transferring information in a swift and agile basis.

Rosenzweig (2003) mentioned that firms can gain two major competitive advantages. Firstly, high integration among supply chain partners can lead to more responsive firms to confront volatile demand due to enhanced information visibility and operational knowledge (Kim, 2006). Secondly, highly integrated supply chain partners have the potential to cut net costs of performing business and total delivered costs to customers (Swink, 2007). According to (Michael E Porter & Millar, 1985), in order to obtain competitive advantage first the desired position in the industry has to be identified and then activities and capabilities of the firm needs to be structured to achieve the desired position. Using and implementing technologies (ERP, e-business, and Web-enabled ERP) can create potential to provide effective information sharing through supply chain (Srinivasan & Dey, 2014). Hence, sharing information through using technologies enables SMEs to gain and sustain competitive advantage (Hsu, 2013).

## 1.2 Problem Statement

Supply chain management (SCM) is related to coordination of products, materials and information flows among suppliers, manufacturer, wholesaler, logistics, retailers, and customers (H. L. Lee & Whang, 2000). There is a growing recognition that SCM provides critical opportunities for firms to create strategic advantage and accomplish reciprocally beneficial performance outcomes (Schloetzer, 2012). Providing proper and robust information sharing between suppliers and retailers and coordinating their replenishment and production decisions under stochastic orders minimizes costs and enhances customer service level (H. L. Lee & Whang, 2000). A major theme in the SCM literature is that more information sharing between supply chain partners increases financial performance (I. J. Chen & Paulraj, 2004).

Information sharing is an integrative practice which can be linked to internal integration as well as external integration (Pagell, 2004; T. Stank & Goldsby, 2001). Internal integration mainly related to interrelationships and trade-offs within a company while external integration is linked through coordination with supply chain partners (T. Stank & Goldsby, 2001). Stevens (1989) mentioned that focus of supply chain management is appeared to be on external integration. However, it has been discussed that supply chain integration is only gained by developing different stages and internal integration precedes external integration. Internal and external integration of supply chain are fundamental if one is to gain desirable logistical performance in terms of time and cost (Gimenez & Ventura, 2005; T. Stank & Goldsby, 2001).

According to (Koçoğlu, 2011), there are very few studies investigated impact of information sharing on supply chain performance. Furthermore, role of supply chain integration as an antecedent of information sharing has been neglected. In order to enhance competitive advantage through bilateral valuable integrated relationships among supply chain members, information sharing can play a significant role (Kim, 2009; Koçoğlu, 2011). Fawcett (2007) mentioned that capability to share valid information is so essential to leverage information as a critical enabler for gaining competitive advantage.

Technology can enhance supply chain performance through information sharing by improving managerial decision making (S. E. Fawcett & Osterhaus, 2007). Leveraging information technology (IT) to develop competitive advantage is emerging as top priorities for companies (Ke, 2009; Kopalle, 2010). Supply chain performance of SMEs can be enhanced through increasing return on investment (ROI), decreasing cycle time, increase customer satisfaction, and increasing return on sales (ROS) (Liu, 2013).

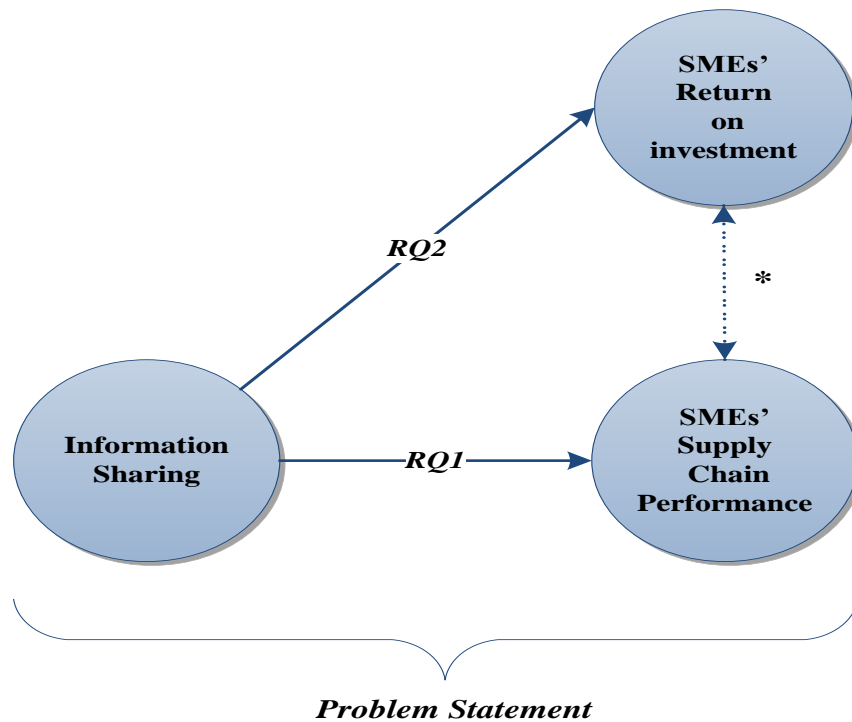
Many factors could influence the performance of a supply chain of SMEs, among which the information sharing is one the crucial ones. There are a few studies concentrate on leveraging power information sharing through value chain as compelled to enhance Supply Chain Performance (SCP) (Rosenzweig, 2003). Concentrating on enhancing supply chain performance, particularly its financial aspects (e.g. ROI and ROS) based on information sharing is the focus of this study. The main research question is designed as follow:

***(MRQ) Can SMEs enhance their supply chain performance based on information sharing?***

In order to answer to the main question completely, this study seeks to answer following sub questions:

*(RQ1) Does information sharing influence SMEs' supply chain performance?*

*(RQ2) Does information sharing support return on investment?*



\* Dotted line represents an idea that it could also be interesting to investigate these two constructs

**Figure 1 Problem statement**

According to Figure 1, Problem statement of this Thesis is indicated. This model concentrates on answering the main research question of the Thesis by emphasizing on three concepts SMEs, information sharing, and supply chain performance. Besides, focusing on supply chain performance and ROI based on information sharing makes a robust structure to answer the research questions. Dotted line represents an idea that it could also be interesting to investigate correlation of ROI and supply chain performance.

Investigating of impact of ROI on supply chain performance besides focusing to answer the research questions provides this study with holistic analysis to investigate information sharing role in gaining better performance and namely competitive advantage.



### **1.3 Objective**

Considering the increasingly globalized and competitive economy where companies are part of a milieu specified by networks of inter-organizational and intra-organizational relationships, a critical prerequisite of information sharing transpires as supply chain integration (SCI) (Koçoğlu, 2011). This study concentrates on the influence of information sharing through internal and external integration of supply chain on supply chain performance and ROI as financial aspect of supply chain performance. Therefore, the main purpose of this study is to evince the influence of information sharing on supply chain performance and ROI on supply chain performance. Moreover, obtaining competitive advantage is directly related to effective information sharing. Thus, information sharing has gotten a significant issue propelling this study to further investigate its impact on supply chain performance.

### **1.4 Overview of Dissertation**

This dissertation consists of seven chapters which seek to answer the main research question strategically. Chapter one presents the preliminary part of the research where clearly specifies the major reasons for choosing the topic and research problem. In order to answer main research question perfectly, addressing two sub research questions is focus of this study. In order to clarify Thesis' topic definitions and implications of SMEs, competitive advantage, sustainable competitive advantage, ROI, and ERP are delivered.

Chapter two presents the research methodology for answering the main research question of this study. Through this chapter the reason of mixed research methods is conducted and what kinds of data are used is addressed. The main concept behind this chapter is to indicate the processes which are undertaken to build up this study.

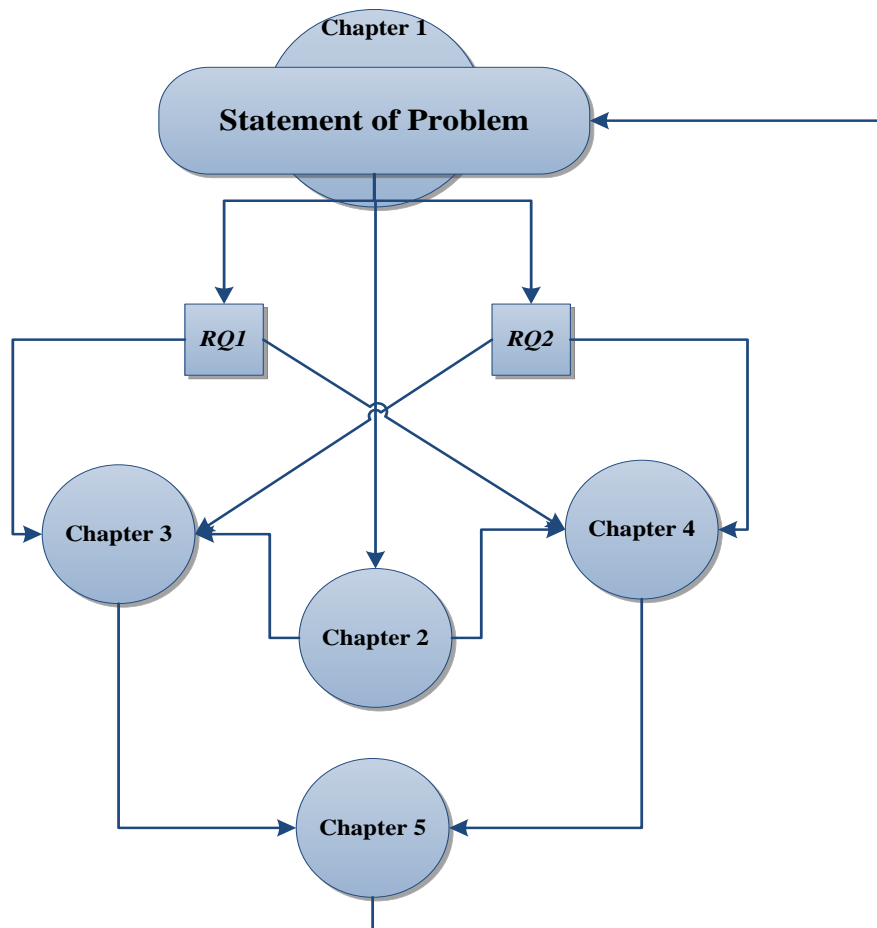
Chapter three provides several fruitful literatures for performing analytical conceptual study. This chapter is organized to answer research questions through using results of scholars who did the same study. Concepts of supply chain performance, supply chain integration, and

information sharing propels this study to develop four hypotheses as result of analytical conceptual study.

Chapter four starts with analyzing the IMSS-IV's data to test the four hypotheses. At the first step, reliability and internal consistency is evaluated then impact of each factor relative to others is measure. By receiving acceptable results, a regression analysis for each construct is carried out. The regression analysis indicate the relationship of independent and dependent variables of this study which assist to determine positive and negative impacts of each construct on other construct.

Chapter five present discussion through results of this study in its empirical study. Besides, some ideas for building up further research are addressed. Finally, in chapter 6, conclusion of this study is delivered through understanding, concepts and results which are obtained. Chapter seven presents an Epilogue of this study. Through this chapter, in a nutshell what has been done by each chapter to perform this study is delivered. Also, a weekly plan for carrying out this study is mentioned to specify activities done to perform the Thesis.

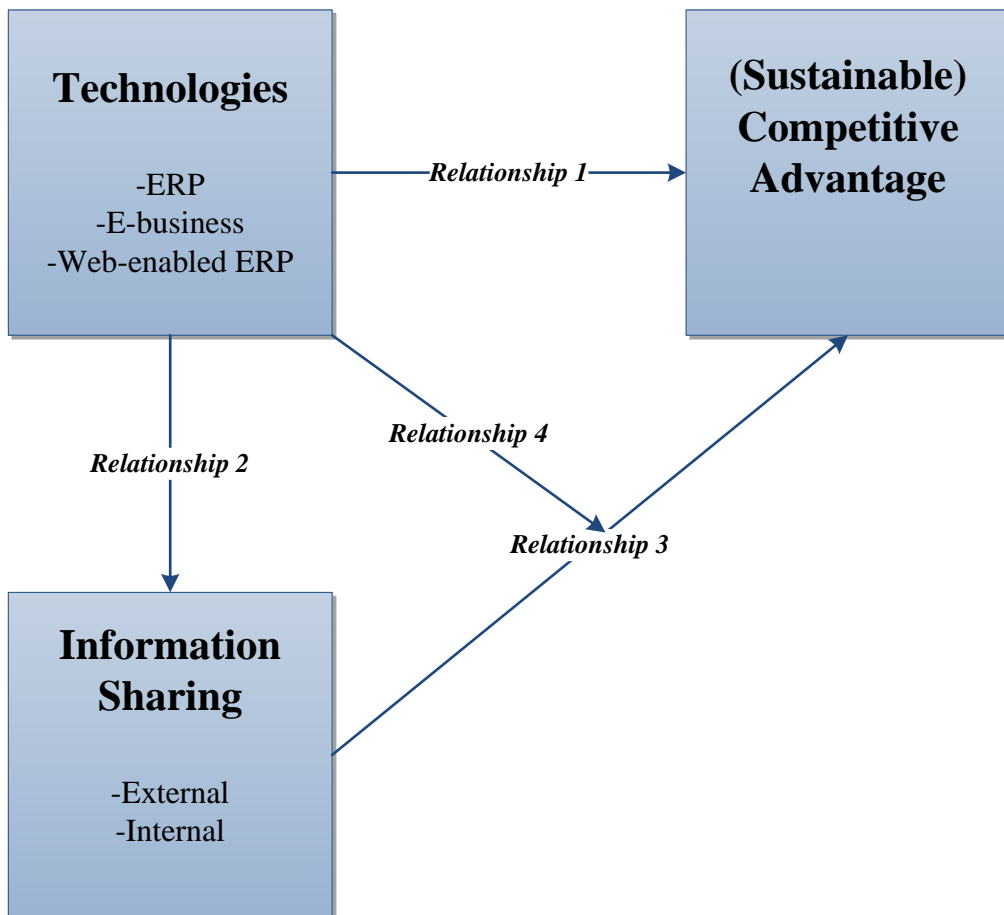
According to Figure 14, roadmap of this study through both contributions and relationships of each chapter are indicated to address our technique to answer the main research question.



**Figure 2 Framework of the Thesis**

## **1.5 Conceptual Model**

In order to address Thesis’ objectives robustly, a conceptual model is indicated (See Figure 2) to indicate implications of the Thesis which is to analyze approaches and technologies for information sharing and gaining and sustaining competitive advantage in SMEs. Conceptual model covers the implications of the Thesis to answer the main research questions strategically. In order to clarify the conceptual model, relationships of each mapped construct are analyzed.



**Figure 3 Conceptual Model**

According to Figure 2, Relationship 1 indicates the extent of technology on gaining and sustaining competitive advantage. Relationship 2 focuses on impacts of technologies on replicating information sharing in an organization (e.g. SMEs). Relationship 3 shows that information sharing (internally or externally) enables SMEs to gain competitive advantage. Finally, relationship 4 concentrates on technologies as enabler for information sharing to gain and sustain complete competitive advantage in SMEs. In order to clarify the relationships deeply, four models are developed.

## **1.6 Model development**

In order to analyze the relationships of approaches and technologies for information sharing and competitive advantage gained by SMEs, four models are developed (See figures 3, 4 and

5). Thesis is focused on model four as the primary model, while model one, two, and three are mentioned as practices for propelling proposed literature to implications.

Each model has a different foundation. Model one focuses on gaining competitive advantage through using or implementing technologies by SMEs in their supply chain. Respective to Model one, Model two concentrates on using technologies in SMEs for replicating information sharing. Sustaining competitive performance has an extremely high significance (Lopez, 2011). However there is not a real consensus for sustaining competitive performance is linked to IT capabilities (C. Zhang & Dhaliwal, 2009).

IT infrastructure does not differentiate an enterprise from its competitors since IT applications are getting highly standardized (C. Zhang & Dhaliwal, 2009). Greater competitive performance can be gained when IT infrastructure is applied to meet customer determined organization needs. IT infrastructure provides the whole supply chain of firms with a positive impact on the effectiveness through enabling firm’s IT-enabled sharing capability. Sharing capabilities can assist firms to create unique, difficult to imitate, and non-substitutable capabilities (Prajogo & Olhager, 2012).

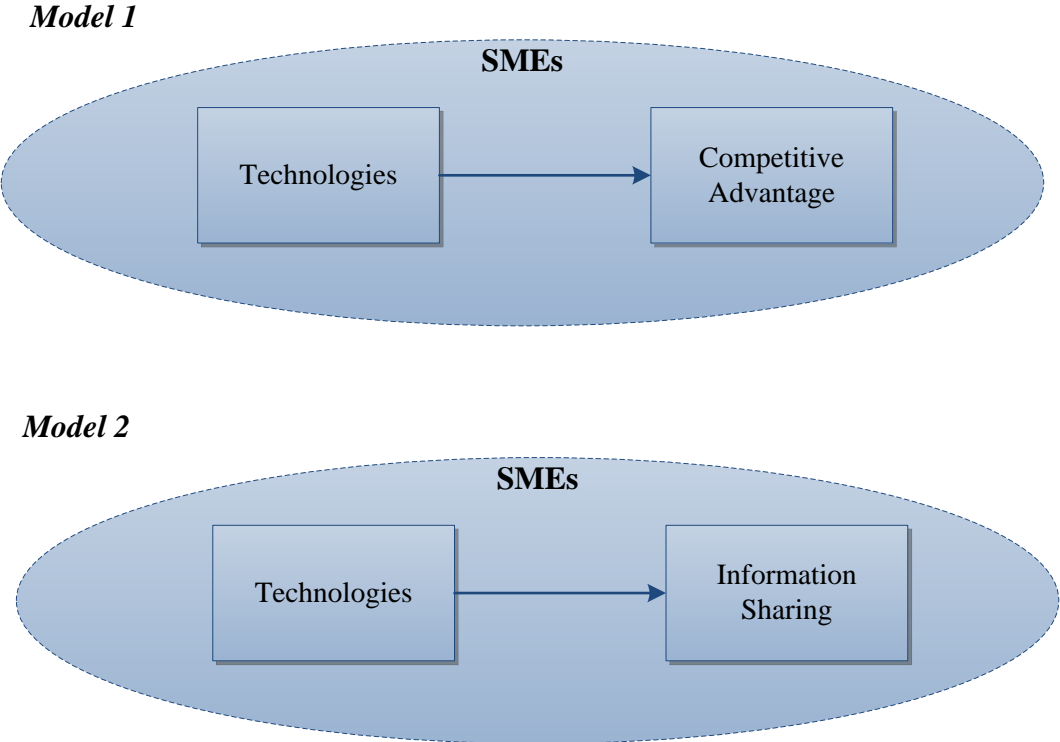


Figure 4, Model 1 and Model 2

C. Zhang and Dhaliwal (2009) use IT term as a broad definition comprising supply chain technologies and information systems applications supporting both operational processes and business-to-business electronic interactions which are central to IT-enabled supply chain networks.

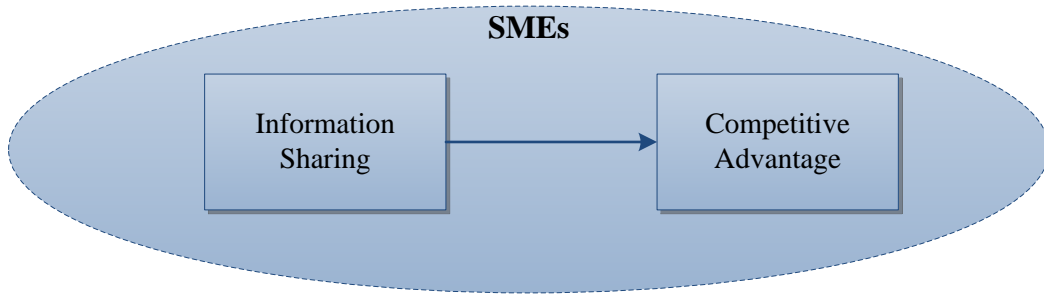
IT is an important enabler of effective supply chain management and global competition success (Gunasekaran & Angappa, 2004; Ngai, 2008). Since business transactions about production, purchasing, shipment, and payment accounts for a large enterprises' daily business guarantee that the operational information is documented and shared, integration is crucial for gaining efficiency in operations and being responsive in supply chains (H. L. Lee, 2002). So, industries place an increased emphasis on operational coordination through supply chain integration (Hill, 2001).

Integrating a supply chain through sharing information with business partners is a key element for effective supply chain management. The use of Technology (e.g. ERP) as a tool can provide information integration capabilities (Hill, 2001). It provides a firm with capabilities to enhance the speed on responding to competitive threats. Technology increases the flow of information through an organization through integration which leads to decrease uncertainty in a supply chain. So, Technology can replicate and enhance information through an Organization (Hill, 2001).

Model 3 emphasizes on obtaining competitive advantage through information sharing in SMEs. It is significant to discern what information capabilities are. Information sharing capabilities contain two aspects (Jin & Yan, 2014):

- (1) The capability of a firm to deal with intangible information existing within all of the relevant parts of the firm itself and among suppliers, distribution network, and customers which the firm encompasses.
- (2) The capability a firm has for constructing a tangible network to link both internally among different areas of the firm and externally with supply chain partners (i.e. integration of IT systems provides information sharing) (Keen, 1991).

### *Model 3*



**Figure 5 Model 3**

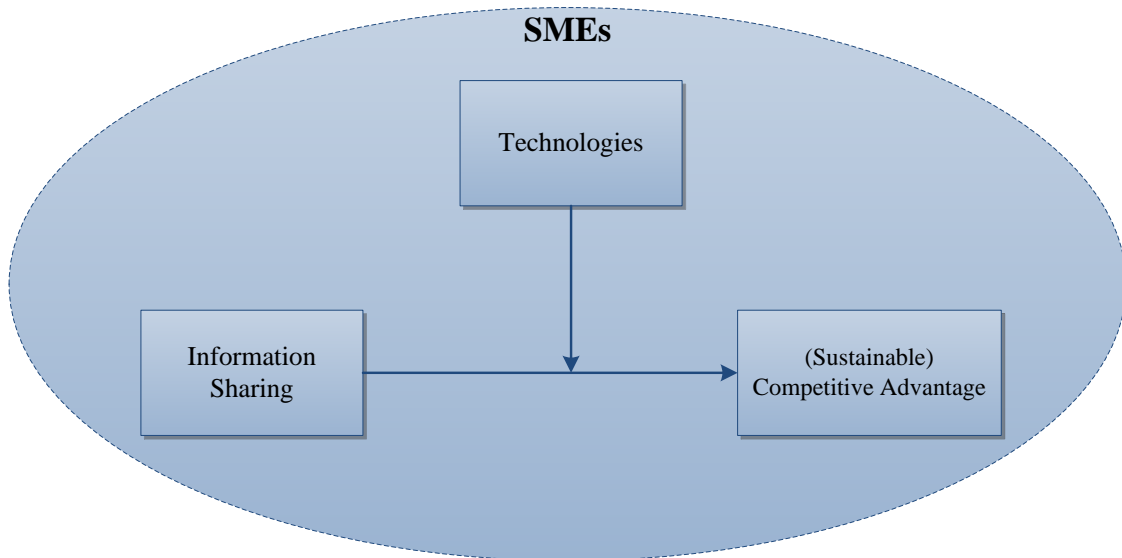
According to (Pandey, 2010), information sharing can propel SMEs to gain different competitive strengths. Managers have to concentrate on right information sharing in their way to increase particular competitive strength. With properly sharing information between business partners and co-coordinating their replenishment and production decisions through demand uncertainty, it is probable to decrease costs and to enhance customer service levels. So, information sharing can lead to gain competitive advantage (Pandey, 2010).

Although IT-enabled sharing capabilities increase competitive performance of the firm without the actual practice of information sharing, a firm's IT-enabled sharing capability both improves the use of practice and developed by enhancing the level of shared information and value of the information (Jin & Yan, 2014).

Model 4, as a primary model developed for Thesis, focuses on technologies used or implemented for information sharing and obtaining and sustaining competitive advantage by SMEs. Through larger transactions, the Return on Investment (ROI) on IT operations like ERP systems and e-business system enhances.

As SMEs seeks to enhance supply chain integration, they should strive to contribute complementarily to final products. Subsequently, IT operations (ERP and e-business) are becoming highly significant in operational strategy development and execution (Markus et al, 2006). It enhances collaboration efficiency among supply chain members and decrease transaction costs (Chae, Yen, & Sheu, 2005). Therefore, IT-enabled supply chain management is essential for firms to coordinate both their internal operation efficiency and external relationships in a supply chain (Manecke & Schoensleben, 2004).

#### *Model 4*



**Figure 6 Model 4**

Taking into consideration the highly competitive environment, it is required to create integrated information flows for working in a supply chain. This is the actual place where technologies (i.e. ERP, e-business, and Web-enabled ERP) prove to be essential. The ability of the enterprise to replicate information and communication with supply chain partners is made possible through technology (Srinivasan & Dey, 2014). Information sharing through external integration of supply chain (i.e. downstream with suppliers and upstream with customers) and specifying how this information is presented is facilitated by ERP technology (Ash & Burn, 2003).

E-business technologies have replicated on the scene in the last decades which some scholars advocate that e-business is a significant solution for sharing information among supply chain partners of a firm (Hsu, 2013). E-business is an internet-based technology (e.g. Extranet, websites, and EDI communication technologies) linking two firms for carrying out e-business functions such as online selling, purchasing, coordination, and information sharing (Hsu, 2013). Since e-business implementation is easy and it needs lower costs, e-business technologies hold the promise of providing information sharing made from ERP systems to extend the supply chain (Ash & Burn, 2003).



ERP and e-business are competitive systems, but their notable benefit is that they can be driver of competitive advantage when they are used in agreement and complement each other (e.g., Web-enabled ERP). Therefore, in today's turbulent and competitive market, when power is shifted to customer side who demands for intelligent products, new strategy is required to address such challenges to gain competitive advantage. So, ERP systems and e-business technologies and their integration (i.e. Web-enabled ERP) can be used to gain competitive advantage (Srinivasan & Dey, 2014).

Sustainable competitive advantage is to maintain a superior position which is not easily copy or surpassed by firms' competitors. Although technology enhances efficiency and quality and decreases costs, it may influence firms' sustainable competitive advantage if it can be appropriately protected from duplication (Greve, 2009).

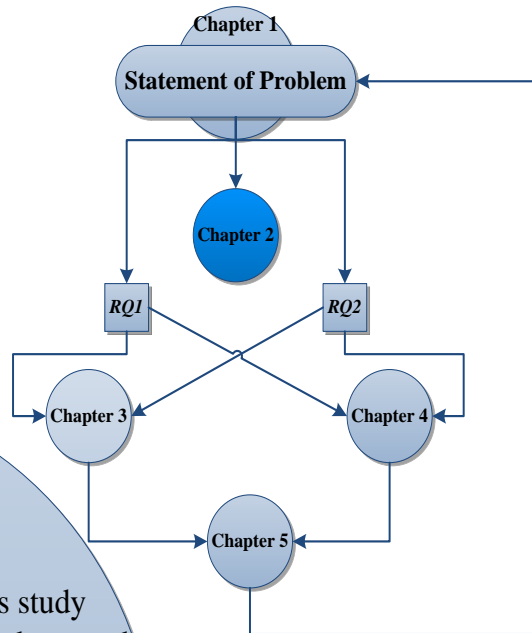
It should be taken into consideration that technology can be used as a valuable resource for SMEs to enhance supply chain performance. In a resource-based view (RBV), technologies are valuable resource to improve quality, and response time to market (Jin & Yan, 2014). Furthermore, ERP systems can play an important role in streamlining system integration across organizations. Using and implementing technologies in order to create potentials to support decision making by providing effective information sharing through a supply chain (Srinivasan & Dey, 2014). Therefore, sharing information through using technologies as enabler for SMEs to gain and sustain competitive advantage is critical (Hsu, 2013).

The developed models simplify and indicate used direction to address main question of this study. Model 3 as primary model for this study is tested across analyzing hypotheses. Besides, model 4 is analyzed and compared to model 3 to test the role of technology as an enabler for information sharing to gain competitive advantage.



# Chapter2

## Research Methodology



### Chapter 2:

- Identify the research type
- Specify research type applied for this study
- Determine what and why using mentioned research approaches
- Identify research design
- Indicate data collection for both in quantitative and qualitative types
- Introducing IMSS-VI objectives, functionalities, and sections
- Specify software applied to analyze this study

## 2.1 Research type

Type of this research is combination of analytical and empirical research type (Mixed methods research). Kothari (2009) defines that in analytical research researcher should use facts or information already available, and analyze them to create a critical assessment of the material. According to (Wacker, 1998), analytical research method mainly adopts logical, mathematical, and statistical model to develop a theory.

On the other hand, empirical research relies on observation and experience often without considering theory. Empirical research is a data-based research leading to conclusions which are capable to be verified by experiment and observation. In empirical research type, a researcher works on creating hypothesis or she guesses the possible results and then provide sufficient fact to verify her hypothesis (Kothari, 2009).

According to core aim of this study and to carry out a fruitful study, this study is classified into two parts: analytical conceptual study and empirical study (See Figure 15). At first part, an analytical conceptual study is deemed the most proper means for collecting the relevant data including both literature study and survey. The analytical research method applies deductive method to arrive at conclusions (Swamidass, 1986).

According to (Wacker 1998) the emphasis of analytical conceptual research, from a theory building perspective, is to extend new insights into traditional problems through logical relationship building. This research methodology includes new insights across logically developing relationships between carefully determined concepts into an internally consistent theory.

At second part, an empirical statistical research is considered as a practical method for analyzing the IMSS 6<sup>th</sup> edition data. Empirical research should use data from external organizations or businesses to test if relationships hold in the external world (Wacker, 1998). Wacker (1998) mentioned that this type of research generally uses interview process to gather data for statistical analysis. Thus, this research type offers empirical support in a theory-building perspective for theoretical relationships in greater samples in real world (Meredith, 1989). So, for testing the hypothesis made through this study an empirical statistical research

is carried out. This empirical study clarifies the relationships of constructs of IMSS 6<sup>th</sup> edition data.

## **2.2 Research approach**

The above description of the research types clarifies that there are two basic approaches for this research, viz., the *qualitative approach* and *quantitative approach*. Qualitative and quantitative research are often presented as underlying different paradigms as lightning conductors to which sets of epistemological assumptions, theoretical approaches and methods are attracted (Brannen, 2005).

Kothari (2009) mentioned that qualitative approach is concerned with subjective evaluation of attitudes, opinions and behavior. It means that this approach is a role of researcher's insights and impressions. Qualitative approach emphasizes on applying group interview to generate results (Kothari, 2009). Qualitative approach includes of many different activities, many of which are concerned with the objective study of realities which offers no protection from the critical standards that should be used to any enterprise concerned to set 'fact' from 'fancy' (Meinel & Silverman, 2014).

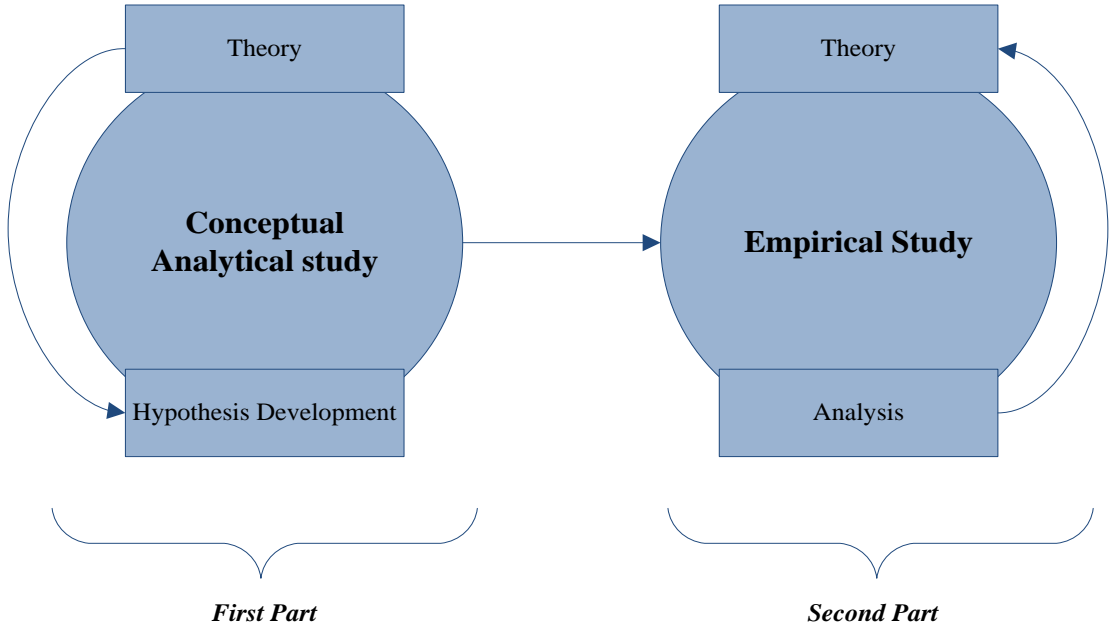
A quantitative approach was selected because the goal of quantitative research is express the phenomena in terms of quantity (Kothari, 2009). As the main purpose of this study is to investigate each hypothesis to find either positive or negative relationship of each ones based on IMSS 6<sup>th</sup> edition data, an experimental approach is selected as the best. Experimental approach is specified by much greater control over research environment and in this case some constructs are coordinated to observe their impact on other constructs (Kothari, 2009).

A qualitative research misses quantitative research's strength to simplify statistical inference, which is when the results of a research sample are simplified to the parent population (Brannen, 2005). Brannen (2005) claimed that quantitative approach collect particular items systematically. It means that some questions on the interview are treated quantitatively while others have a qualitative character.

Taking into consideration that this study applies both qualitative and quantitative approach, a mixed methods research is used. Mixed methods research is defined as the class of research where scholars combine qualitative and quantitative research techniques and implications into a single study (Johnson & Onwuegbuzie, 2004).

According to (Jick, 1979), qualitative and quantitative methods should be viewed as complementary rather than competitor camps. So, triangulation can be prescribed for this study as ‘combination of methodologies in the study of the same phenomenon’ (Din, 1987). Therefore, a mixed-methods should be adapted to aid particular theoretical, practical and methodological objectives (Brannen, 2005).

Figure 15 indicates the research types for this study. According to the Figure 15, combination of qualitative and quantitative methods and triangulation to mix methodologies are performed by this study. In analytical conceptual study a deductive approach and in empirical study an inductive approach is undertaken. It should be taken into consideration that an inductive approach is used for mixed method research, as a main research method for this study, to address the proposed research questions strategically.



**Figure 7 Research methodology parts**

Mixed-method is neither a tool kit nor must it be seen as a belt approach. This method is applied to address the distinct questions modelled in a research investigation which may lead to use range of methods. Nevertheless, the resulted data should be analyzed and constructed in relation to those methods and based on hypotheses by which they are created (Brannen, 2005).

Mixed methods research sits in a new position where qualitative research is on the right side and quantitative research is on the left side (Johnson & Onwuegbuzie, 2004). According to (Bryman, 2012), qualitative and quantitative research are combined in terms of:

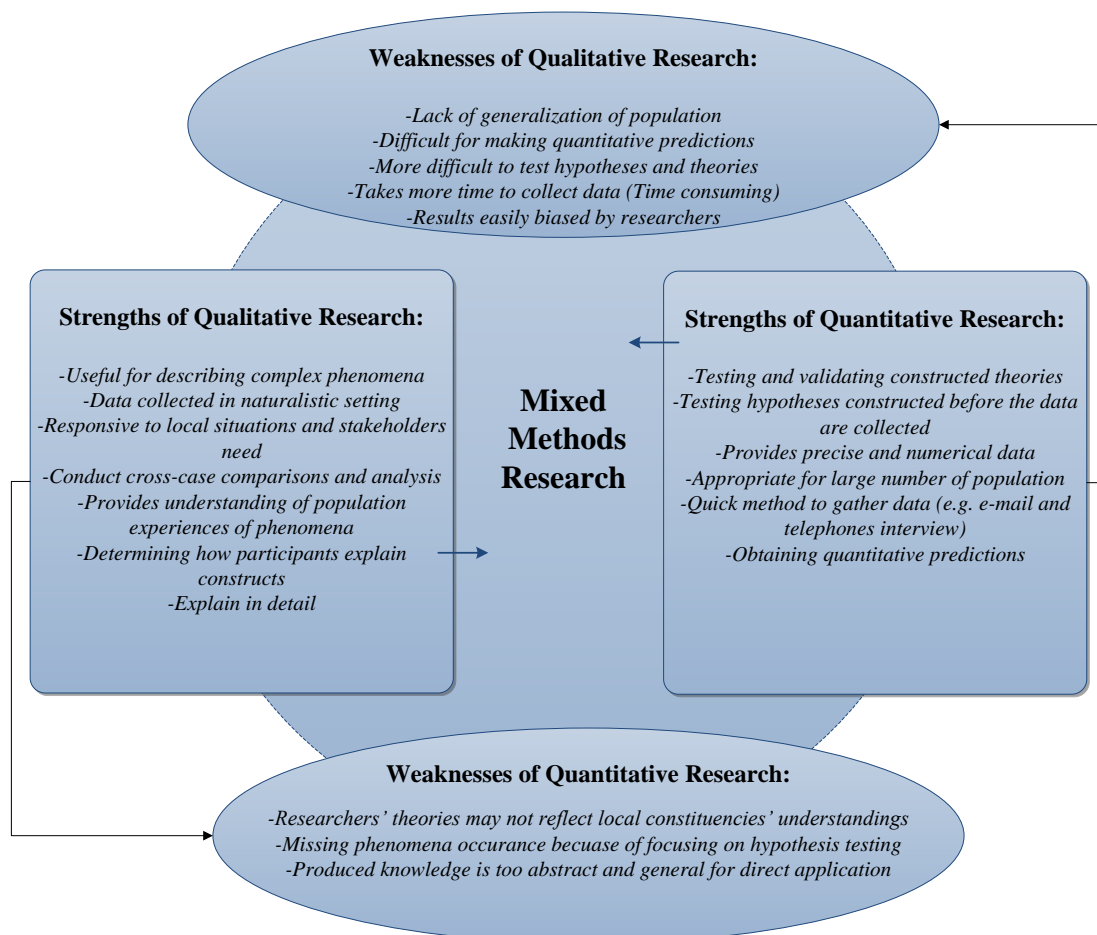
- I. The significance set to qualitative and quantitative approaches in the research
- II. The time sequencing of the approaches

However, Bryman (2012) claims that such differences are not always probable in practice since they focused on determining the dominance of one approach. Mixed methods research provides great potential for practicing researchers who intend to see methodologies develop techniques to what researchers apply in practice (Johnson & Onwuegbuzie, 2004). This research as the third research paradigm can also link the chasm between quantitative and qualitative research (Onwuegbuzie & Leech, 2005). Johnson and Onwuegbuzie (2004) emphasized that the focus of mixed methods research is attempt to fit together the insights addressed by quantitative and qualitative research into a feasible solution.

In order to mix research in an effective manner, this study considers the entire relevant characteristic of qualitative and quantitative research. In qualitative research, this study focuses on exploration, theory generation, hypothesis development, and qualitative analysis. In quantitative research, this study emphasizes on deduction, validation, theory/hypothesis testing, using IMSS 6<sup>th</sup> edition data, and statistical analysis.

According to (Johnson & Onwuegbuzie, 2004), obtaining an understanding of the strengths and weaknesses of qualitative and quantitative research put researchers in a situation to combine strategies and apply mixed methods research. According to figure 16, a researcher can gain strengths of both qualitative and quantitative research to enrich mixed methods research and to cover weaknesses of each method. This method may provide a researcher with an effective method to gain robust results.

Admittedly, this research applies mixed methods research to support both analytical conceptual and statistical study to gain robust results by contribution of qualitative and quantitative research strengths.



**Figure 8 Mixed researches method**  
 Inspired by Johnson and Onwuegbuzie (2004)

According to Figure 16, it can be understood that applying mixed methods research assists this study by providing two research methods which one's strengths can cover another weaknesses. So, the mixed methods can eliminate the possible weaknesses.



### **2.3 Research design**

A robust problem following the task of defining the research problem is creating a design for the research project namely research design. A research design is the arrangement of conditions for analyzing data in a manner aiming to mix relevance to research purposes with economy in procedure (Kothari, 2009). It means that, research design is a conceptual structure in which a research is conducted. It includes blueprint for the collection and analyzing the data. Research design streamlines research to be as efficient as possible to yield maximal information (Kothari, 2009).

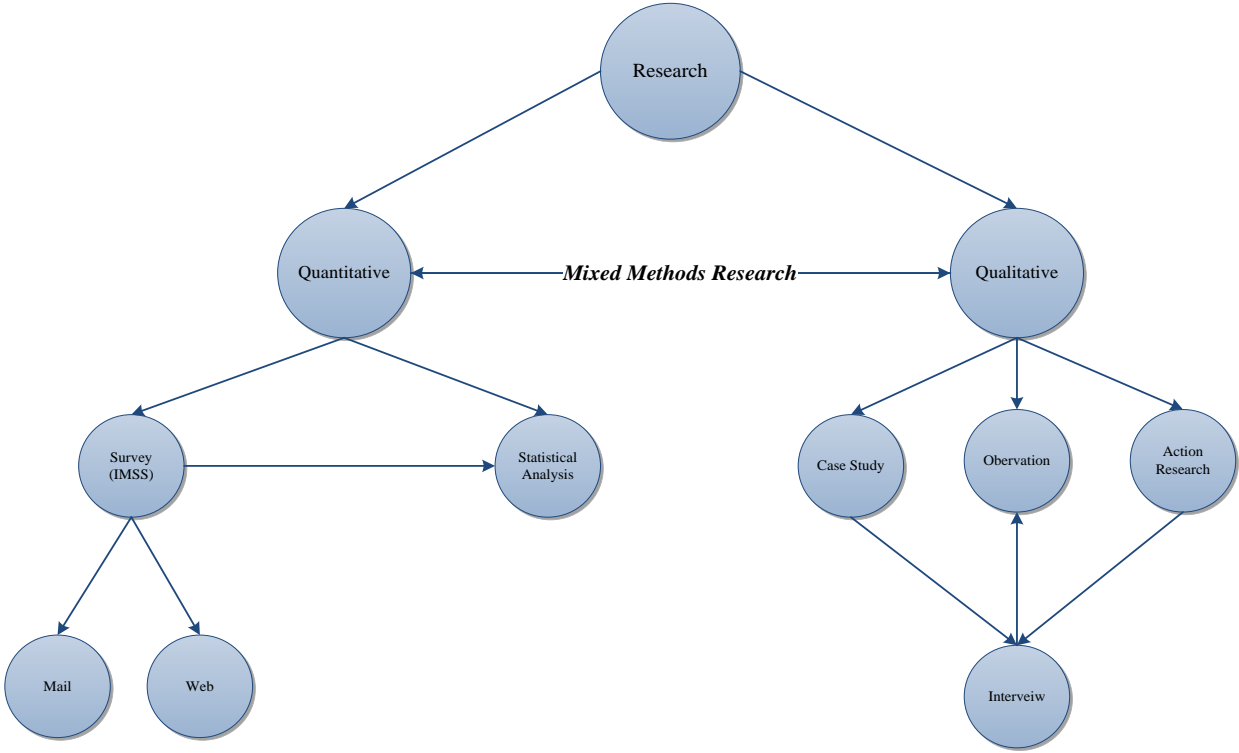
This study pursues to indicate importance technologies and approaches for information sharing and competitive advantage gained by SMEs based on IMSS data. The study is made to analyze the relationship of technologies and information sharing for obtaining competitive advantage in SMEs. Data is obtained from the sixth round of the IMSS (IMSS-VI). In order to do so, a survey data analysis through statistical field and simulation are carried out. Furthermore, the possible approach of data collection for IMSS-VI is addressed through mix research methods.

In a quantitative part, applying the survey (i.e. IMSS) propels this study to choose an analytical research since the main purpose of analytical research is to use facts or available information and analyze these to make a critical evaluation of the material (Kothari, 2009). In order to analyze the large sample of IMSS-VI a cross-sectional method is applied for survey-type research. Specifically, this study seeks to replicate our findings with analysis performed on the collected IMSS data (R. Cagliano, Caniato, & Spina, 2003). Also analyzing statistical analysis based on IMSS data leads us to find the positive or negative relationship of each construct. An inductive approach is selected as the best to carry out quantitative research. Inductive reasoning moves from specific observations to broader generalizations and theories.

In qualitative part, action research could be used to bring theory and practice in the pursuit of practical solutions to enrich the results as a possible research design (Reason & Bradbury, 2001). McNiff (2013) mentioned that action research includes learning in and through action and reflection and it is performed in diverse contexts. Action research provides researchers to improve their learning (McNiff, 2013). Using an action research through qualitative study

enriches IMSS data gathering by providing concepts as learning outcomes through interviews results.

IMSS-VI could apply case study through interviews with managers to gather required data. Case study method is a popular form of qualitative analysis and it includes a careful and complete observation of entire community (Kothari, 2009). It means that case study can assist to IMSS-VI data gathering through a precise observation of IMSS previous results. IMSS results of previous years (IMSS-I, II, III, IV, and V) can aid this study to gain sufficient information for drawing correct inferences and either longitudinal analysis.



**Figure 9 Anatomy of possible research design of IMSS-VI**

According to Figure 17, research method anatomy of possible research design of IMSS-VI addressed. So, a possible research design for IMSS could be through interview, mail, and Web. Since the initial research design includes both qualitative and quantitative methods, mix research methods were incorporated in order to best link methods to answer research questions (Kaplan & Duchon, 1988). Quantitative study by using IMSS-VI data through statistical analysis is performed by this study.

## 2.4 Data Collection

Qualitative methods include an extensive search of many databases which are available to researchers and interview. In order to perform a fruitful analytical conceptual study for the first section, following databases and internal journals (e.g., production economics, operations management, production research, operations and production management, logistics management, and supply chain management) have been investigated for SMEs, competitive advantage, information sharing, Supply chain performance, and return on investment literatures:

- Scopus™
- ScienceDirect®
- Springer Link
- Emerald Intelligence
- JSTOR
- Wiley InterScience
- IIE Tailor & Francis
- IEEE Xplore™

Google scholar has applied for filling out the gap of the literature with most relevant and professional papers. After searching each database based on mentioned keywords, abstract and introduction is read and practical literatures are gathered stringently in accordance with research questions. Then, reading the whole articles to grasp the implication is carried out.

Required data is collected based on IMSS 6<sup>th</sup> edition among Autumn 2013- Spring 2014. IMSS is designed to explore and identify the manufacturing strategies, practices and performance of firms around the world. Quantitative methods were employed to collect and analyze data from the IMSS 6<sup>th</sup> edition questionnaire. IMSS is sent to companies in local languages through an email, regular mail and interviews. Specifically in Norway, the IMSS-VI's data for Stavanger was collected using interviews and for NTNU was collected through online survey and follow-up telephone conference. When responses received, they put together in an integrated database. IMSS 6<sup>th</sup> edition includes 570 companies. Table 1 indicates

countries which participated in this survey. All participants were assured of confidentiality. According to Figure 19, research methodology for this study is indicated. Figure 19 clarifies step by step of this study and how it is managed to be written. Besides, fully read articles are addressed through each database. Contribution of analytical conceptual and empirical study and what is undertaken to fulfill this study is presented.

## **2.5 Data**

In the quantitative study, the data used to test the hypotheses are drawn from IMSS 6<sup>th</sup> edition. A research project carried out by a global network of investigators in 2011. The IMSS project originally carried out by the London Business School and Chalmers University of Technology, studies manufacturing and supply chain strategies within the assembly industry (ISIC 25-30 codes) (Caniato, 2009). It uses a detailed and holistic questionnaire that local research groups manage simultaneously in several countries. The responses are gathered in a seamless global database (Lindberg, 1997).

The sample frame of the study consisted of a range of industries which are mostly manufacturing units through the Europe and Asia. The initial sample consisted of 569 medium and large sized firms in total, residing in Netherland, Romania, Finland, Hungary, Norway, Sweden, Portugal, Spain, Italy, China, India, and Taiwan. According to Table 1 the participant's countries in IMSS 6<sup>th</sup> edition is presented. Also, Table 2 addressees ISIC codes to clarify the industries took part in the IMSS-VI.

**Table 1 Countries**

Countries	Number	Percentage
Netherland	49	8,59
Romania	40	7,01
Finland	34	5,96
Hungary	56	9,82
Norway	17	2,98
Sweden	27	4,73
India	136	23,85
Portugal	34	5,96
China	63	11,05
Spain	30	5,26
Italy	56	9,82
Taiwan	28	4,91

**Table 2 ISIC code**

ISIC Code	Number	Industry Description
25	171	<i>Manufacturing of fabricated metal products, except machinery and equipment</i>
26	90	<i>Manufacture of computer, electronic and optical products</i>
27	91	<i>Manufacture of electronic equipment</i>
28	129	<i>Manufacture of machinery and equipment not elsewhere classified</i>
29	60	<i>Manufacture of motor vehicles, trailers and semi-trailers</i>
30	23	<i>Manufacture of the transport equipment</i>

In order to address the applied survey objectives and approaches in collecting data for analyzing manufacturing strategy, IMSS definition and functionality are delivered by next section.

### **2.5.1 International Manufacturing Strategy Survey (IMSS)**

International Manufacturing Strategy Survey (IMSS) designs a common database and gathering data for the study of manufacturing management strategies and practices on both global and national scale (See appendix). In order to promote industrial practices causes and trends should be taken into consideration. Great competition among industries globally has enhanced the pressures on them. These pressures urge the industries to take initiatives and innovative trends to modify their practices and strategies to sustain their development to challenge their abilities (IMSS, 2013).

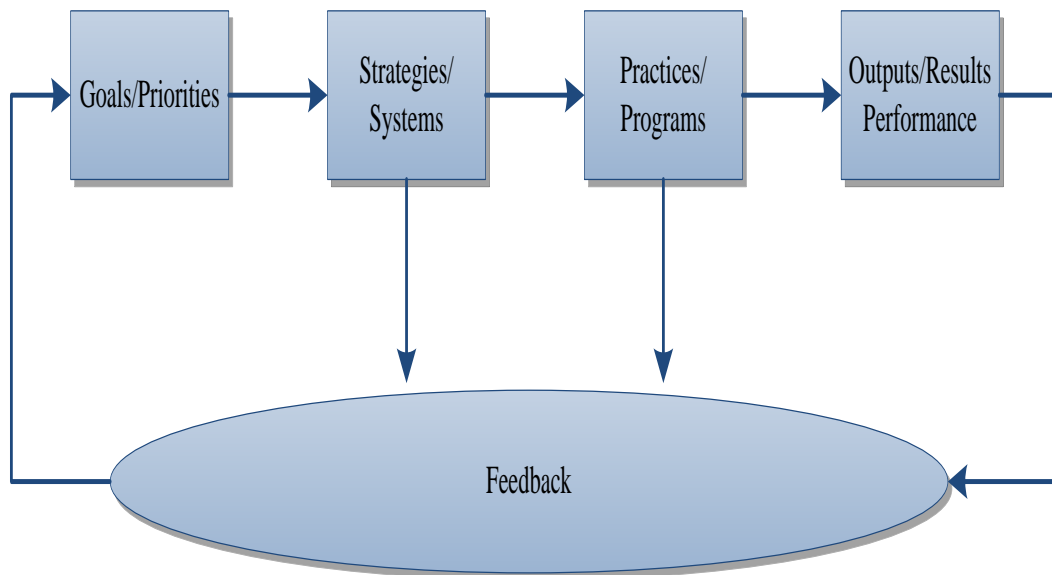
Adopting and replicating current technological and organizational practices promote the contingencies for flexible and cost efficient production with high quality products. Environmental and social demands propel industries to use newest technological and organizational modes in order to minimize the risk of obsolete. Particularly, manufacturing firms confront with several and serious challenges which needs to be streamlined and structured to solve. The main goal of IMSS project is to investigate manufacturing strategies and practices in industrialized nations globally (IMSS, 2013). IMSS consists of 3 phases which are as follows:

***Phase 1:*** The questionnaire is designed based on state-of-the-art measures.

***Phase 2:*** The questionnaire is tested and validated with some pilot firms.

***Phase 3:*** The questionnaire is translated in the local language and send out to companies.

According to Figure 18, the IMSS underlying model is indicated. Based on the model, gaining competitive advantage is focused. This is iterative model which seeks to acquire goals based on practices and strategies to achieve desirable results with using feedback.



**Figure 10 The IMSS underlying model**

Source: (IMSS, 2013)

Every partner of IMSS which has participated performs the data collection in its own country and then sends all of the data to a unified and shared database. The collected data is applied for scientific purposes and to deliver reports and bench markings to participating firms.

In this study the 6<sup>th</sup> edition of IMSS is used to investigate manufacturing strategies, practices and performance of SMEs including Norwegian ones. The IMSS is divided into three sections:

### **Section A**

In this section description, strategy and performance of the business unit are specified. It mostly seeks for finding competitive strategy which is deployed by business unit and getting data regarding organization of the plant. Also performance of the business unit based on its sales and services which are offered alongside with the products are focused.

### **Section B**

In this section description, strategy and performance of manufacturing for the dominant activity of the plant are identified. The focus of this section is to specify companies' dominant activity regarding cost structure, manufacturing process design and performance. Comparing

of companies performance to their previous years based on indicators provide valuable data for companies to estimate their performance.

### **Section C**

In this section current manufacturing and supply chain practices, and past action program are specified. Section C could be counted as the most significant section in collecting data regarding functionalities which have been done in the whole value chain. Section C focuses on following dominant activities of firms:

- *Planning and control*
- *Technology*
- *Quality*
- *Environmental and social sustainability management*
- *Product development*
- *Risk Management*
- *Supply chain*
- *Manufacturing network*

In order to evaluate the IMSS data based on the objectives of this study and to answer all research questions and admittedly main research question, some software should be used to analyze the data. The software is selected based on finding an appropriate needed for this study.

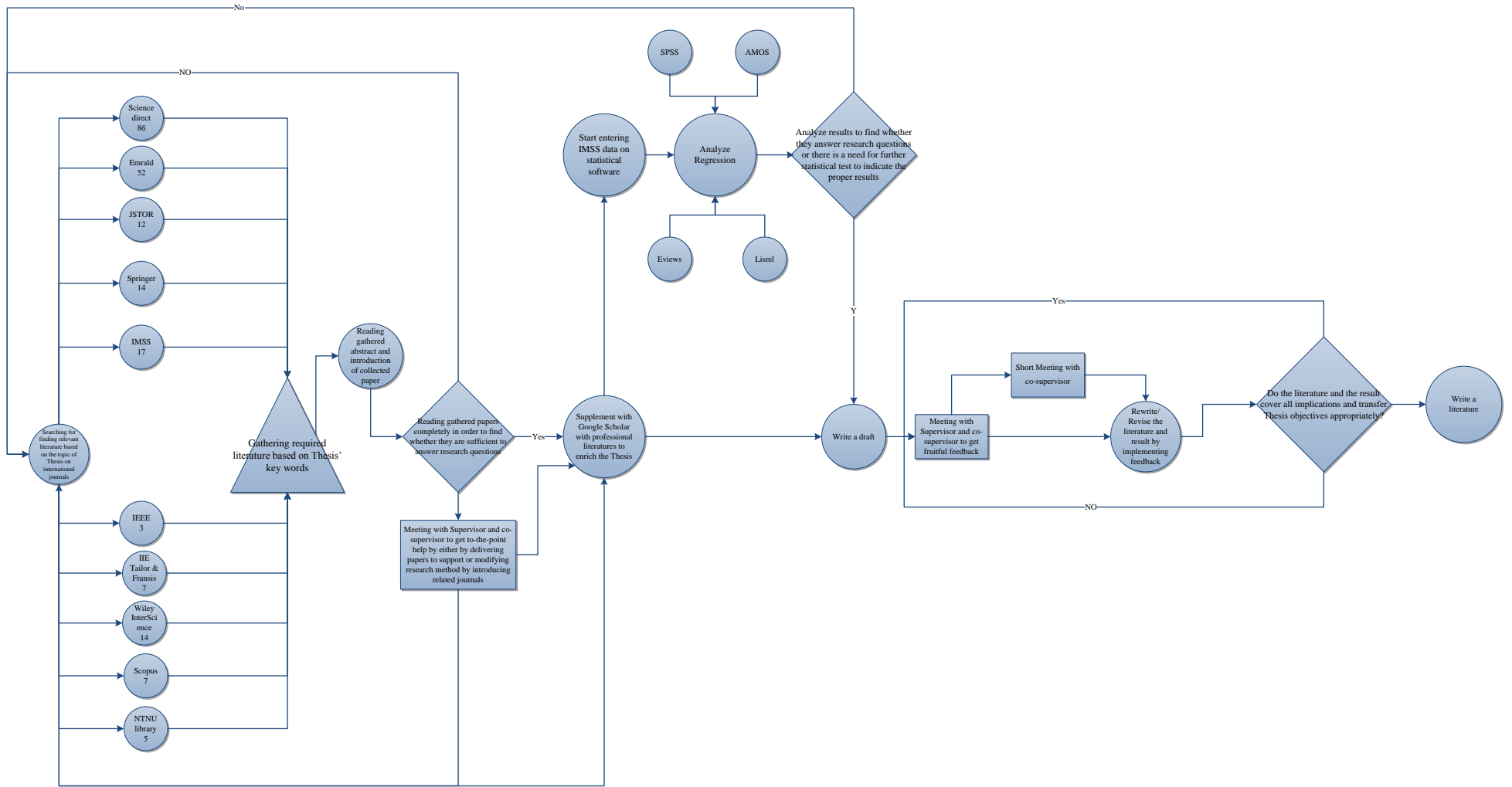


## 2.6 Software

In order to run statistical analysis including regression analysis and confirmatory factor analysis various programs is applied. These programs are listed as follows:

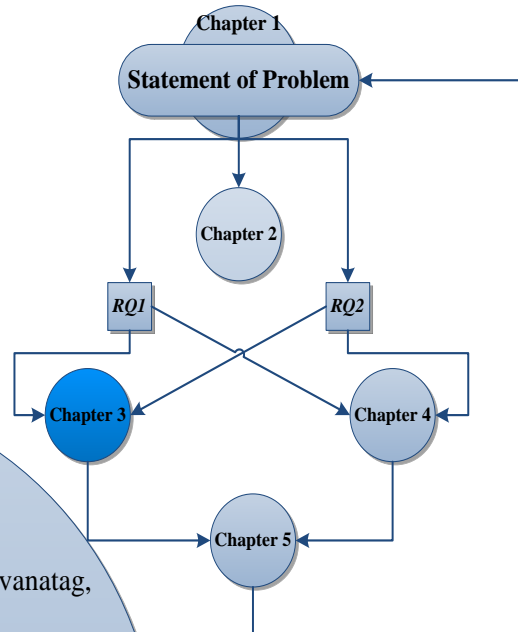
- 1- SPSS (<http://www.ibm.com>)
- 2- SPSS AMOS (<http://www.ibm.com>)
- 3- Eviews (<http://www.eviews.com>)
- 4- Lisrel (<http://www.ssicentral.com/lisrel/>)

SPSS and Eviews are used to take regression analysis. SPSS AMOS and Lisrel used to provide confirmatory factor analysis and goodness of fit for this study which broadly will be discussed in chapter four.



**Figure 11 Research Methodology**

# Chapter3 Conceptual Study



## Chapter 3:

- Define concepts of SMEs, competitive advantage, ROI, and ERP
- Define information sharing and its potential benefits for firms
- Specify supply chain integration and its types and functionalities to structure supply chain
- Provide fruitful literatures to indicate the contribution of information sharing and supply chain performance
- Define supply chain performance and its contribution with supply chain performance
- Proposing four hypotheses based on the IMSS-IV' data and literatures through information sharing through internal and external integration and their effects on supply chain performance improvement

### **3.1 Small and Medium-sized enterprises (SMEs)**

Small and Medium-sized enterprises (SMEs) have various definitions. According to the European Union (EU) uniform definition (T. E. Commission, 2004), SMEs are independent firms with fewer than 250 employees and having either a turnover of less than 40 million euro or total assets of less than 27 million euro. The definition of SMEs differs based on their annual turnover (e.g. according to (T. E. Commission, 2004), SMEs are defined as ‘Enterprises employing fewer than 250 employees which comprise an annual turnover limiting to 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro’.

Based on (Haksever, 1996; Van der Wiele & Brown, 1998), SMEs are considered to have less than 500 employees. There are many accepted definitions of SMEs and the classifications differ either industry to industry or country to country (O'Regan & Ghobadian, 2006). Each country has specific criteria such as Employment, sales, or investment for defining SMEs (Ayyagari, 2007). It appears that there is not a consensus on SMEs' definition (Deros, 2006). Taking in to consideration that SMEs definition is depended on each country. It means that SMEs in one country may be counted as an large firm in some other countries (e.g. China and Norway) (Eshaghzadeh, 2013)

SMEs have a considerable role in economic growth in recent policy making (Hoffman, 1998). Some authors believe that SMEs are a critical segment of the industrial economies (Eikebrokk & Olsen, 2007; Robles-Estrada & Gómez-Suárez, 2007). Therefore, SMEs existence and growth have been an important issue. Economic development can be gained by key role of SMEs. They always challenge with capital shortage and need technological assistance in the beginning of the R&D activities. They have dominant position in the industrial and commercial infrastructure of many countries (Deros, 2006).

SMEs play a significant role in modern economies because of their flexibility and capability to innovate (Gunasekaran & A, 2000). Also, SMEs provide employment opportunities and support large size manufacturing organization. Because of technology advancement, even smallest business has the potential to trade in global market (J. Tan, 2006).

Information sharing implication is to distribute applicable information for systems and organization units. It can be referred to '*Knowledge sharing*' or '*Information Integration*' in a supply chain (Lotfi & Sahran, 2013). Based on (Tsung, 2000), the impact of information sharing strategies on process and product quality in a supply chain, information can be a driver for improving the quality of products.

Information sharing can provide the beneficial effects on quality improvement by transferring the required information to each segment in the supply chain. Tsung (2000) mentions that without information sharing, although an individual process may be managed to have more process capability and dimensional quality that improvement may lead to poor assembly matching.

According to (X. Zhao & Xie, 2002), coordination and integration in supply chain management (SCM) have gotten a considerable concern of the business world. Information sharing as a driver of competitive advantage can help companies to survive in today's economy.

So in SCM, supply chain partners integrate as a strategic alliance to share risk and benefit, supply predominance each other to satisfy customers' needs and effectively reduce cost to gain competitive advantage in the supply chain. A key solution in this collaboration process is to share information among supply chain partners.

X. Zhao and Xie (2002) mentioned that disregards to technology and human restrictions, information resources have the nature of sharing and could be shared by all. Nature of information is to be shared among all. Sharing information of resources and making them be of attractive new economic functions. Information resources can help companies in taking easier and more accurate decision. For instance, minimizing or eliminating uncertainty, optimize the behavior of management and improve the efficiency of decision making and management.

The focus of this part is to indicate that SMEs play a considerable critical role in modern economies. Since SMEs are flexible and they have great ability to innovate which help them so much to seek for competitive advantage and sustain their competitive position in markets for longer time. In today's global competitive markets, technology advancement brings about

SMEs to have great potential to compete actively. So, many SMEs do strive to gain competitive advantage based on their capability by implementing new approaches and technologies like information sharing, ERP, and E-business to enhance their supply chain performance

### **3.2 Competitive Advantage**

Most firms develop their strategy - their theory of how compete successfully – by applying the strategic management process. The strategic management process is a sequential set of analyses and opportunities that can enhance the likelihood that a company will deploy a strategy enabling it to perform better to generate competitive advantage (Jay Barney, 2007).

Competitive advantage is the ability a firm has to create more economic value than competitors firms (Jay Barney, 2007). Economic value is difference between the perceived benefits gained by customers and the full economics cost of products they purchase. Therefore, the size of company's competitive advantage is the difference between economics value a company is able to create and the economic value its competitors can generate (Jay Barney, 2007).

Michael E. Porter (1980) stated that “competitive advantage works as a heart of firm's performance in competitive markets” and Michael E. Porter (1980) intended to indicate concept of his book is to “how a firm can actually create and sustain a competitive advantage in an industry—how it can implement the broad generic strategies.” Therefore, competitive advantage understood as having low costs, differentiation advantage, or a successful focus strategy. Moreover, Michael E. Porter (1980) debated that “competitive advantage raising substantially out of value a firm is able to develop for its end customers and it exceeds the firm's cost of generating competitive advantage” (Eshaghzadeh, 2013) (P26).

Michael E. Porter (1996) mentioned that the profitability of a firm depended on the attractiveness if the industry and its competitive advantage within the industry. Industry attractiveness is stemmed from competitive force within the industry and how firms can cope

with or manage the competitive forces. Firm's competitive advantage and profitability need that firm choose specific generic strategy and strive not to 'stuck in the middle'.

Industry profitability and competitive advantage of a firm in the industry are relied on five competitive forces. These competitive forces are as follows (Michael E. Porter, 1996):

- Competitive rivalry within the industry
- Threat of new entrants
- Threat of substitutes
- Bargaining power of buyers
- Bargaining power of suppliers

Managers define competition too narrowly, involving just today's rivals. Competition for profits goes far beyond established industry competitors to also comprising suppliers, customers, potential entrants, and substitute products. When these five forces are mighty, almost no company attains attractive return on investment in the medium or long term. Porter determines the five forces for shaping competition through example of recent modification in those forces (Eskildson, 2010).

Porter commences with potential barriers to entry for new competitors. The threat on entry in an industry depends on height of entry barriers existed and the reaction entrants can anticipates from incumbents (Michael E. Porter, 2008). These involve large supply-side economies of scale and large demand-side benefits of scale, customer switching cost, capital requirements, restrictive government policy, and incumbency advantages independent of size. The threat of entry will be high if entry barriers are low and newcomers anticipate little reprisal from the rivals (Eskildson, 2010).

Powerful suppliers attain more of the value for themselves by charging higher prices and changing cost to industry participant (Michael E. Porter, 2008).Supplier power is increased as being more focused by the industry it businesses with and it is decreased by product differentiation and concentrating deeply on one specific industry (e.g. lack of substitute and high switching cost for existing customers) (Eskildson, 2010).

Powerful customers can attain more value by decreasing costs, enhancing quality and providing better services. If buyers have negotiation leverage relative to industry participants, they will be powerful buyers (Michael E. Porter, 2008). Buyer power is enhanced by fixed and low variable cost suppliers, lack of supplier differentiation, lack of buyers, and lack of reliable suppliers for forward integration. Michael E. Porter (2008) mentioned that buyers are more price sensitive if the product indicates an important cost component, or the buyers are attaining low benefits.

A substitute carries out similar functionality as an industry's product by a various means (e.g. e-mails is a substitute). Substitutes are always present while they are easy to neglect since they may seem to be very different from the industry's product. When threat of substitutes is great, industry profitability decreases. Strategies must particularly ready to modify in other industries that may make them attractive substitutes when they were not before (Michael E. Porter, 2008).

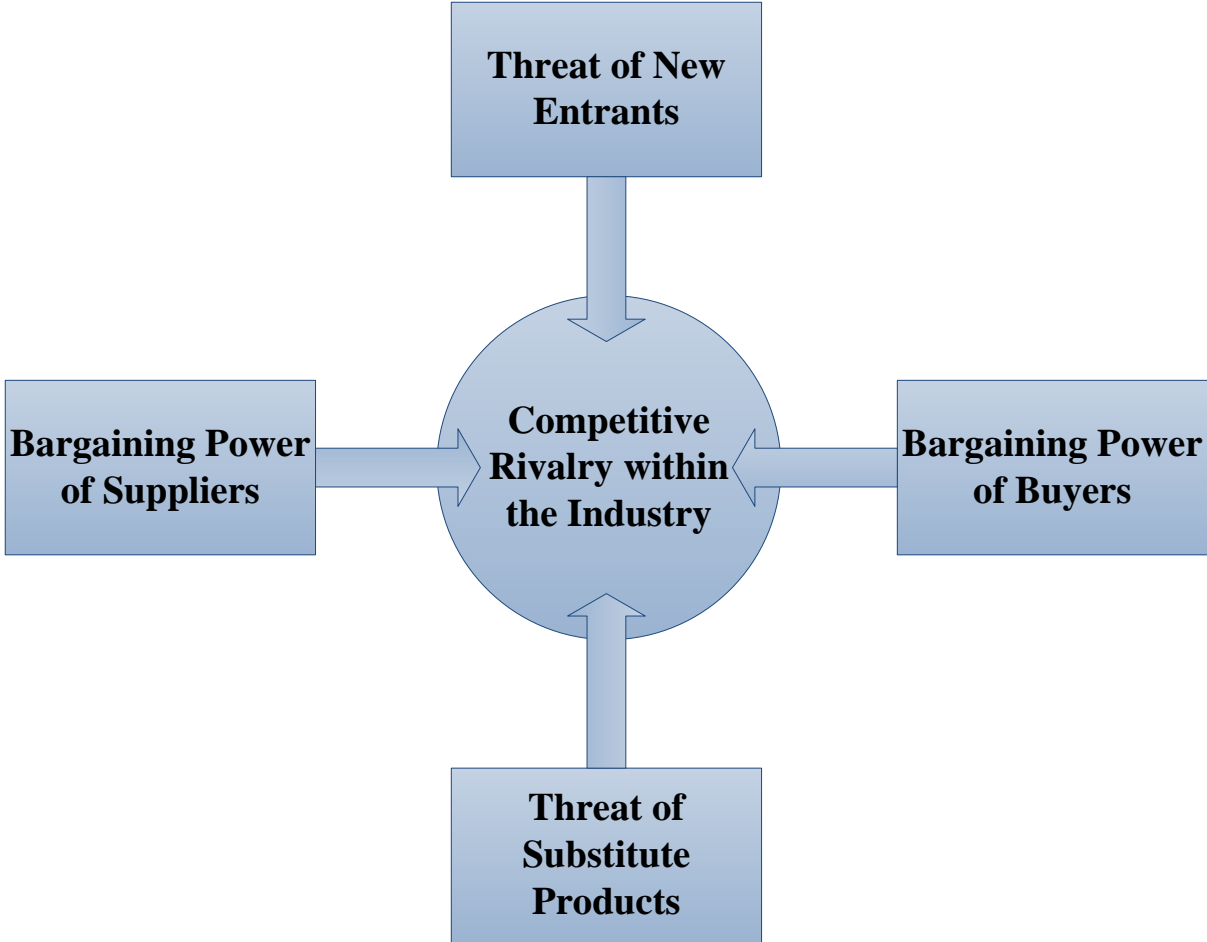
Rivalry among existing competitors includes price discounting, new product introductions, and advertising service improvements. It should be taken into consideration that high rivalry restricts the profitability of an industry. Rivalry decreases industry profit potential based on intensity with competing firms and basis which they compete (Michael E. Porter, 2008).

The strength of rivalry indicates not just intensity of competition but also competition basis. The dimensions on which competition takes place have a critical impact on profitability. Rivalry can enhance average profitability of an industry, when competitors aim to meet the needs of distinct customer segment with different combination of prices and brand identities. In order to propel competition in a positive direction, understanding of the structural underpinnings (i.e. Technology and industry growth rate) of rivalry should be clarified (Michael E. Porter, 2008).

Taking into consideration (advanced) technologies can lead to be more competitive in a market while technologies by themselves are not sufficient to make an industry structurally either attractive or not. However, Michael E. Porter (2008) argues that low-technology industries with price-intensive buyers, high entry barriers, and high switching costs are sometimes get more benefits than industries using internet technologies which attract competitors (Michael E. Porter, 2008). It means that technology itself is not enough for an



industry to be attractive but it can be used as an enabler for being attractive. Zurn and Mulligan (2013) propose that time to market, product quality, and niche products costs are all positively influenced by technology. According to Figure 6, five competitive forces which one industry needs to be attractive are indicated.



**Figure 12 The five force model**  
Source: Jay Barney (2007)

The five force model has three significant concepts for managers searching to choose and implement strategies. First, this model identifies the most common sources of threats in industries. Second, the overall threat in those industries can be specified. Finally, the average level of performance in an industry can be forecasted. Therefore the five forces model determines processes tending to move an industry toward the economic condition of robust competition (Jay Barney, 2007).

According to (Michael E. Porter, 2008), an important question in competitive strategy is a firm's relative position within its industry. Positioning specifies whether firm's profitability is above or below the industry average. The underlying basis of above-average performance in the long run is sustainable competitive advantage. Since firm can have myriad of strengths and weaknesses vis-à-vis its rivals.

Michael E. Porter (2008) determined two basic types of competitive advantage a firm can possess: low cost or differentiation. Cost advantage and differentiation arose from industry structure. They result from company's ability to cope with the five forces better than its competitors. The two basic types of competitive advantage combined with the scope of activities for which a company searches to gain them result to three generic strategies for obtaining above average performance in an industry: cost leadership, differentiation, and focus.

For cost leadership means that firms sets out to get the low-cost producer in its industry. The sources of cost advantage are varied and depend on the structure of the industry. Firms may include the pursuit of economies of scale, proprietary technology and preferential access to raw materials. In differentiation strategy a firm seeks to be unique in its industry along some aspects that are widely valued by buyers. The logic of the differentiation strategy needs that a firm chooses attributes in which to differentiate itself that are different from its competitors. Focus strategy rests on the choice of a narrow competitive scope within an industry. This strategy has two variants. In cost focus a firm seeks a cost advantage in its objective segment, while in differentiation focus a firm seeks differentiation in its objective segment (Michael E. Porter, 2008).

Generally, industries are perfectly competitive when they are under high degree of threats from new entry rivalry, substitutes, suppliers, and buyers (Jay Barney, 2007). Competitive advantage has gotten valuable strategy assisting firms succeed in business operations and gain superior performance and growth. Porter mentions that although operational effective is essential, it is not enough as strategy (Eskildson, 2010).

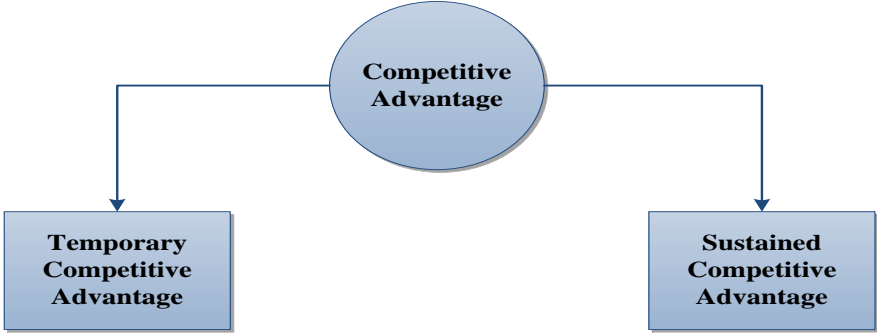
Furthermore, competitive advantage is a company's conceived competitive strength relative to rivals in markets (Lei & Huang, 2014). Competitive advantage is assessed frequently in relation to industry structures, markets, products, customers, strategies and communications (Easton, 1993). Taking into to consideration today's turbulent markets and risk of duplicating

strategies, thus, strategies should seek for sustainable competitive advantage (Eskildson, 2010).

### 3.3 Sustainable Competitive Advantage

Sustaining competitive advantage is the challenge faced by several businesses in today’s fast paced word (Warraich, 2013). Although the concept of ‘sustainability’ has been subjected for discussion in microeconomics for several times (Rumelt, 1991), there have been lack of definition for ‘sustainable competitive advantage’ explicitly (Coyne, 1986). There is an exception to this provided by (Cecil, 1990) who proposed that ‘a sustainable competitive advantage is a capability of one competitor that cannot be copied by another’.

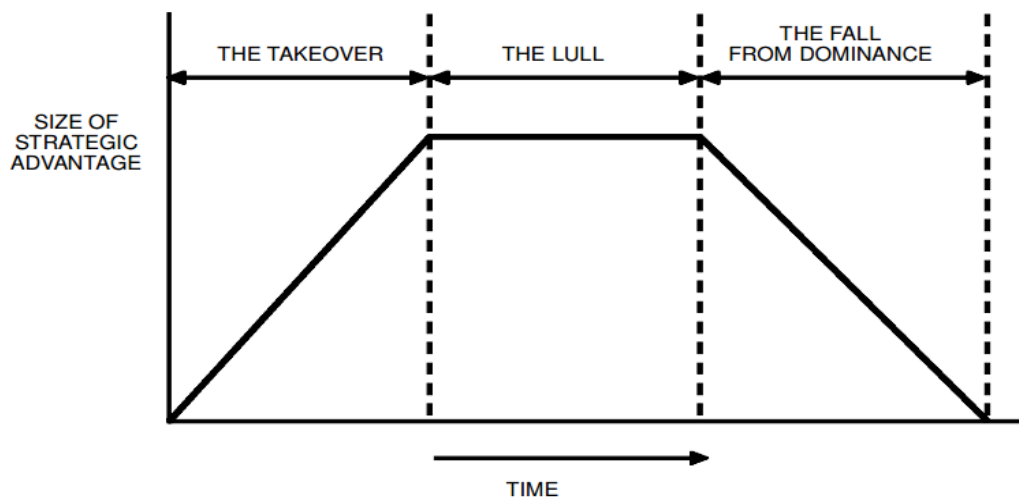
A company’s competitive advantage can be either temporary or sustained (See Figure 7). A temporary competitive advantage maintains for a very short period of time. On the other hand, a sustained competitive advantage can last so much longer (Jay Barney, 2007). Zurn and Mulligan (2013) define sustainable competitive advantage as capability to deliver a solution which a customer values in a way that is not available across other sources. Figure 7 indicates parity of competitive advantage which can be either sustained or maintain temporarily.



**Figure 13 Competitive advantage**  
Source: Jay Barney (2007)

MacMillan (1989) provides a model of sustainability as it is indicated in Figure 8. According to the model in the first stage, a firm conquers the dominant position within a market by creating a competitive advantage. In the next stage, there is a competitive lull when competing firms commencing to get aware of situation, conceived the dominant firm’s competitive advantage and start change their own product offerings.

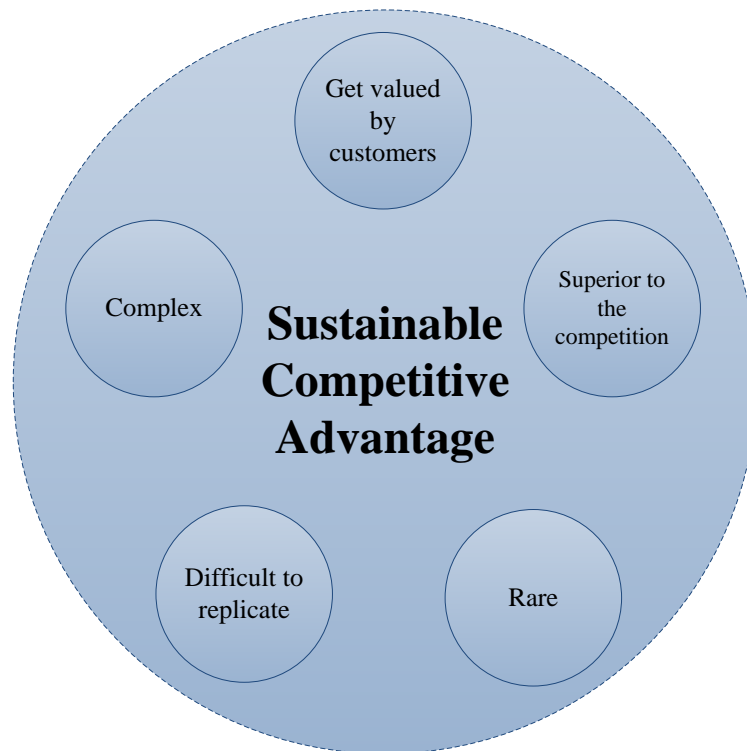
Over this stage the dominant firm gains the rewards of competitive advantage in the form of above normal profits. Consequently, there is a stage where there is an inclination from dominance as the competitive advantage of the dominant firm is wrinkled. It should be taken into consideration that the actual duration of these three stages is conceived as how long it takes to create a competitive advantage and respond to competitors (Walley & Thwaites, 1996).



**Figure 14 a sustainability model**  
Source: MacMillan (1989)

Two concepts can be understood by Figure 8. Firstly firm should create competitive advantage and then sustain it. Secondly, firm can sustain competitive advantage through the lull zone in order to minimize the risk of missing it.

According to (Jay Barney, 2007), in order to sustain a competitive advantage it should have some characteristics. Jay Barney (1991) mentioned that competitive advantage must get valued by customer to be sustainable. It can get valued both directly or indirectly (e.g. products attributes like color and state-of-the-art of machines that produce various colored products). Also sustainable competitive advantage should be rare. It means that few products possess the attribute so it can be differentiated. Since, if several products have a specific attribute, ability to differentiate and confer competitive advantage will be inclined (Eshaghzadeh, 2013)(Page 29).



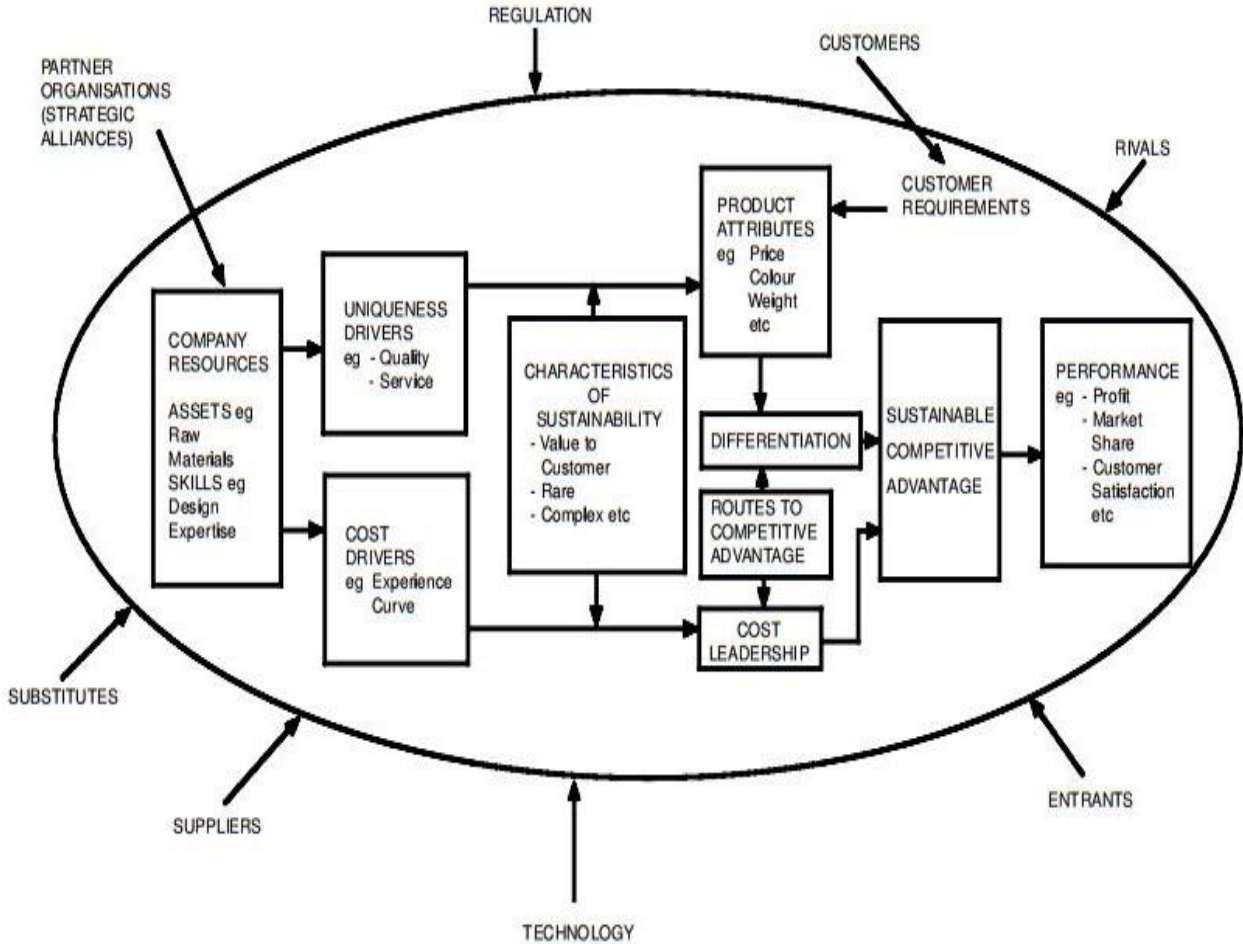
**Figure 15 Sustainable competitive advantage**

Source: Jay Barney (1991)

Based on (Jay Barney, 1991), sustainable competitive advantage should be imperfectly imitable (i.e. there is no possibility to copy exactly) (See Figure 9). Besides, it does not contain any strategically equivalent substitutes. Sustainable competitive advantage must be complex which based on (Bharadwaj, 1993) this complexity ‘usually arises of the interrelationship between different skills and assets’. This characteristic is sometimes referred to as ‘specificity’ since in the extreme a unique combination of skills and assets are needed to satisfy the needs of specific customers (Walley & Thwaites, 1996).

Taking into consideration the competitive advantage implications, it can be discerned that competitive advantage has a unique position which firms can gain toward their competitors through their competencies. In order to sustain competitive advantage, firms should do some treaties to minimize the risk of duplicating their strategy by their rivals (Jay Barney, 2007). Firms, specifically SMEs, can enhance their supply chain performance by gaining competitive advantage across technology advancement to share information (see Figure 10) such as E-business, ERP, and Web-enabled ERP systems which may streamline their business processes and enhance their capability to not only gain but also sustain competitive strategy.

According to Figure 10 (a holistic model for sustainable competitive advantage), it will be applied to integrate the different implications concerning the nature of sustainable competitive advantage. The model clarifies all of the possible aspects to create and sustain competitive advantage. This model is used by study to indicate that how technology can help SMEs to gain and sustain competitive advantage (Model 4).



**Figure 16 Model for sustainable competitive advantage**  
 Source: Walley and Thwaites (1996)

In order to gain and sustain competitive advantage, firms can try to enhance their supply chain performance. Financial aspect of supply chain performance, ROI, can be measured in order to show that how successful a firm was in its financial purposes (Phillips, 2006).

### 3.4 ROI

Return on investment (ROI) defines as the ultimate measure of accountability answering the question: is there a financial return for investing in a project or performance improvement solutions? The implication of comparing earnings to investment has been replicated in business to measure the success of different investment opportunities (Phillips, 2006). The rate of return on investment is a principal concept which is widely implemented for important businesses and financial purposes (Solomon, 1963).

In order to measure success of various investment opportunities, benefit-cost analysis can also be made. ROI and the benefit cost ratio enables business to measure their successes, though on (ROI) present earnings (net benefits) as compared to cost, while the other (benefit-cost ratio) estimates benefits to costs. In order to clarify concepts, the basic equations for the BCR and ROI have brought as follows (Phillips, 2006):

$$BCR = \frac{\text{Project Benefits}}{\text{Project Costs}}$$

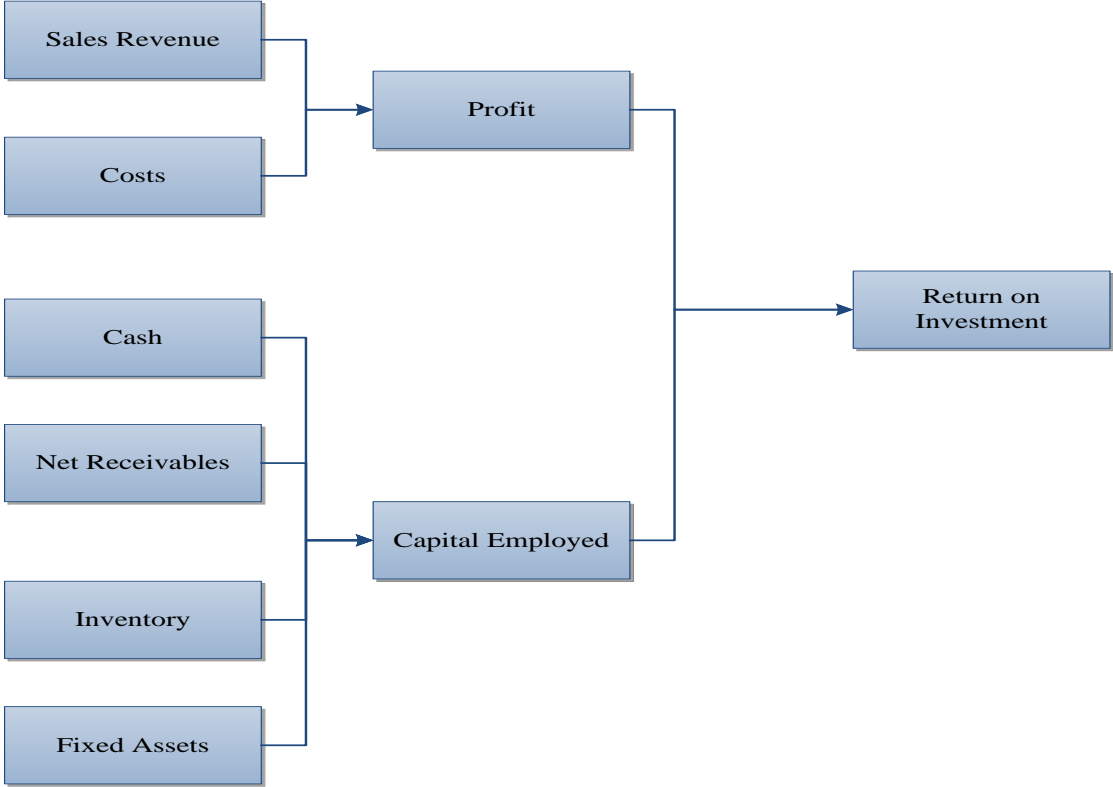
$$ROI (\%) = \frac{\text{Net Project Benefits}}{\text{Project Costs}} \times 100$$

For instance, a BCR of 2:1 means that for every 1 Euro invested, 2 Euros received. This example for ROI means that for every 1 Euro invested, 1 Euro get back after the costs are covered (i.e. receiving previous investment plus 1 Euro as return on investment). In several cases the ROI and BCR are conveyed together (Phillips, 2006).

Using the concept of ROI helps organization to streamline decision making through financial and resource assessment. ROI can be extended as ratio between the net profit and the capital that was employed to produce that profit, therefore (Christopher, 2012):

$$ROI = \frac{\text{Profit}}{\text{Sales}} \times \frac{\text{Sales}}{\text{Capital employed}}$$

So, ROI can be product of two rations: the  $\frac{\text{Profit}}{\text{Sales}}$  and  $\frac{\text{Sales}}{\text{Capital employed}}$ . Thus, in order to enhance ROI one or both of these two ratios should be improved. Several firms concentrate on the margin in their attempt to drive up ROI, yet it can be more significant to apply leverage if increased capital turnover to boost ROI. For example logistics impact on ROI is addressed by Figure 11 (Christopher, 2012). This figure illustrates the major factors identifying ROI and the potential for development through more effective logistic management to gain higher margin (Christopher, 2012).



**Figure 17 Impacts on ROI**  
 Source: (Christopher, 2012)

The main concept that can be gained by Figure 11 is that supply chain performance may increase by decreasing ROI. It means that fast and reliable deliveries and spending costs on providing these facilities incur ROI to decrease while supply chain performance will be increased.

Although several progresses results of ROI implementation in one business, important barriers inhibit the implementation of the implication. Taking into consideration that some barriers are realistic while others are myth based. For instance, cost and time will increase as ROI implemented. Since ROI may add additional cost and time to evaluation process of the



project. Fear of calculating ROI because of failure appeared to be other barrier for measuring ROI (Phillips, 2006).

ROI presents some obvious benefits while several distinct benefits can be derived from ROI implementation in a supply chain. These benefits are measure contribution, set priorities, and evaluation target (Phillips, 2006). The definition of each benefit and how it can be determined is mentioned as follows:

### **Measure Contribution**

Measure contribution is the most accurate and reliable widely applied process to indicate the influence of training. The ROI will identify if the project lead to monetary value. It specifies the contribution and investment made in a project (Phillips, 2006).

### **Set Priorities**

In order to find which program has the most contribution to the organization, ROI is measured. Successful programs replicated to other areas and inefficient programs may be stopped (Phillips, 2006).

### **Evaluation Targets**

Several firms strive to manage the processes by setting targets for each level. Each target evaluated based on human resource development programs. Establishing evaluation target has two important advantages: the process provides objectives for human resource development staff to calculate accountability improvement, focusing more attention on particular process (Phillips, 2006).

In order to measure financial performance of firms, five items can be taken into consideration: return on investment (ROI) and assets, return on sales (ROS), market share, and cost structure (K & Jayaram, 2003; S. Li & Lin, 2006). It means that firms evaluate their performance based on these ratios. By measuring supply chain performance firms can find whether they are on the way to achieve their objectives effectively (i.e. competitive advantage) or signal looming financial trouble (F. T. Chan, 2003).

One of the performance measure employed in this study is business unit performance based on return on sales (ROS). Return on sales (ROS) is used as a measure firm profitability and business unit performance. ROS is computed as follows (Palepu, 1985):

$$ROS (\%) = \frac{\text{Net Income (before interest and tax)}}{\text{Sales}} \times 100$$

Palepu (1985) mentioned that ROS is the net profit after taxes (excluding extraordinary items) as a percentage of net sales. So, it can be discerned that taking business unit performance as a construct to measure profitability both ROS and ROI can applied. Therefore, ROS is used by this study.

The significance of measuring supply chain performance in the supply chain is focused by several scholars (Forslund, 2010). Many studies have revealed obstacles of supply chain performance as supply chain partners entail various objectives, lack of standardized performance metrics, and problem with trust (Busi & Bititci, 2006; Forslund, 2010). One of the critical tools that may enhance supply chain performance is ERP system although it can be an obstacle the same time (S. Fawcett & Magnan, 2008; Forslund, 2010).

### **3.5 ERP**

ERP systems have gotten great attention in the recent years because of its bona fide capability to streamline business processes, decision-making and enhance efficiency of its adopters (Aloini, 2007). They also can help firms to decrease their operation costs and enhancing customer satisfaction (Eldin, 2012).

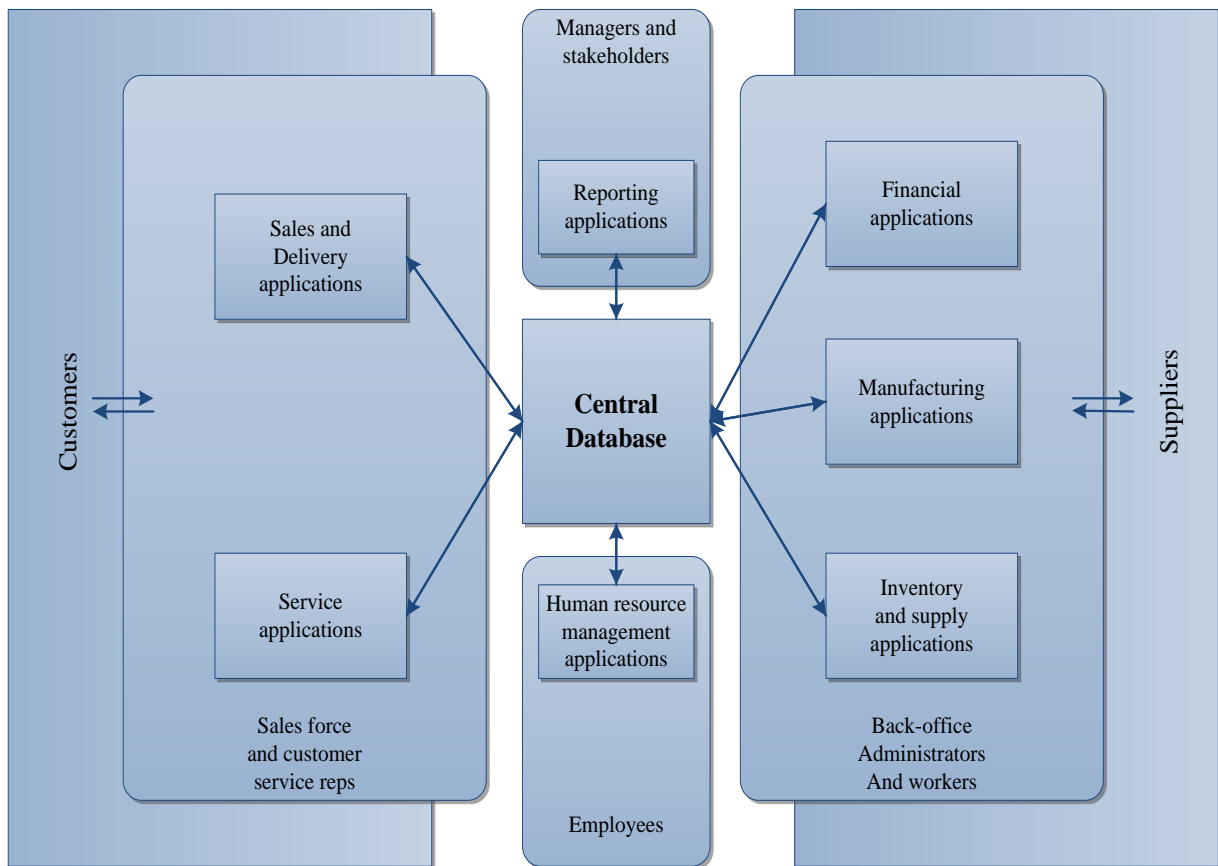
Information systems should be able to support standardized information flow (Welker, 2008). Internal information sharing through supply chain integration mainly pertains to information on the availability of inventory items and to be supported by ERP systems or workflow management systems (Kelle & Akbulut, 2005; Shtub, 1999).

Harwood (2003) defined ERP system as an integrated information system serving all areas of the business. It manages transaction, sustains records, and provides real time information and streamline planning and control. However, its effectiveness is a resulted by success of the implementation lifecycle. An ERP system is a modularized suite of business software applications that are seamlessly integrated to provide automated interactions and common source of data for an enterprise (APICS, 2007).

The ERP objects to integrate business processes and ICT into a synchronized suite of procedures and metrics excelled organizational boundaries (Wier, 2007). Kumar and van Hillegersberg (2000) claim that ERP developed form manufacturing industry is the first generation of ERP systems. Development of these first generation was an inside-out process arranged from standard inventory control to material requirement planning (MRP), material resource planning (MRP I), manufacturing resource planning (MRP II), and then develop to a ERP.

ERP applies database technology to coordinate and integrate information linked to firm's business comprising data linked to business partners. Preferably, all business transactions such as inventory management, customer order management, production planning and distribution are received, recorded, processed, checked, and monitored (Helo, 2008). ERP systems integrate traditional business processes such as production, purchasing, sales, and inventory management through using a central database including information about materials, orders, products, capacities and customers (Kelle & Akbulut, 2005; Shtub, 1999).

ERP system integrate all information and processes of an enterprises into united system concerning how business partners access, gather, store, collect, summarize, interpret, and use information. An ERP system integrates various components of computer software and hardware to provide information sharing throughout the enterprise (Chofreh, 2014).



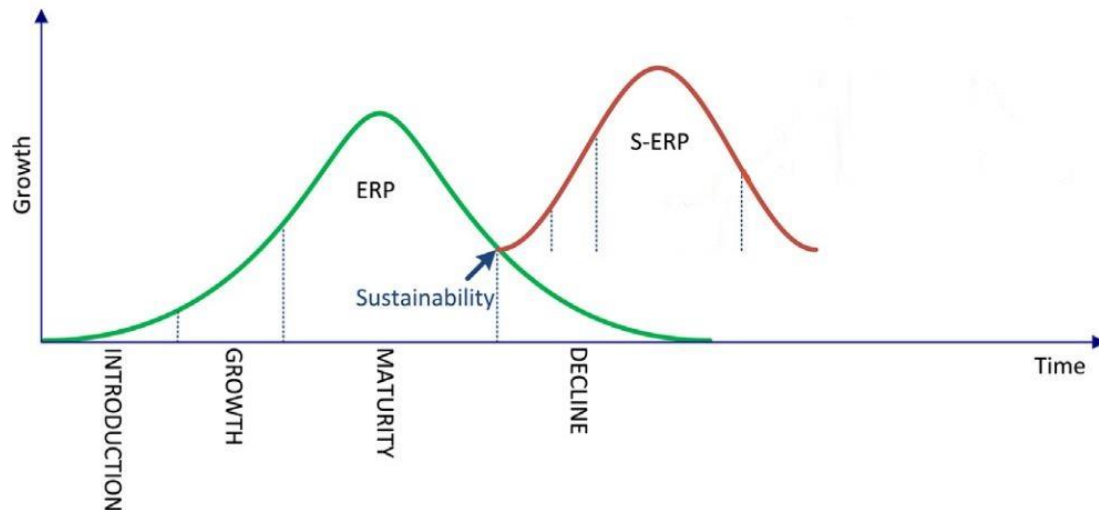
**Figure 18 Anatomy of ERP**  
 Source: Davenport (1998)

Figure 12 indicates anatomy of ERP system and clarifies the concept of integration and information sharing with supply chain members. Supply chain members which are contributed to process within the firm can access the information to coordinate availability of ordered items. ERP system are designed to provide information required for taking decisions and therefore such decisions are supported by replicating ERP systems (Welker, 2008).

A significant element of most ERP systems is applying a seamless database to collect data for the various system modules. Therefore to solve the problem of lack integration between sustainable businesses functions the scholars and practitioners acquire to employ sustainable-ERP system as new class of integrated information system (Chofreh, 2014).

In order to achieve sustainability in a firm, it needs a holistic, integrative and thorough view spanning both products and manufacturing processes involved in its fabrication and the whole supply chain through multiple product life cycles. This requires developed models for sustainability performance estimation and optimization for sustainability performance

evaluation and optimization technologies at the process, product, and system levels (Jayal, 2010). According to Figure 13, ERP life cycle can be extended through Sustainable-ERP. It means that Sustainability of ERP implementation assist firms to postpone the decline phase of their ERP systems.



**Figure 19 Life cycle of ERP and Sustainable-ERP**

Source: (Chofreh, 2014)

A basic principle of ERP is that it should be standardized system (Melin 2003). Light (2005) argues that ERP systems are best successfully implemented when the standard model is used. According to (Somer and Nelson, 2004) three significant business drivers for using ERP is to enhance productivity, provide competitive advantage, and meet customers' needs. The objective of ERP is to support business processes development (Wier et al., 2007). This means that customization of ERP results in generating and adopting an ERP fitting the final-user firm's specific business processes. Thus, competitive advantage can be obtained and sustained (Johansson and Newman, 2010).

As it is mentioned by this study, the underlying concepts are briefly addressed in order to start analyzing. The focus of this chapter is deemed on introduction and problem statement. To address what is going to be carried out by this study, a model is developed to structure this study. In next section an overview of dissertation is delivered to define each chapter of this study.

### **3.6 Information shared in Supply chain:**

Manufacturing units play a crucial role to improve economic development (Lotfi & Mukhtar, 2013). In order to survive in today's global economy, designing approaches to cooperation is required by manufacturers and therefore should provide solutions to share up-to-date information within the enterprises. Specifically, though, as in any global corporation, SMEs require proper and up-to-date knowledge in order to compete, they tend to be more delicate to problems of high staff turnover and knowledge retention. Therefore, this information must be rightly managed, distributed and engaged in the enterprise (Nunes, 2006).

The main implication of the information sharing is to distribute useful information for systems and organization units. Enterprises which respond to these four questions:

- What to share?
- Whom to share with?
- How to share?
- When to share?

The quality of answers provided for these question will assist to avoid redundancy, minimize sharing costs and being more responsive(Sun & Yen, 2005).

According to (Ding, 2011), closer linkages based on information sharing have gotten a considerable place in effectively managing supply chains to enhance performance through effective use of resources and capabilities. This information sharing causes customer satisfaction and sustaining competency. Ding (2011) emphasizes on importance of information sharing in supply chain integration to sustain competencies and seize time based opportunity. Typical information shared through the supply chains are:

- Inventory levels
- Production plans
- Demand forecasts
- Supply capacity

Considering existence of various information in a supply chain, including logistics information, strategic information, tactical information and so on. Information resources' time validation results in high need for effective sharing of all required information resources to meet unlimited needs in the supply chain. On the other hand, because of information resources' value and producing costs, some of the information could be shared among partners. Finding the equilibrium point in this trend is to share information in a supply chain. Some of the familiar types of information may be categorized as follows (Ding, 2011):

### **Inventory Information**

Inventory information is a kind of information which supply chain partners would like to share the most. Taking into consideration that emphasis of inventory information is to avoid safe stock repetition and being stock out. On the other hand, inventory information decrease the total stock level and stock cost, forecast better and provide decent decision on production and stock plan. *Continuous Replenishment Programs* (CRP) and *Vendor-Managed Inventory* (VMI) are counted as important information in this mean (Ding, 2011).

### **Sales Data**

Sharing sales data could minimize or eliminate the cumulated order blow up, replicate customer need authentically, and decrease the loss resulted of excess or lack of innovative products. In order to gain advantage of replicating better product plan and exploit new products, sharing data POS (Point of Sale) and analyzing of sales trend based on demand and historical data should be taken into account (Ding, 2011).

### **Sales Forecasting**

Each enterprise (SMEs or large enterprises) would make a forecast in order to find the direction of planning and quantity of demand in face of competitive market. Supply chain business partners make forecast based on their plan individually, which can be one the major driver of making a bullwhip effect. Sharing sale forecasting information can provide supply chain partners to join up to forecast together and therefore competition ability of whole supply chain is developed. For example, *Collaborative Planning, Forecasting and Replenishment* (CPFR) put forward by Wal-Mart as a strategy to share sales forecasting (Ding, 2011).

## **Order Information**

The focus of the order information is to eliminate bottleneck in a supply chain and obtaining advantage by sharing it. So, when order information is shared, the quality of customer services is enhanced and payment cycle is decreased which leads to minimize the labor cost of handicraft operation (Ding, 2011).

## **Product Ability Information**

Product ability information includes supplying ability of suppliers, productivity of manufacturers, and transportation ability of distributors selling ability of retailers etc. Product ability information could help reduce latent shortage gaming behavior and further repel the latent cause of bullwhip effect (Ding, 2011).

## **Exploitation Information of New Products**

Sharing information of new products, manufacturers could gain real demands from retailers, and then receive timely supply of goods from suppliers. Exploitation information of new products is connected to all members of supply chain which eliminates risks to some extent (Ding, 2011).

According to (Min et al., 2005) empirical study, information sharing is the heart of supply chain collaboration. Shared information is a crucial ingredient of day-to-day operations as well as more strategic collaborative activities. Information covering an extensive range of activities is united among several partners. Shared information provides a common base for partners and aimed the flows of products, services, funds, and feedback between the partners. Information sharing is frequent and replications become a matter of routine that includes multiple levels across the organizations (Min et al., 2005). So, more attention should be given to information sharing.

Based on (Koçoğlu, 2011), supply chain integration plays an important role in information sharing process as it strengthens connectedness, coordination and collaboration among supply chain partners. Furthermore, organization can enhance their supply chain performance based on information sharing.



Several scholars propose that closer information-based linkages become a dominant way of effectively managing supply chains probing developed performance through effective use of resources and capabilities (Ding, 2011). Mostly, supply chain partners seek to enhance the overall efficiency by providing an appropriate way of information sharing. Benefits of information sharing lies in suppliers' capability to react to the customers' needs considering inventory levels to minimize uncertainties in the demand process faced by the manufacturer, and in turn decrease the supply chain operating costs. This would count as a driver to share its gained profit with its customers (Ding, 2011).

Based on (Ding, 2011), several scholars believe that information sharing is a key driver of productive supply chain by accelerating the information flow, minimizing the response time to customer needs, providing collaboration and coordination and sharing the risks as well as the benefits. Hence, information sharing provides the firm competitive advantage in the long run (Jingquan Li & Sikora, 2006). Taking into consideration that the software and hardware are not counted sufficient. Enterprises should have the inclination to take part in information sharing activities (Rosen et. al., 2007). Currently enterprises do not operate individually; they have now been integrated as a network to many other partners (Mourtzis, 2011).

Moreover, information sharing influences the supply chain performance in term of both total cost and customer service level (Y. Zhao, 2008). Y. Zhao (2008) indicates that partner relationship plays a critical role in implementing SCM practice and developing SCM performance. Based on (Lin, 2002), the higher level of information sharing is linked with the lower total cost, precisely the higher order fulfillment rate, the shorter order cycle time.

Manufacturing paradigms has gotten a considerable role in obliging supply chain to perform agile (Cousins & Menguc, 2006). Building up a deeper relationship to propel firms to be adapted and aligned with cooperative needs results in mutually beneficial supply chain partnership in the value network (Flynn, 2010). To enhance firm performance, firms concentrate on coordinating internal processes and activities with their boundaries (Jayaram & Tan, 2010; Jayaram, Tan, & Nachiappan, 2010). Therefore, information sharing through integrated relationships among business partners to deliver highest value to customer count as driver of competitive advantage (Wolf, 2011).

According to (Yeung, 2009), today's manufacturers are becoming progressively reliant on their suppliers to gain competitive advantages. In order to validate integrative supply chain strategies, information sharing combine core elements form heterogeneous data management systems, data warehouses, and other enterprise applications into common platform (Jhingran, 2002). This brings about that information sharing to be counted both a managerial and technology issues in a supply chain. Yeung (2009) mentioned when information sharing is coordinated, it will improve a capability to link those diverse systems effectively.

Activities for sharing information externally focuses on supporting data sharing and communication between supply chain members through a large variety of customized products. Information sharing is targeted to provide communication regarding product information; price and lead time through electronic data interchange (EDI) systems. EDI systems are deployed to transfer purchasing orders and invoices. Internet recently has enhanced the information sharing between supply chain partners (Welker, 2008).

Benefits can be gained by both upstream suppliers and downstream customers. By achievement of both internal and external linkages aligned to approach global system objectives (Yu, Ting, & Chen, 2010), companies shift from arm's length to an integrated continuum of possible relationships (Barlow & Li, 2005) , therefore creating an integrated coordinated supply chain is a potential source of gaining competitive advantage (Barratt & Barratt, 2011).

Lack of coordination occurs when decision makers have incomplete information or incentives that are not compatible with system-wide objectives. Benefits of information sharing in supply chain networks captivate some researchers and practitioners in distinct disciplines (e.g., (Huang, 2003; Kanda & Deshmukh, 2008; Sahin & Robinson, 2002). Information sharing has a critical role in decreasing supply chain costs (Barratt & Barratt, 2011). According to (Barratt & Barratt, 2011), in most cases core partners of supply chain take an initiative to promote the overall efficiency by probing an appropriate approach of information sharing. It can be discerned that the benefits of information sharing lie in suppliers' capabilities in responding to customers' need by acquiring the knowledge of customers' inventory level to decrease uncertainties in the demand process met by manufacturer which in turn decreases the supply chain operating costs. By reducing the supply chain costs,

manufacturer would encourage to share its gained profit with its customers to enhance customer satisfaction (Barratt & Barratt, 2011).

According to (Ding, 2011), benefits which can be obtained by information sharing in supply chains include inclination in cost of inventory, improvement in ordering processes and partners' relationship. Integration demand information sharing by a retailer to upstream supplier is the basis of initiatives such as timely response to customers need, and information sharing is often embedded in program like Vendor Managed Inventory (VMI) or regular replenishment. For example, manufacturer can minimize the problems in the demand process by improving accuracy of forecast of future orders placed by customers (H. L. Lee & Whang, 2000). According to Table 3, benefits of information sharing through a supply chain is brought.

**Table 3 Benefits of information sharing**

Authors	Benefits of Information Sharing
(Ding, 2011) (H. L. Lee & Whang, 2000) (X. Zhao & Xie, 2002) (Mourtzis, 2011)	Reduction of costs
(Barratt & Barratt, 2011)	Improving partner relationship
(H. L. Lee, So, & Tang, 2000)	Increasing material flow
(Zhou & Benton Jr, 2007)	Enabling faster delivery
(S. Li & Lin, 2006) (Spekman, 1998)	Improving order fulfillment and customer satisfaction
(Sahin & Powell, 2005) (La Londe, 2004)	Enhancing channel coordination
(Chandra, 2007)	Facilitating the achievement of competitive advantage
(H. L. Lee & Padmanabhan, 2004)	Minimizing the time for introducing to market
(J.-H. Cheng, 2011) (S. Li & Lin, 2006) (Jingquan Li & Sikora, 2006) (Madlberger, 2010)	Effectiveness of supply chain

Based on (X. Zhao & Huo, 2011), external integration with customers and suppliers is vis-a-vis influenced by internal integration and relationship commitment to customers and suppliers. Companies should develop internal integration capabilities through system-integration, data-integration, and process-integration before gaining an eloquent external integration.

According to (S. E. Fawcett & Osterhaus, 2007), to achieve high level of integration with customers and suppliers in the value chain, firms should have capabilities to integrate with external partners. Therefore, before an external integration implemented completely, companies should have a willingness to integrate with external supply chain partners based on their relationship commitment. So, Information sharing can be replicated for internal and external integration among supply chains.

### **3.7 Supply chain Integration**

With expanding economic globalization, modern enterprises are facing increasingly fierce and complicated market environment, and the stochastic and personalization of customer need are also enhancing (Yanhuia & Xiana, 2012). The global economy has modified markets rules between firms involved in any specific supply chain. So, it is essential to develop new collaborative and cooperative relationships throughout the supply chain to enhance the degree of integration (de la Fuente, 2008). The Current competitive market does not adapt with traditional supply chain management, so that some problems arose in enterprises (e.g. bullwhip effect). In order to solve these problems, the underlying solution is to implement integrated supply chain management (Yanhuia & Xiana, 2012).

Supply chain integration has brought about changes in manufacturing, supply strategies, and enhanced global competition levels (G. L. Ragatz, Handfield, Robert B, Petersen, Kenneth J, 2002). It has been discerned by companies that to gain competitive position in a global market, they should offer high quality products and cheaper prices than their competitors. According to (Stump & Gerard A, 2002), companies not only should enhance productions

techniques, but also to concentrate on the integration of supply chain activities (i.e., supply activity with customers demand).

Improvement in supply chain integration leads to high quality delivery at low cost to maximize return which backs its concept (i.e. linking suppliers, manufacturers, and customers) (Calantone, 2002). Supply chain integration brings about linking suppliers into the organizations value chain if they are to deliver superior value to the consumer (G. L. Ragatz, Handfield, Robert B,Petersen, Kenneth J, 2002). Moreover G. L. Ragatz, Handfield, Robert B,Petersen, Kenneth J (2002) argues supplier integration results in critical enhancement in terms of cost reduction, delivery quality, and shorter cycle time.

(Yanhuia & Xiana, 2012) point out that supply chain information integration is essential to adapt to the change of competitive environment. The main implication behind supply chain integration is to link up all the existing resources and therefore to enhance the operation efficiency of the supply chain.

Taking into consideration that integration has an antecedent in the business process literature (Frohlich & Westbrook, 2001). Frohlich and Westbrook (2001) argues that greater coordination between the manufacturing processes of the firm and the supply chain provides customers with a seamless interaction. Successful manufacturers seem to be those who have wisely linked their internal processes to external suppliers and customers in unique supply chain. So, upstream and downstream integration of supply chain with customers and suppliers has gotten a significant role in manufacturing strategy (Frohlich & Westbrook, 2001).

Reinforcing this approach, G. L. Ragatz and Handfield (1997) pointed that the “effective integration of suppliers into product supply chains will be a key element for some manufacturers in gaining the improvements required to sustain competitiveness”. Based on (de la Fuente, 2008) conceptual analytical study, the main aim of integration supply chain is to solve the following underlying problems:

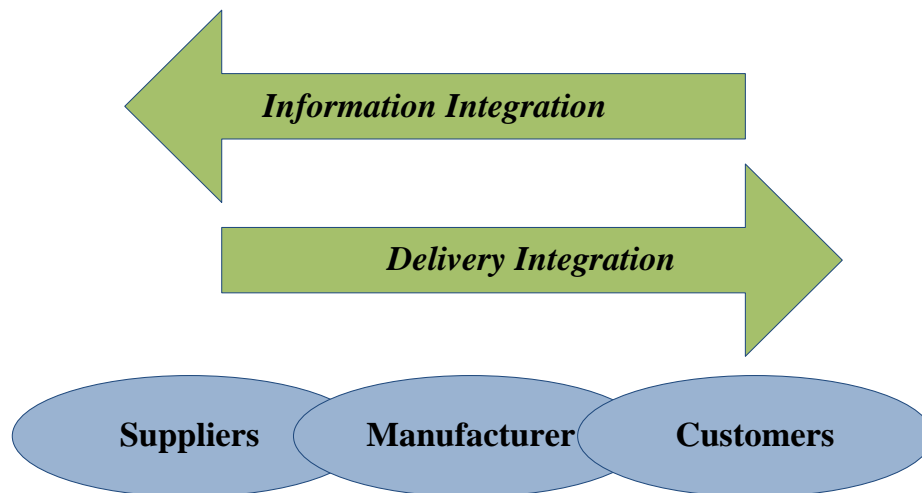
- Integrating processes and decisions between business partners
- Lack of information sharing and information sharing to link supply chain members

The goal of closely integrating manufacturers with suppliers and customers is to create and coordinate manufacturing processes seamlessly across the supply chain in a way that most competitors cannot very simply match (Anderson & Katz, 1998). Based on (Birou, 1998), the possibility to use process integration across functional boundaries is recently considered as key element to competitive success.

Frohlich and Westbrook (2001) pointed out that there supply chain at the tactical level, the literature suggests that there two interrelated forms of integration that manufacturers frequently replicate. The first type of integration includes coordinating and integrating the forward physical flow of deliveries between business partners and manufacturers (e.g. just-in-time). Van Hoek (1998) argue that delivery integration through postponement of products and mass customization is so significant.

The other type of integration comprises backward coordination of information technologies and flow of information from customers to suppliers (Trent & Monczka, 1998). Information technologies permit multiple organizations to manage their activities in an effort to coordinate a supply chain (Handfield & Nichols, 1999).

Integrating supply chain using Information technologies includes electronic data interchange (EDI) system to share data from planning and control systems (e.g. ERP system) (Jayaram & Vickery, 1998; Van Hoek, 1998). According to (Jayaram & Vickery, 1998), integration of paperless documents into business systems with no manual intervention by use of information technology that provides all functional areas to transmit and to access information from one point to another is significant predictor of delivery and time.



**Figure 20 Integration in supply chain**  
 Source: Frohlich and Westbrook (2001)

According to figure 20, integration in supply chain is indicated. The main implication of this figure is to show the coordination of the business partners with manufacturers based on information and delivery integration. In order to replicate the concept of this figure, forward and backward integration are defined and their implications are addressed.

### **Forward integration**

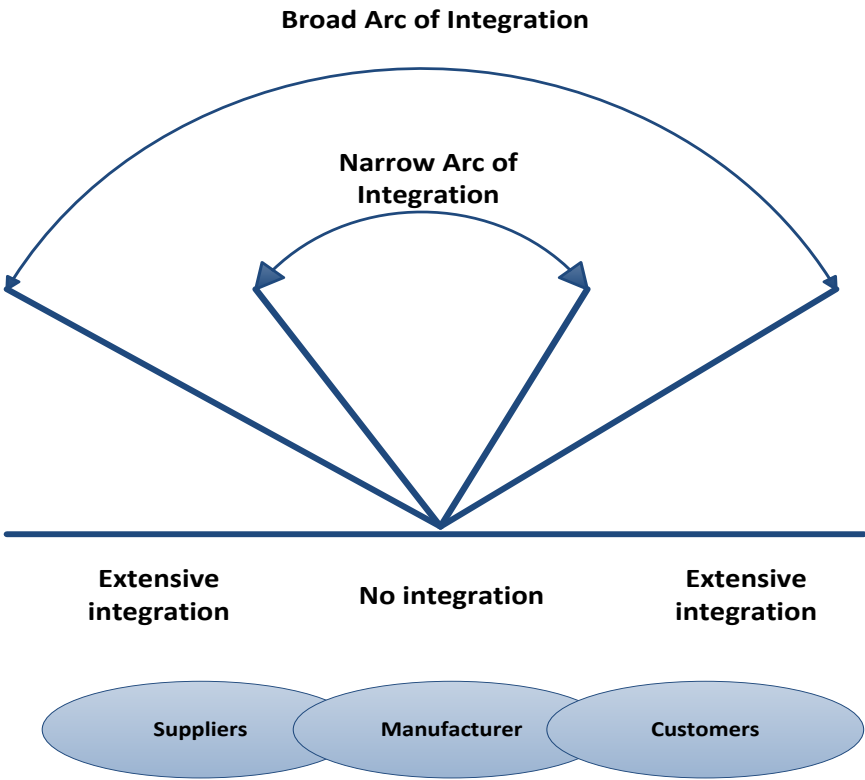
Forward integration as an approach in supply chain integration coordinates supply chain from the supplier to the manufacturer to the customer (Trent & Monczka, 1998). Teece (2010) points out that more forward integration becomes an attractive option for educating customers about product benefits and accomplishing the right level of sales effort. A modern example of logic of forward integration is Apple's decision to open its own retail stores. These stores admit Apple to manage the level of knowledge and service provided by sales staff at retail (Teece, 2010).

### **Backward integration**

Backward integration related to the management prospect (e.g., just-in-time) (Choi and Hong, 2002) and manufacturing strategy (e.g., customization) (Berman, 2002). This approach is implemented in order to improve efficiency and cost saving (Teece, 2010).

According to (O’Leary-Kelly & Flores, 2002), integration itself is the extent to which fragmented parties work together in a cooperative manner to achieve reciprocally acceptable outcomes. Streamlining and interconnecting both within and outside firm boundaries through supply chain integration refer to managing business processes (Romano, 2003).

This scope of integration within and across organizational boundaries has been practiced through arc of integration by (Frohlich & Westbrook, 2001). The concept proposes that the narrower the arc, easier to archive integration (i.e. within internal functions).



**Figure 21 Arc of integration**  
 Source: (Frohlich & Westbrook, 2001)

Figure 21 indicates that all manufacturers simply make strategic decisions concerning the extent of upstream and downstream integration which they intend to undertake. So, some manufacturers gauge a little integration with suppliers and customers, therefore, there is relatively narrow arc of integration while others can pursue a strategy with a broad arc of integration. Frohlich and Westbrook (2001) point out enhancing level of integration with suppliers and customers promote potential benefits of supply chain that finally leads to performance improvement.

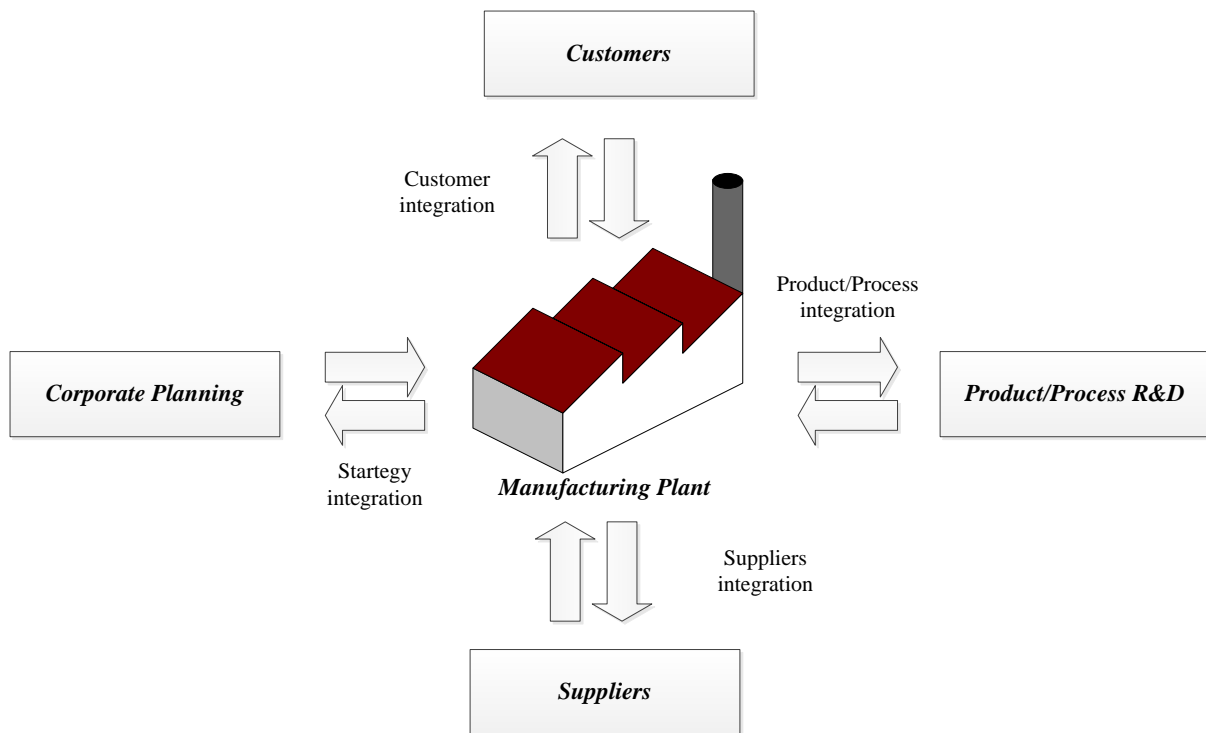


According to (Michael E Porter & Millar, 1985), the value chain framework provides a useful theoretical foundation for integration concept. Michael E Porter and Millar (1985) pointed out linkages among value-adding activities encompasses two primary dimensions. Firstly, Porter mentions making vertical linkages across supply chain activities comprising those executed by business partners (Swink, 2007).

A second dimension of the integration includes horizontal linkages within a company (i.e. linkages of direct value chain activities) (e.g., production) with supporting activities such as new product development. According to the framework (see Figure 22), four types of strategic integration are determined through vertical and horizontal dimensions:

- Supplier integration
- Customer integration
- Product-process technology integration
- Corporate strategy integration

Figure 22 shows that how strategic integration activities generate information and knowledge flows related to manufacturing plant. According to the framework, a manufacturing plant's operations can be affected by the acquisition of technical knowledge and planning information from external sources (i.e. suppliers and customers) and corporate strategy managers.



**Figure 22 Four types of strategic integration in the value chain**  
 Source: Swink (2007)

Michael E Porter and Millar (1985) mentioned that stronger linkages and higher degree of integration across these functional and organizational boundaries result in better performance for the focal organization. SCI as the combination of efforts to integrate supplier and customer information (i.e. vertical integration) reflects external integration expressed firm's cross-business relationships upstream with suppliers and downstream with customers. It also involves internal practices (i.e. cross functional teams) applied to share and thus internalized these external inputs within the organization (Swink, 2007).

Swink (2007) pointed out strategic integration activities in each four mentioned areas. They focus on sharing strategic information and knowledge with four sources (i.e. customers, suppliers, product/process technology developers, and corporate strategy decision makers) to the plant. Taking into consideration of strategic fit (i.e. consistency between manufacturing strategy and business strategy and competitive environment respectively (Wheel Wright, 1984)), strategic integration plays critical role in development of organizational capabilities resulting in competitive advantage (Powell, 1992).

Strategic integration assists firms to match resource replication with strategic demands, therefore gaining a fit between manufacturing competitive capabilities and the environment. Strategic integration in each of mentioned area as follows (Swink, 2007):

### ***Strategic customer integration***

It is the process of obtaining and integrating customer requirements information and related knowledge. Strategic customer integration is performed in manufacturing plants to acquire and incorporate a better understanding of customers' preference and to make relationships with customers. Commonly, activities are linked building greater strategic customer integration comprising regular contact with customers, communication of satisfaction questionnaire, and both formal and informal direct employee-customer interactions(Swink, 2007).

### ***Strategic supplier integration***

It is the process of obtaining and sharing operational, technical and financial information and related knowledge with suppliers and contrariwise. Strategic supplier integration is performed in manufacturing plant to satisfy product and production requirements through improving and more effectively exploiting both the supplier's and plant's capacities and cost structures (Swink, 2007). Swink (2007) identifies common associated activities with suppliers as co-development, partnerships, joint planning meeting, and shared information system.

### ***Product-process technology integration***

This integration is the process of co-developing products and processes and sharing information and related knowledge. Product-process technology integration is tracked in manufacturing plants so that manufacturing processes may integrate a robust understanding of product requirements and thus product designer can have better understanding of manufacturing process capabilities (Swink, 2007). Swink (2007) identifies common associated activities with product-process as approvals for designs and publishing guidelines for designing.

### ***Corporate strategy integration***

This integration is the process of gaining sharing goals, plans, and related knowledge associating to business and manufacturing strategies. Corporate strategy integration is needed to enhance the alignment between business level and plant level decisions (e.g. performance objective settings) (Swink, 2007). Swink (2007) identifies common associated activities with corporate strategy integration involve formal and informal communications among various levels of the organization hierarchy and pure documented plans.

Although, more firms are getting aware of supply chain integration, they are failing in their efforts at internal and external integration. It can largely relate to trends of outsourcing, important of product value and how added functions are committed effective information integration (Jayaram & Tan, 2010). Therefore, as it is mentioned, the research objective is to understand how effective supply chain integration through information sharing can affect supply chain performance.

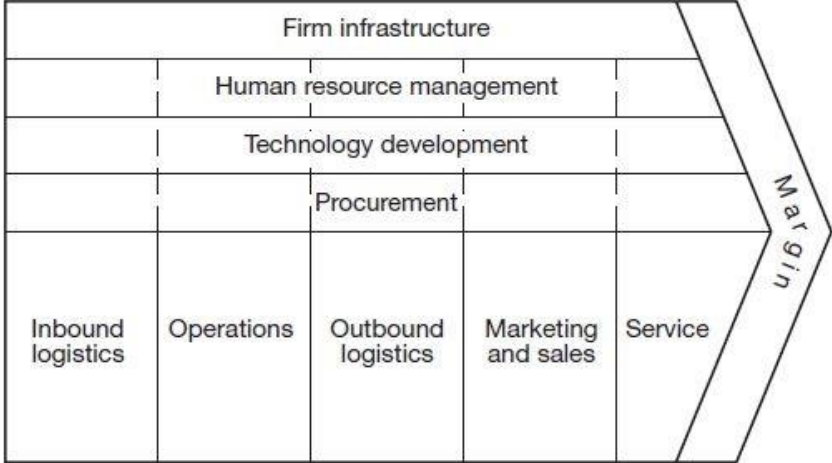
### **3.8 Supply chain integration and information sharing**

The sharing information through the supply chain can permit firms to move from a product, functional, or departmental organization to an organization oriented toward processes (such as product development processes and supply chain management processes) (Van Hoek, 1998).

Supply chain integration (SCI) has a significant role in modifying manufacturing and supply strategies and enhancing globalization (Cousins & Menguc, 2006). Increased levels of global competition urges firms to offer higher quality products with cheaper prices than their competitors. According to (Frohlich & Westbrook, 2001), it means that companies are required not only to enhance production techniques but to concentrate on the integration of supply activity with what customer need.

The improvements would lead to the delivery of high quality products on appropriate time at low cost to improve return on sales (Cousins & Menguc, 2006). In order find the foundation

of the SCI, Porter’s value chain model (see Figure 23) (Michael E Porter & Millar, 1985) is emphasized on creating the value linkages among the member of the chain (S. Li & Lin, 2006).



**Figure 23 The value chain**  
 Source: (Porter, 1985)

According to the value chain model (Figure 23), going through the chain of organizations activities will add more value to the product. So, firms will obtain marginal value marginal value for products and services. The more effective firms gain marginal value, the more competitive advantage they gain (Michael E Porter & Millar, 1985). Enhancing information sharing value across organizations can greatly minimize the uncertainty related to the distortion of information and product variety (Jingquan Li & Sikora, 2006).

The popularity of SCI is arisen from linking supply chain members and aligning business partners’ goals to achieve a seamless system of values is essential for companies to deliver superior value to customers (Yu et al., 2010). It is so critical to provide effective linkage among supply chain activities including internal functions of an organization and external operations of business partners and other supply chain member (Kim, 2009). Since correct supply chain relationship streamlines the coordination of information flows from forward integration (i.e. supplier to manufacture and customer) as well as backward integration (i.e. customer to manufacturer and customer) (Cousins & Menguc, 2006).

Creating correct supply chain relationships based on strategic collaboration with supply chain members as result of SCI (Yeung, 2009); leverage the flow of well-timed, correct and quality information (Jingquan Li & Sikora, 2006). Taking into consideration that SCI encompasses the complementarities between integration and information sharing, it provides an effective and flow of information. There are a few studies concentrates on leveraging power of SCI on information as compelled to enhance Supply Chain Performance (SCI) (Koçoğlu, 2011).

Most implications of supply chain integration simply distinguish the existence of two flows across the chain; flow of goods and flow of information (Fisher, 1997; Pagell, 2004). Supply chain integration should include both information and material and specified by enhanced logistics-related communication and greater coordination of companies logistics activities with business partners (Stock, 2000). In order to enhance the overall efficiency of the supply chain, coordination, collaboration and cooperation among supply chain partners used interchangeably (Singh & Power, 2009).

Information integration refers to the sharing of underlying information through the supply chain network provided by information technology (IT). One of the fundamental objectives information integration is to gain real-time transmission and processing information needed for supply chain decision making (Prajogo & Olhager, 2012). Therefore, both information technology and information sharing can be accounted as antecedents to martial flow integration.

Information and communication technologies play a critical role in supply chain management including (Prajogo & Olhager, 2012):

- Admit firms to enhance the complexity and the volume of information required to be communicated with their business partners
- Allow firms provide precise information regarding inventory level, delivery status, forecasting, and production planning
- Streamline the alignment of forecasting and scheduling of operations among business partners
- Providing better internal coordination in firms

The implementation of IT in supply chain has attained considerable attention with different technologies has been introduced for business-to-business (B2B) communication (Prajogo & Olhager, 2012). Soliman and Youssef (2001) mentioned that effective IT led to enhance supply chain integration among business partners in terms of material flows. Several firms have changed their IT strategy from developing information systems in-house to buy ERP systems (Hong & Kim, 2002).

ERP is one of the most widely accepted approaches for gaining competitive advantage for firms (Z. Zhang, Lee, & Huang, 2005). ERP systems are designed to provide seamless integration of processes through functional sections with enhanced workflow, standardization of different business practices and accessing to real time data (Mabert, Soni, & Venkataraman, 2003). The major benefits of ERP systems are to provide organized structured through information sharing (Jacobs & Bendoly, 2003). Therefore it can be understood that technologies (e.g. ERP systems) are drivers of information sharing to gain competitive advantage.

In order to gain competitive advantage, it could be a wise approach to measure supply chain performance whether to find how well a firm is effective. So, in the next section, supply chain performance and its contribution to supply chain integration and information sharing are addressed.

### **3.9 Supply chain performance**

Several empirical studies have focused on seeking SC linkages on operational and business performance. These studies include a variety of SC definitions, performance measures and methodologies. For example, supplier involvement in product design has a positive influence on product quality using a case study design (Carter & Ellram, 1994).

According to (Narasimhan & Jayaram, 1998) structural equation modelling, relationship between sourcing decisions, manufacturing objectives, customer responsiveness and manufacturing performance are examined. They found that integrating SC activities

encompasses aligning sourcing decisions to gain manufacturing objectives in terms of cost, time, flexibility, and quality.

According to (De Toni & Tonchia, 2001), There are four different performance dimensions and type of indicators. It can be divided into two groups: cost and non-cost dimensions. These performance dimensions are as follows:

### **1- Costs/productivity**

Cost as a first dimension of supply chain performance comprises performance of the economic-financial type or directly linked with them. The cost performance indicators have traditional measures, such as (De Toni & Tonchia, 2001):

- Productivity;
- Managing of the working capital;
- Cheapness of the productions costs (i.e. materials, labor, and machinery).

In more facets, material costs, inventory costs and direct labor productivity are included as cost performance. Productivity as performance indicator recognized from the capital and production in a technical sense. Labor and machine productivity are measured by physical size (i.e. work in progress (WIP) and inventory), while the monetary scale explains capital productivity (De Toni & Tonchia, 2001).

### **2- Time**

Time as a performance dimension involves two specific type: internal and external. Internal times are those company controls while the customer does not see directly. External times are those related to the customer (e.g. delivery time and frequency of introducing new products) (De Toni & Tonchia, 2001). De Toni and Tonchia (2001) point out that based on their investigation external times are discerned not only as speed of delivery, reliability and times to improve new products (time-to-market), but also as structural logistics times of supplying, distribution and production.



External times focus on responding to the market (i.e. Make-to-stock, Make-to-order, Assemble-to-order, and Engineer-to-order) and finally identify the average delivery time to the customer (De Toni & Tonchia, 2001). The intensity of measuring the external times particularly covers order carrying-out times, and the supplying and manufacturing lead times (De Toni & Tonchia, 2001).

Internal times measuring process time, run times and machine set-up times in virtue of the possible comparison with standard times. As it is mentioned, internal costs may not be distinguished outside the company by the customers or may not directly affect the external times performance in order to respond to the market (De Toni & Tonchia, 2001). Although a company may have poor internal time performance (e.g. long waiting and set-up times among work centers), they make very swift deliveries to the customer as it practices make-to-stock and they provide rapid distribution lead times (De Toni & Tonchia, 2001).

### **3- Flexibility**

Flexibility is an ability to modify something (e.g. production mix) in relation to other performance dimensions (i.e. cost, time and quality) (De Toni & Tonchia, 1998). De Toni (2001) mentions that there are different types of flexibility which are measured as performance of a firm. These types are as follows:

- Volume flexibility;
- Mix flexibility;
- Product modification flexibility;
- Process modification flexibility;
- Expansion flexibility.

Expansion flexibility is the one mostly measured. It is followed by the product and process modification flexibilities. On the other hand, volume and mix flexibilities are less measured. It appears that technological flexibilities (i.e. product and process modification) are simpler to measure rather than managerial ones (volume and mix) (De Toni & Tonchia, 2001).

#### 4- Quality

Quality as a performance dimension considers following factors(De Toni & Tonchia, 2001):

- Produced quality;
- Perceived quality (based on customer satisfaction) ;
- In-bound quality (i.e. suppliers quality);
- Quality in terms of costs (procedures costs, programs costs, controls costs and those are linked to sustain high standard of quality).

Although controlling in-bound quality is high, the statistical process control is not yet prevalent as measuring customer satisfaction. It is preferred to seek for the quality system costs and amount of returned goods (De Toni & Tonchia, 2001).

Taken into consideration the comparison between performances, direct costs (i.e. labor and materials), labor productivity, net process time, and the inventory seem to be mostly measured (De Toni & Tonchia, 2001). Non-value-added times, delivery, time-to-market, the quality produced, and the customer satisfaction are sparsely measured.

Salvador (2001) found that when suppliers interact on subjects related to material flows and quality, there is important time influence in terms of delivery punctuality. According to (K. C. Tan, Lyman, & Wisner, 2002), improving an inclusive set of SC practice and SC performance metrics had a positive influence on performance, while some others have an adverse effect.

Based on the mentioned articles, SCM has a significant role on promoting supply chain performance. For example, K. C. Tan et al. (2002) mentions that information sharing and customer service management can improve supply chain performance. Therefore, although SC dimensions such as adaptation and trust have been widely tested in marketing literature in terms of their effects on marketing performance (Heide & John, 1992), their impact on SC performance has taken less consideration in the supply and operation management journals.

According to (Bhattacharya et al., 2013), sustainability of a business based in competitive and turbulent economy market needs determining performance measures on most of the critical

assessing criteria of the supply chain. For instance, strategies as an integral part of the business are considered critical for evaluation.

G. T. M. Hult and Ketchen Jr (2006) point out that traditional SCM model identifies the SC performance as the degree of fit between ideal profiles of knowledge elements and business strategies. Companies such as Wal-Mart, Toyota, and Dell have replicated supply chain management skills into dramatic competitive advantages and superb performance. This emerges that supply chain management has a great value to enhance performance (G. T. M. Hult & Ketchen Jr, 2006). It should be taken into consideration that neither supply chains be observed just as production and distribution mechanisms. On the other hand, it is a critical competitive weapon (Hult & G Thomas M, 2004).

According to (Shepherd & Günter, 2006), there have been relatively few studies concentrating systematically on measuring supply chain performance. Furthermore, in order to categorize differences of supply chain performance are indicated (See Table 4). For example, F. T. Chan and Qi (2003) determine six core processes (i.e. inbound and outbound logistics, marketing and sales, suppliers and customers). Lockamy III and McCormack (2004) argue that supply chain performance should be measured at multiple responsiveness, flexibility, cost and efficiency indicators.

**Table 4 Supply chain performance measurement**

Articles	Supply chain performance measurement	Technique	Research Methodology
(F. T. Chan, 2003)	Quantitative and qualitative performance measurement <i>Quantitative:</i> Cost, resource utilization <i>Qualitative:</i> Quality, flexibility, visibility, trust, and innovativeness	Analytic hierarchy process (AHP)	Empirical Study
(A. Gunasekaran, Patel, & McGaughey, 2004)	Time (delivery lead time) Costs (supply chain, logistics, and information processing) Flexibility	ABC analysis	Empirical Study (150 British companies)
(De Toni & Tonchia, 2001)	Costs (Production costs and productivity) Non-costs (characteristic of products, production technologies, managerial techniques)	Principal components analysis	Empirical Study (115 Italian manufacturing companies)
(Beamon, 1999)	Flexibility Resource (Cost, WIP, and finished goods) Outputs (items produced and delivered) Responsiveness	Mathematical modelling	Empirical Study
(Neely, 1995)	Quality (Reliability, Aesthetics, Conformance) Cost (Manufacturing, Value added, selling price, and service) Time (Manufacturing lead time, Delivery lead time, Due date performance, Frequency of delivery) Flexibility (Material quality, output	Literature review	Conceptual Analytical Study

	quality, volume, mix, resource mix)		
(F. T. Chan & Qi, 2003)	Cross organizational performance Input and outputs	AHP, Fuzzy method	Empirical Study
(Lockamy III & McCormack, 2004)	Plan, Source, make and deliver factors	Statistical analysis	Empirical Study
(Charan, 2012)	Quantitative and qualitative performance measurement Financial, customer, Internal business process, Innovation and Growth perspectives	Situation actor process (SAP) and learning action performance (LAP) analysis	Empirical Study

### 3.10 Supply chain performance and Supply chain integration

There is need for supply chains to be involved in collaborative relationships, integrated to establish a single virtual organization in terms of global approach with the aim of improving profit and decreasing total operating costs (Ding, 2011). This approach echoes in distinct industries reminding companies to coordinating all parties to share their resources and collaborate (Yeung, 2009).

According to (Kim, 2009), supply chain management probes to increase competitive performance by closely integrating the internal factions within a firm and link them effectively with the external operations of supply chain members (i.e. suppliers, customers, manufacturers). Achieving supply chain integration is a complicated task. The strategy should span product and material flow from vendors to end customers and embrace an array of

distinct organizational entities, external (e.g., suppliers and customers) as well as internal (e.g., functions) (Kim, 2009).

The benefits of SCI can be gained through efficient linkage among different supply chain activities, and the linkages should be subject to the effective construction of distinct supply chain practices for integrated supply chain. It means that organizations following the effective construction of SCM practices are required to focus on SCI. Implemented SCM practices to obtain superior supply chain performance (cost, quality, flexibility and time performance) need internal cross-functional integration within an organization and external integration with suppliers and customers to be successful (R. Cagliano, Caniato, Federico, Spina, Gianluca, 2006; Van der Vaart & van Donk, 2008).

Internal integration is studied within the company's boundaries and it pursues to eliminate the traditional function "silo approaches" and focus on better coordination among functional extents (Gimenez & Ventura, 2005). Hillebrand and Biemans (2003) accomplished that internal integration is a prerequisite for productive external integration.

Lambert (1998) argues that all companies within a supply chain should first overcome their own functional silos to effectively implement SCM. Based on (Pagell, 2004), integration determined as a process of interaction and collaboration in which purchasing, manufacturing, and logistics together in a cooperative manner to achieve bilateral admissible results for their organization.

According to (Trent & Monczka, 1998), integrating of management sourcing, flow, and managing materials through multiple functions and suppliers is determined as objective of SCM. Since internal integration is within span of control it is so significant to industry practitioners (Feger, 2009).

Feger (2009) argues that the strength point of a supply chain is linked with SC internal integration through a relation from the purchasers to the end customers. Managing internal functions of firms and their links among internal activities has a direct effect on the health of the supply chain.

Internal integration examines integration through distinct parts of an organization. Based on the literatures, internal integration has three level of analysis: full, some, and no internal integration. Each level indicates the interaction and collaboration of the purchasing, manufacturing, and logistics for achieving acceptable results (Pagell, 2004).

Based on (Kim, 2009) empirical study, SCI in pursuit of supply chain practices might differ in scope and emphasis. It means that SCI has a considerable role as strategic “levers” that SCM practices can be used to increase the chances for company accomplishment.

At strategic level of analysis, alignment and fit through consistency has been linked to competitive advantage. According to (Hayes & Wheelwright, 1984), businesses that are internally integrated have different functional level strategies that are internally consistent. It means that each function is required to be strategically integrated in to the whole firm to gain competitive advantage (Pagell, 2004).

Several studies on integration have pursued to identify the performance benefits of integration (Basnet, 2012). According to Table 5, previous studies which have come to a consensus about SCI improvement are brought as follows:

**Table 5 Benefits of supply chain integration**

<b>Authors</b>	<b>Improving supply chain performance through SCI</b>	<b>Research Methodology</b>	<b>Internal/External integration</b>
(G. Li & Yang, 2009)	Gaining competitive advantage	Empirical study of 182 firms in China (structural equations modelling)	Internal and External Integration
(Y. Zhao, 2008)	Decreasing transaction costs	Analytical conceptual study	Internal and External Integration
(Clark & Lee, 2000)	Improving flexibility	Mixed research method	Internal Integration
(H. L. Lee & Padmanabhan, 1997)	Reducing inventories, Eliminating bullwhip effect	Analytical conceptual study	Internal Integration
(Cousins & Menguc, 2006)	Enhancing deliver quality, decreasing cycle time	Empirical study	External Integration
(Swink, 2007)	Consolidate strategic knowledge and information	Empirical study (Regression Analysis)	Internal and External Integration
(X. Zhao & Flynn, 2007)	working simultaneously on supply chain practice and information sharing	Empirical study	Internal and External Integration
(T. P. Stank & Daugherty, 1999)	Decreasing inventory level	Empirical study	Internal and External Integration
(Rosenzweig, 2003; Vickery, Jayaram, Droge, & Calantone, 2003)	Enhancing operational performance	Empirical study	Internal and External Integration
(Goldhar & Lei, 1991)	Decreasing lead time	Empirical study	Internal and External Integration
(Narasimhan & Kim, 2001)	Integration of information technology decisions into logistics enhance supply chain performance	Empirical study 590 large	Internal and External Integration



		manufacturing firms	
(Chen & Mu-Chen, 2007)	Increasing marketing-logistics collaborative activities	Empirical study	Internal Integration
(Ellinger, 2000)	Enhancing evaluation and reward system, cross-functional collaboration, effective inter-departmental relations and distribution service performance	Statistical Analytical Study (Regression Analysis)	Internal Integration
(Giménez & Ventura, 2003)	Gaining competitive advantage	Statistical Analytical Study(structural equations modelling)	Internal and External Integration
(Kahn & Mentzer, 1998)	Enhancing communication and information sharing	Empirical study of 514 companies	Internal Integration
(Calantone, 2002)	Increasing knowledge through information sharing	Statistical Analytical Study(structural equations modelling)	Internal Integration
(Hausman, 2002)	Gaining profit through manufacturing and marketing	Exploratory investigation	Internal Integration
(Pagell, 2004)	Obtaining admissible outcomes to use integration as structure and culture of the plant, cross-functional teams, and information sharing	Empirical study of 11 different plants	Internal Integration
(DA Mollenkopf & Gibson, 2000)	Increasing cross-training	Statistical Analytical Study (Regression Analysis)	Internal Integration
(Basnet, 2012)	Improving performance through multiple functions within companies such as sales, production, and distribution	Empirical study (Case study)	Internal Integration

(Van der Vaart & van Donk, 2008)	enhance Return on Investment (ROI), Profit, and market share	Conceptual analytical study	External Integration
(Frohlich & Westbrook, 2001)	Improving market performance through arc of integration	Empirical study of 322 manufacturers	External Integration
(Narasimhan & Kim, 2002)	Linking SCI to corporate diversification strategy, gaining competitive position	Empirical study of 623 manufacturing organizations (Regression Analysis)	Internal and External Integration
(Moshkdanian & Molahosseini, 2013)	Increasing information sharing and logistics integration	Empirical study (Case study)	Internal and External Integration
(H. Chen & Daugherty, 2009)	Increasing efficiency, innovative capabilities Accessing to information and knowledge	Conceptual analytical study	Internal and External Integration
(Vachon & Klassen, 2006)	Enhancing environmental monitoring and collaboration (green supply chain practices)	Empirical study of 84 plants (Regression Analysis)	External Integration
(S. Zailani & Rajagopal, 2005)	Improving quality, flexibility	Conceptual analytical study	External Integration
(Quesada, Rachamadugu, Gonzalez, & Martinez, 2008)	Gaining competitive advantage	Statistical Analytical Study (Regression Analysis) through IMSS II	External Integration
(S. Zailani, Rajagopal, Premkumar, 2005)	Enhance quality Minimize costs	Conceptual analytical study of east Asian and US companies	External Integration
(Kim, 2006)	Strategic lever for gaining competitive capabilities Enhance firms successes	Empirical study of 590 Korean corporations	External Integration

As it is indicated (see Table 5), a significant amount of research has been conducted on improving supply chain performance through supply chain integration which by and large has indicated that integration is beneficial for customer service and a firm's bottom line.

According to (Cheng & Jack CP, 2010), empirical studies indicate that companies need to have correct supply chain relationships in order to deliver benefits linked with SCI into SCP. It should be taken in to consideration that SCI leverages SCP through information sharing, Sharing information from the origin of sourcing of raw materials to the end customer, enhancing flexibility, decreasing lead time, improving inventory, and reliable delivery (Panayides & Venus Lun, 2009).

Furthermore, higher levels of information technologies (IT) involved in the communication, and transaction of supply chain members that are geographically disseminated, strengthens secure, and reliable supply chain activities, streamlining coordination among supply chain partners (Cheng & Jack CP, 2010).

Information sharing has gotten a considerable role among organizations as the value creating factors are changing from physical and financial assets towards intangible assets (Koçoğlu, 2011). Because SCM emphasizes productive (effective and efficient) flows of both physical and financial assets both directions commencing from the main source of raw materials toward the consumption of the product by the end-customer (Zhou & Benton Jr, 2007). Zhou and Benton Jr (2007) suggested that effective supply chain practice and effective information sharing are two foundations of supply chain improvements.

Although some firms focus on developing supply chain practice, others focus on leveraging information sharing among supply chain members. Because these two major approaches are not independent and therefore firms must work simultaneously on supply chain practice and information sharing (Zhou & Benton Jr, 2007). In order to propose a profound example, Toyota as a world class in supply chain practice began to implement SAP in late 1990s (Zhou & Benton Jr, 2007).

Internal integration by providing linkage deals with an easy access to key operational data from the integrated database. These operational data provided through highly integrated information system which is linked to different internal departments in an organization and

planning systems with a high degree of information system integration for production processes (Yeh & Chang, 2007).

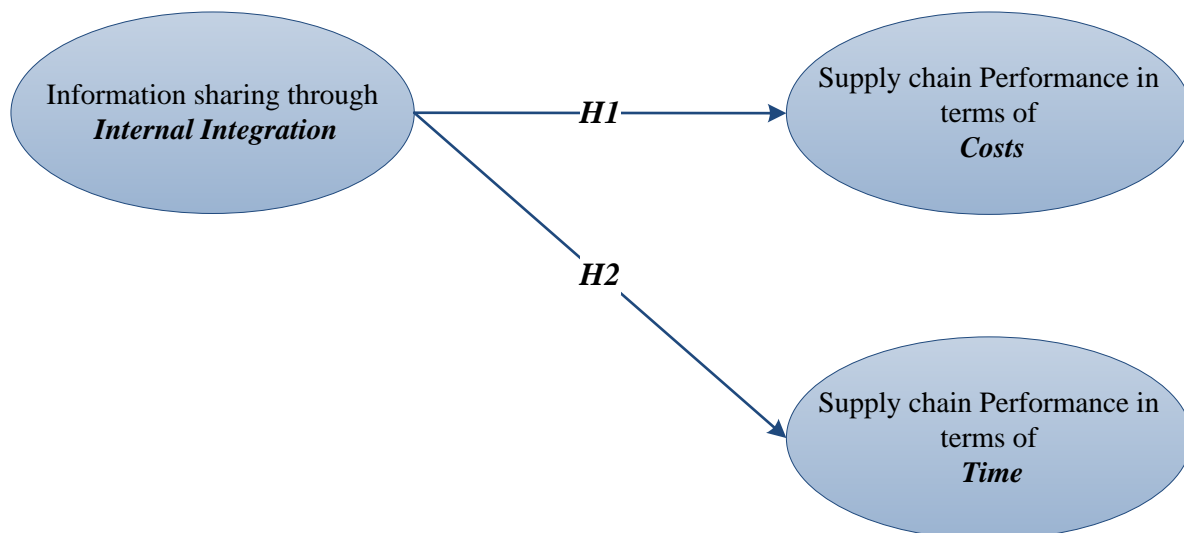
According to (Yeh & Chang, 2007) internal integration of supply chain is the most significant contributor to cost-containment while integration with the supplier is the top strategy to gain supply chain reliable performance. Therefore, it is reasonable to claim that the effectiveness of SCI may influence how successful companies are gaining the projected results arising from supply chain performance.

Taking into consideration that an integrated supply chain results in an information sharing in timely approach, which in turn enhances material flows through the chain and minimizes all processes failing to promote product value (T. M. Simatupang, Wright, Alan C, Sridharan, Ramaswami, 2002).

It is logical that a higher level of integration with business partners (e.g. buyers) have to enhance the relationship with end customers of the products through enhanced customer service, lower costs, and better information utilization. This should lead to higher margins, market shares, and profits (Van der Vaart & van Donk, 2008). Therefore, based on provided discussion the following Hypotheses are developed:

***Hypothesis 1:*** Information sharing through internal integration of supply chain has significant influence on supply chain performance in terms of costs

***Hypothesis 2:*** Information sharing through internal integration of supply chain has significant influence on supply chain performance in terms of time



**Figure 24 Information sharing through internal integration and supply chain performance**

According to Figure 24 it can be understood that there are relationships between information sharing through internal integration of supply chain and supply chain performance in terms of costs and time. It means that the extent of information sharing through internal integration of supply chain can positively/negatively affects supply chain performance.

Supply chain integration (SCI) increases the degree of partnership in regards with external supply chain partners, thus in order to gain inter-organizational information sharing, firm level strategies, practices and processes should be integrated (S. Li & Lin, 2006). Dynamics environment surrounded collaborative relationships between suppliers and customers diminishes the required technological and managerial resources as competitive capabilities (Kim, 2009).

SCI manages all relevant parties through replicating resources to conglomerate core elements from heterogeneous source of information in to common platform and gaining sharing of information (Yeung, 2009). Taking into consideration that SCI enhances information sharing through endangering the trust based relationships (Kim, 2009). Building up a profound relationship with suppliers and customer through coordination and integration of activities improves customer responsiveness and flexibility and eventually the flow of information sharing (Yeung, 2009).

As companies sought to further enhance their operational performance, it became essential to probe inter-organizational responses to logistics problems. At this time external supply chain

integration appears as a solution to be focused. This solution characterized by the sharing of resources and deeper reliance on bought-in expertise. This resulted to specific improvement such as out sourcing and vendor managed inventory (VMI) (Dong & Xu, 2002; Knemeyer & Murphy, 2005). VMI admits the firms to diminish total cost inventory related costs and therefore provides a robust incentive for firms to integrate their inventory systems (Dong & Xu, 2002).

External integration replicates the integration domain to outside of the organization to comprise suppliers and customers (Moshkdanian & Molahosseini, 2013). External integration involves coordination forward physical flow of deliveries between suppliers, manufacturers, and suppliers (Saunders, 1997).

External integration with business partners provide a company with a technological and logistical capabilities which can effect on gaining high customer satisfaction, quality, and differentiation capabilities (Bowersox, 1989). This argument implies that SC capabilities have a considerable role as a lever for effectively linking corporate competitive advantage and performance improvement (Kim, 2006).

In the literature of externally integration, there are some proponents that fall under the flag of just-in-time (Narasimhan & Jayaram, 1998). (H. L. Lee, 2002) pointed out that external integration of supply chain closely related to implement product postponement and mass customization to enhance the efficiency.

According to (Smart, 2008), stronger external supply chain integration leads to increase benefits as the level of supply chain grows both downstream (Reeder & Rowell, 2001) and upstream (Narasimhan & Das, 1999). With Focusing on literature on external integration, two major areas are emphasized: customer integration, supplier integration (Moshkdanian & Molahosseini, 2013).

Base on (S. E. Fawcett & Magnan, 2002), several firms were still at the early stages of inter-company collaboration, since managers spent important resources steering the "waters of their own harbor" rather than forming external integration. Vachon and Klassen (2006) pointed out that external integration of supply chain can be driver of green supply chain to minimize pollutions, wastes and harmful disposals.

Linking with external suppliers and customers in a unique supply chain through their internal processes brings about advantages for manufactures to improve their efficiency (Frohlich & Westbrook, 2001; Diane Mollenkopf & Dapiran, 2005). External supply chain integration is a critical factor to gain competitive advantage in the current e-global environment (Quesada et al., 2008).

According to (Rosenzweig, 2003), firms can gain two major competitive advantages. Firstly, high integration among supply chain partners can lead to more responsive firms to confront volatile demand due to enhanced information visibility and operational knowledge (Kim, 2006). Secondly, highly integrated supply chain partners have the potential to cut net costs of performing business and total delivered costs to customers (Swink, 2007).

Taking in to consideration the external integration of supply chain, focusing on upstream (suppliers) and downstream (customers) are required. Upstream supply chain integration refers to integrating the company with its suppliers (G. L. Ragatz & Handfield, 1997). It concentrates on effective integration with suppliers as a key factor for gaining competitive advantage (Quesada et al., 2008). For instance, in new product development, integrating with suppliers can lead to enhancing customer satisfaction, minimizing quality problems, and decreasing time to market (Takeishi, 2001).

Downstream supply chain integration refers to integrating the company with its customers. This side of integration emphasize on new customer-focused strategies and new technologies that provides closer relationships with customers (Tollin, 2002), such as customer relationship management (CRM) (Quesada et al., 2008).

According to (S. Zailani & Rajagopal, 2005), it is so critical to provide an arm-length relationship with business partners in order to increase win-win partnership (i.e. customer-supplier relationships). This leads to cut overall cost of the chain. Taking into consideration that building up a robust relationship with business partners requires careful planning and decision making (S. Zailani & Rajagopal, 2005) . In order to build up a robust alliance with business partners, there is need for sharing information. Sharing significant and proprietary information with suppliers and customers may lead to enhance quality and to minimize costs (S. Zailani & Rajagopal, 2005).

Supply chain partners can discern each other's business better and help each other through sharing information at the right time in order to gain higher supply chain performance (Koçoğlu, 2011). According to (Van der Vaart & van Donk, 2008) empirical study regarding SCI and SCP, SCI and SCP has a direct relationship. It means that SCI can enhance Return on Investment (ROI), Profit, and market share.

Chandra (2007) pointed out that integrated map of information sharing can be provided through involvement of different supply chain members of distinct competencies through supply chain integration. Sharing implicit competencies and expertise can be gained through arm's length relationships by providing benefits where supply chain members involved (Koçoğlu, 2011).

SCI leverages supply chain performance through transparency provided by information sharing from sourcing of raw materials till end customers by increasing flexibility and reducing lead time, enhancing inventory and reliable delivery (Panayides & Venus Lun, 2009). Furthermore, Based on (Cheng & Jack CP, 2010), enhancement of information technology through sharing information and improving transaction of supply chain members streamline coordination among supply chain partners.

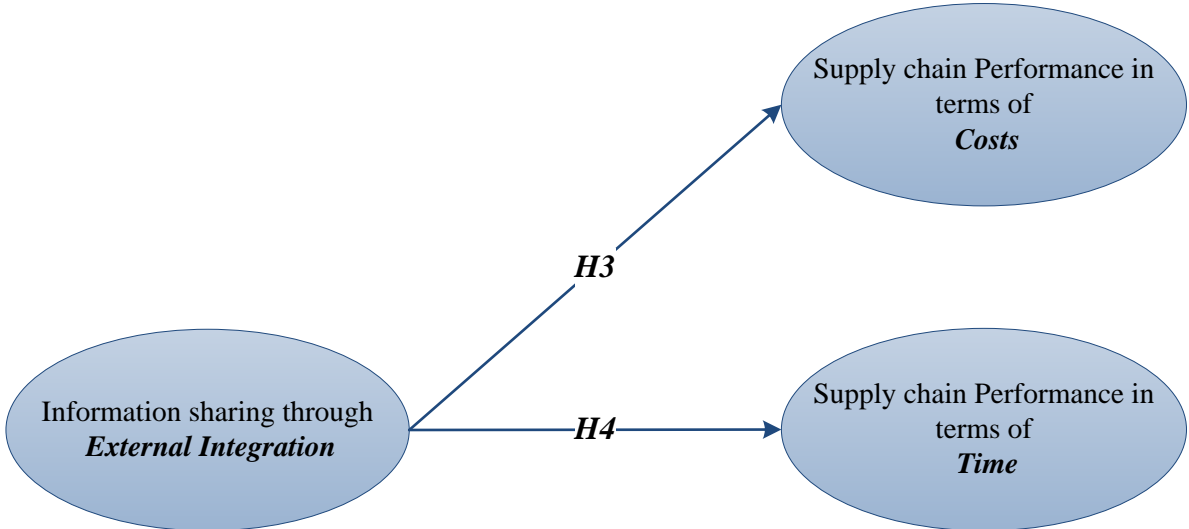
SCI provides robust IT infrastructure delivery timely and reliable information admitting a suitable and low cost communication with lower risk of information deficiency (G. Li & Yang, 2009). Effective integration of suppliers and customers in to supply chain serves a key factor to obtain competitive advantage (Bowersox, Closs, & Cooper, 2002).

Based on (G. Li & Yang, 2009), strong IT infrastructure provides timely, correct and reliable information admitting a convenient and low cost communication with lower information uncertainty enabled through SCI. Therefore, SCI enhances SCP through sharing information across supply chain partners externally. Parallel to the above discussion the following hypotheses are developed:



**Hypothesis 3:** Information sharing through external integration of supply chain has significant influence on supply chain performance in terms of costs

**Hypothesis 4:** Information sharing through external integration of supply chain has significant influence on supply chain performance in terms of time

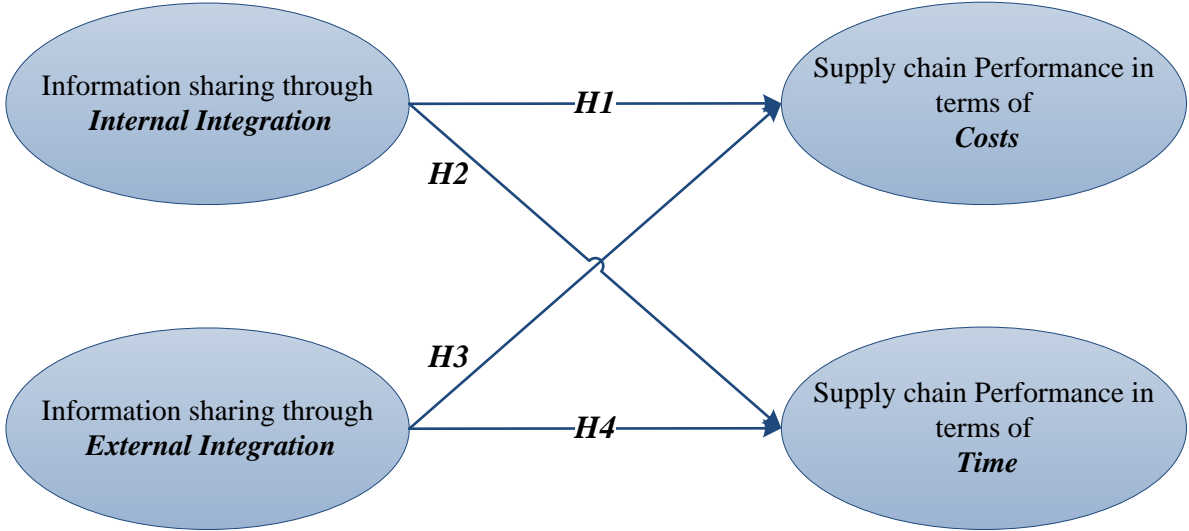


**Figure 25 Information sharing through external integration and supply chain performance**

According to Figure 25 it can be understood that there are relationships between information sharing through external integration of supply chain and supply chain performance in terms of costs and time. It means that the extent of information sharing through external integration of supply chain can positively/negatively affects supply chain performance.

Internal and external integration are different while they are closely related concepts (H. Chen & Daugherty, 2009). Noticeably, it is beneficial to examine both when studying supply chain integration (Rodrigues, 2004). Narasimhan (1997) mentioned that SC practical capabilities implemented to gain superior supply chain performance (cost, quality, flexibility, quality, and time) need both internal integration through cross-functional integration with in a firm and external integration of supply chain with suppliers and customers to gain competitive advantage.

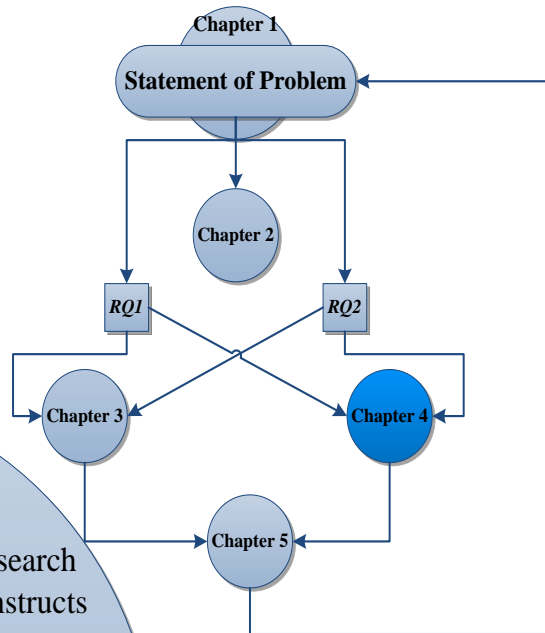
Figure 26 presents the complete model for indicating that information sharing through external and internal integration of supply chain can affect supply chain performance in terms of cost and time.



**Figure 26 Information sharing through internal and external integration and supply chain performance**

Therefore, information sharing as a key driver of gaining competitive advantage in any SCM systems considered a significant approach for SMEs and supply chain integration (Moberg, 2002; Y. Zhao, 2008). Information sharing provides effective and efficient supply chain by accelerating information flow, reducing the response time to customer’s needs, enhancing coordination and collaboration and sharing the risks as well as the benefits. Thus, it can bring competitive advantage for organization in a long run (S. Li & Lin, 2006).

# Chapter4 Empirical Study



## Chapter 4:

- Define empirical study for this research
- Data analysis to understand each constructs reliability for being test
- Impacts of each factor to other factors are explained through confirmatory factor analysis
- Examine convergent and discriminant validity of measurement items
- Run regression analysis to find results
- Pearson correlation and coefficient analysis are performed
- Analysis of variances carried out to indicate the extent and significant effect of each construct on other constructs

## 4. Empirical Study

How to critically assess the relationship between SCI and SCP is a very significant issue (Van der Vaart & van Donk, 2008) and focus of this empirical study. A question here is whether it is useful to relate SCI to SCP of the SMEs, particularly when performance is measured in overall terms such as costs, times, and ROI. In order to test the hypotheses which are mentioned in Chapter three, an empirical study is deemed the most proper means for collecting the relevant data including IMSS 6<sup>th</sup>.

Wacker (1998) pointed out that empirical methodologies provide empirical verification of models while delivering evidence for the development of new theory. In empirical research should use data from external organizations or businesses to test if relationships hold in external world.

In order to empirically verify theoretical relationships in large sample from actual businesses empirical statistical research is employed in this study (Wacker, 1998). Wacker (1998) mentioned that the more complicated research issues gets, the more possibility the study will use this methodology. Thus from a theory-building perspective, empirical statistical study provides empirical support for theoretical relationships in larger samples in real world (Meredith, 1989).

To statistically analyze the research model and test designed hypotheses, Structural Equation Modeling (SEM) technique is applied in this study. In Structural Equation Modeling (SEM), the measurement model refers to the relationships between the research constructs (latent variables) and their indicators (show variables) and the structural model captures the hypothesized causal relationships among the research constructs (Koçoğlu, 2011).

SEM or path analysis provides researchers with influential multivariate technique to measure direct and indirect influences and to carry out test models with multiple dependent variables by using several regression equations concurrently (Alavifar, 2012). SEM is applied for validity and reliability evaluation of model measures as a multivariate technique.

Multiple regressions are appropriate for evaluating constructs and relations between constructs. Although the intent of a correlation is to assess the relationship between the dependent and independent variables, the first aim of regression analysis is to predict (Tabachnick & Fidell, 2001). Multiple regressions as variance predictor are an approach to identify the model of relationship between dependent variable as Y and independent variables as X (Alavifar, 2012). Multiple regressions equation contains more explanatory variables which are indicated as follows:

$$Y_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_n X_{ip} + \varepsilon_i, \quad i = 1, \dots, n$$

Where:

$Y_i$ : Dependent variable  $i$

$\beta$ : Parameter estimates

$X_{ip}$ :  $i^{th}$  observation on the  $p^{th}$  independent variable

$\varepsilon_i$ : Error

In this linear equation  $\beta_0$ ,  $\beta_1$ , and  $\beta_n$  are parameter estimates, when the  $p^{th}$  independent variable,  $X_{ip}$ , changes by one unit the value  $\beta_n$  indicates the amount of  $i^{th}$  dependent variable,  $Y_i$ , changes while the other independent variables stay constant. The assumptions of multiple regression involves appropriate specification of the model, linear relationships, near interval or interval data with restricted range and the same level or relation through the range of independent variables (Alavifar, 2012).

Linear regression is an approach to model the relationship between a numerical variable Y and one or more explanatory variables explained X (Alavifar, 2012). The relationships hypothesized in Chapter three were investigated using regression analysis. This approach enables the researchers to examine the relationship among variables after taking into account variance attributable to other variables (Pedhazur, 1991). In order to evaluate multiple regressions in sequential steps SPSS software is used.

Multiple linear regression analyses are used to develop models relating the four measures of performance to the four independents variables (Lee & Chang Won, 2007). Four dependent variables for supply chain performance are identified as: unit manufacturing cost, ordering costs, manufacturing lead time, and procurement lead time. Four independent variables are

sharing information with purchasing department, sharing information with sales department, sharing information with key suppliers, and sharing information with key customers.

In testing the hypotheses the information sharing variable in internal integration and then information sharing in external integration were regressed on the supply chain performance in terms of costs and time (unit manufacturing cost, ordering costs, manufacturing lead time, and procurement lead time).

Correlation analysis is carried out to evaluate criterion-related validity. Pearson correlation coefficients between all the different measures were examined for four dependent and four independent variables. Pearson correlation analyzes that whether independent variables are significantly correlated with dependent variables or not. It calculates the strength of the association between two construct (Cohen et al., 2013; Gujarati, 1995)

Besides the coefficients analysis of dependent and independent variables is carried out to indicate the multiple regressions equation. In order to identify whether there are any significant differences between the means of four independent variables analysis of variance (ANOVA) is performed (Gujarati, 1995).

Before commencing regression analysis on SPSS, data analysis through reliability and factors loadings and confirmatory factor is analyzed to measure impact of each factor relative to other factors.

## 4.1 Data Analysis

The degree of relationship was measured on a 1-5 Likert scale where 1 represents no use and 5 represent high level of integration. For each construct, reliability and internal consistency is evaluated using standardized Cronbach's alpha (Cronbach, 1951). The Cronbach's alpha of the latent factor based on these 8 items is 0.703 which indicates that reliability is guaranteed (Nunnally, 1978; Sekaran, 2000). Values of larger than 0.60 suggest that the calculation scales are reliable (Nunnally, 1978). Cronbach's alpha defines the internal consistency or average correlation of items in a survey instrument to estimate its reliability (Santos, 1999).

Cronbach's alpha for the two constructs ranged from 0.758 to 0.766 (Table 6-7), showing that the IMSS 6<sup>th</sup> edition was reliable. The factor analysis results (Tables 6-7) supports the validity of these constructs as indicated by the high factor loadings if all items within each scale that were above 0.60.

Factor loadings entail those values clarifying how closely the variables are related to each one of the discovered factors. Factor loadings are also known as factor-variable correlations. They work as key aspect to discern what the factors mean (factor is a fundamental dimension accounting for some observed variables) (Kothari, 2009). Therefore, the squared factor loading is the percent of variance in that indicator described by the factor (Jayaram & Tan, 2010). Taking into consideration that factor loadings of each indicator are higher than 0.70 level, confirmatory factor analysis, indicator is explained by the factor. It means that the impact of each factor relative to others is the main objective.

A correlation matrix is evaluated preliminarily to identify whether it is factorable (Pett, 2003) through both supply chain integration and supply chain performance, including Kaiser–Meyer–Olkin measure and Bartlett's test of sphericity.

A Kaiser–Meyer–Olkin measure of sampling adequacy (KMO) value indicates that the sum of partial correlation is relatively compact (They are close to 1), Therefore, factor analysis has to yield different and reliable factors. Kaiser (1974) endorsed that greater than 0.50 of KMO values is acceptable.

According to Tables 6-7, the KMO values are ranged from 0.681 to 0.699 areas which are above the threshold level of 0.50, approving that factor analysis is appropriate for the data. Besides, Bartlett's test of sphericity indicates that the null hypothesis is rejected at  $\alpha = 0.05$  which endorses that factor analysis is proper for the data.

As a result, factor analysis results indicate that the external and internal integration of supply chain through information sharing and supply chain performance constructs can be adequately represented by the set of measured items. It means that sharing information with purchasing department is dominant factor to enable supply chain integration. Respectively, sharing information with sales department, key suppliers, and key customers are dominant factor for supply chain integration.

**Table 6 Factor analysis of external and integration of supply chain through information sharing**

<i>Internal and External supply chain integration through information sharing (Cronbach's <math>\alpha = 0.758</math>)</i>	<i>Loadings</i>
<i>Sharing information with purchasing department</i>	0.790
<i>Sharing information with sales department</i>	0.791
<i>Sharing information with key suppliers</i>	0.767
<i>Sharing information with key customers</i>	0.708
<i>Kaiser–Meyer–Olkin measure of sampling adequacy</i>	0.699
<i>Bartlett's test of sphericity: approximate <math>\chi^2</math></i>	564.095
<i>Degrees of Freedom</i>	6
<i>Significant Level</i>	0.0001
Extraction sums of squared loadings total variance explained = 58.474%	

**Table 7 Factor analysis of supply chain performance**

<i>Supply chain performance (Cronbach's <math>\alpha = 0.766</math>)</i>	<i>Loadings</i>
<i>Unit manufacturing cost</i>	0.798
<i>Ordering costs</i>	0.751
<i>Manufacturing lead time</i>	0.794
<i>Procurement lead time</i>	0.721
<i>Kaiser–Meyer–Olkin measure of sampling adequacy</i>	0.681
<i>Bartlett's test of sphericity: approximate <math>\chi^2</math></i>	580.978
<i>Degrees of Freedom</i>	6
<i>Significant Level</i>	0.0002
Extraction sums of squared loadings total variance explained = 58.776%	

According to Table 7, it can be understood from factor loading that unit manufacturing cost is a dominant factor for calculating supply chain performance. Furthermore, ordering costs,



manufacturing lead time, and procurement lead time are dominant factor for measuring supply chain performance

## 4.2 Confirmatory factor analysis

In order to examine the unidimensionality, and convergent and discriminant validity of measurement items, confirmatory factor analyses using SPSS were conducted. The confirmatory factor analysis is carried out using AMOS 22. The measurement of model fit with the IMSS 6<sup>th</sup> data is checked with model chi-square goodness-of-fit, and approximate fit indices (Piaw, 2009). Appendix indicates the results of validity tests on measurement variables constructing supply chain performance in terms of costs and times and sharing information through internal and external integration of supply chain.

The Normed Fit Index (NFI) (Bentler & Bonett, 1980) evaluates the model by comparing the  $\chi^2$  value of the model to the  $\chi^2$  of the null model. The null/independence model is the false case scenario as it identifies that all measured variables are uncorrelated (Hooper, 2008). Values for statistics range between 0 and 1 which values greater than 0.90 indicate a good fit (Bentler & Bonett, 1980).

The Comparative Fit Index (CFI) (Bentler & Bonett, 1980) presumes that all latent variables are uncorrelated (null/independence model) and compares the sample covariance matrix with this null model. A value greater than 0.90 is needed to confirm miss-specified models are not accepted (Hu & Bentler, 1999).

The Root Mean Square of Approximation called RMSEA by Browne, Cudeck, Bollen, and Long (1993). The RMSEA presents that how fit is the model; with unidentified but optimally specified parameter estimates would fit the populations' covariance matrix (Byrne, 2013). RMSEA is one the most sensitive informative fit indices because of sensitivity to estimated parameters in the model (Diamantopoulos & Siguaw, 2000). It means that RMSEA intends to select the model with lesser number of parameters (Piaw, 2009).

According to (MacCallum, 1996), an RMSEA in the range of 0.05 to 0.10 was measured an indication of fair fit and values above 0.10 specified poor fit. An RMSEA of between 0.08 to 0.10 provides a mediocre fit and below 0.08 shows a good fit.

According to Table 8, it can be discerned that the CFA resulted in NFI and CFI are closely near 0.9 and RMSEA indicated mediocre satisfactory fit statistics ( $\chi^2$  value = 0.000 < 0.05). Therefore, the measurement structure of 8 items produced satisfactory fit statistics.

**Table 8 Goodness of fit**

Goodness of Fit summary					
Construct	$\chi^2$ value	df <sup>a</sup>	NFI <sup>b</sup>	RMSEA <sup>c</sup>	CFI <sup>d</sup>
Supply chain performance in terms of times and costs	74.689 ( <i>P=0.000</i> )	2	0.874	0.098	0.875
Information sharing through internal/external supply chain integration	65.370 ( <i>P=0.000</i> )	2	0.886	0.092	0.888

Notes: df<sup>a</sup> – Degree of Freedom; NFI<sup>b</sup> – Normed Fit Index; RMSEA<sup>c</sup> – Root Mean Square of Approximation; CFI<sup>d</sup> – Comparative Fit Index. All the standardized estimates of the observed is lower than 0.05 (it is statistically significant at the 95 percent significant level)

### 4.3 Results:

At the first step, descriptive analysis is run in order to indicate the mean and standard deviation of both costs and information sharing through internal and external integration of supply chain. Mean and variance of each construct is measured and delivered by Table 9. The range of the construct is between 1 to 5 (Likert scale). It means that 1 is low and 5 are high. For example, when the mean of sharing information with purchasing department is 4, it means that sharing information is in a ‘Good’ status through internal integration of supply chain.

**Table 9 Descriptive statistic**

Items	N	Mean	Std. Deviation	Variance
	<i>Statistic</i>	<i>Statistic</i>	<i>Statistic</i>	<i>Statistic</i>
Sharing information with purchasing department	541	3,57	,965	,931
Sharing information with sales department	541	3,54	1,004	1,008
Sharing information with key suppliers	536	3,32	,960	,921
Sharing information with key customers	532	3,14	1,128	1,273
Use of Technology (ERP)	338	3.30	1.145	1.310
Unit manufacturing cost	542	2,50	,976	,953
Ordering costs	538	2,44	,874	,765
Manufacturing lead time	543	2,82	,961	,923
Procurement lead time	539	2,71	,901	,811
Return on sales (ROS)	570	2,71	1,314	1,727
Valid N (listwise)	304			

According to the Table 9, these analyses could be made based on IMSS data as follows:

Efforts for sharing information with purchasing department in the last three years are increased (3.57). Besides, sharing information with sales department is enhanced (3.54) so it can be discerned that internal integration of supply chain through information sharing is increased in the last 3 years (2010-2013).

External integration of supply chain through information sharing with key suppliers and key customers improves in the last three years. Internal integration of supply chain through

information sharing has higher enhancement in comparison to external integration of supply chain.

Use of technology is enhanced in last three years which indicate that more companies are starting to get use of technology in their supply chain. Supply chain performance of the firms compare with those of their main competitors is slightly decreased. Taking into consideration that ROS is one of the indicators of financial aspect of supply chain performance is almost the same through three years. Decrease of Unit manufacturing cost, ordering cost, manufacturing lead time and procurement lead time as supply chain performance compared to 3 years ago classifies as follows:

- 1-Manufacturing lead time
- 2-Procurement lead time
- 3-Unit manufacturing cost
- 4-Ordering cost

As a result, internal and external integration of supply chain through information sharing has increased and supply chain performance in terms of cost and time has decreased independently. In order to carry out a complete analysis, according to the conceptual model relationships of internal and external integration of supply chain toward supply chain performance are investigated.

According to the regression of Supply chain performance as dependent and internal/external integration of supply chain as independent variables, relationships are analyzed. The results clarify the positive and negative relationship between positive and negative variables. It means that whether independent variables support dependent variable.

In order to conduct regression analysis, Pearson correlation, coefficient, and ANOVA analysis is performed. According to the table 10, reasons for using these analyses are brought. The main implication of this table is to show the plan and the necessity to analyze the linear relationships between two constructs through regression and required analysis which can be made to provide robust results.

**Table 10 Pearson correlation, coefficient, and ANOVA analysis**

<b>Pearson Correlation</b>	<b>Coefficient</b>	<b>ANOVA</b>
-There is positive relationship between constructs -Investigate positive/negative linear relationship and strength of the linear relationship	-Investigate constructs' significance -Find regression equation model to indicate positive/negative relationship	-Identify the influence independent variables put on the dependent variable -Investigate the mean of two sample (e.g. Information sharing and Supply chain performance)

#### 4.3.1 Internal integration and supply chain performance in term of cost

Descriptive statistics of supply chain cost and internal integration separately indicates decrease in costs and enhancement in internal information sharing. Taking the mean into consideration, it is discerned that supply chain performance in term of cost is decreased slightly. Besides, it shows that internally integration among companies (IMSS data), has enhanced.

**Table 11 Descriptive statistics of supply chain performance in term of cost and sharing information through internal integration**

<b>Construct</b>	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Variance</b>
Unit manufacturing cost	542	2,50	,976	,953
Ordering costs	538	2,44	,874	,765
Sharing information with purchasing department	541	3,57	,965	,931
Sharing information with sales department	541	3,54	1,004	1,008
Valid N (listwise)	518			

According to Table 11, it can be understood that sharing information is increased while supply chain performance is decreased. So, Pearson correlation and coefficient analysis can be performed to find the relationship of each construct to other construct.

**Table 12 Correlations of information sharing through internal integration and supply chain performance in term of cost**

		<b>Unit manufacturing cost</b>	Sharing information with purchasing department	Sharing information with sales department
Pearson Correlation	<b>Unit manufacturing cost</b>	1,000	-,016	,083
	Sharing information with purchasing department	-,016	1,000	,614
	Sharing information with sales department	,083	,614	1,000
Sig. (1-tailed)	Unit manufacturing cost	.	,359	,029
	Sharing information with purchasing department	,359	.	,000
	Sharing information with sales department	,029	,000	.

		<b>Ordering costs</b>	Sharing information with purchasing department	Sharing information with sales department
Pearson Correlation	<b>Ordering costs</b>	1,000	-,004	,104
	Sharing information with purchasing department	-,004	1,000	,615
	Sharing information with sales department	,104	,615	1,000
Sig. (1-tailed)	Ordering costs	.	,462	,009
	Sharing information with purchasing department	,462	.	,000
	Sharing information with sales department	,009	,000	.

### **Pearson correlation analysis:**

Unit manufacturing cost and sharing information with purchasing department are not correlated while it correlates with sharing information with sales department. According to significant analysis of sharing information with purchasing department and manufacturing cost ( $0.359 > 0.05$ ), the null hypothesis is not rejected. It means that there is no a statistically significant correlation between unit manufacturing cost and sharing information with purchasing department. Specifically, the statistical significance of the correlation model is not applied. On the other hand there is not a significant correlation (i.e. null hypothesis is rejected) between unit manufacturing cost and sharing information with sales department so there is a positive correlation ( $0.029 < 0.05$ ).

Beside the same results are calculated for ordering cost and internal integration of supply chain through information sharing. Sharing information with purchasing department and ordering cost are not correlated while ordering cost correlates with sharing information with sales department. There is not a significant correlation ( $0.462 > 0.05$ ) between Sharing information with purchasing department and ordering cost. It means that the significance of the correlation model is not applied While sharing information with sales department has a high positive correlation with ordering cost ( $0.009 < 0.05$ ).

In order to investigate estimated supply chain performance in term of cost based on internal integration of supply chain coefficients tables are brought. Estimated manufacturing cost and ordering cost are indicated. Coefficient tables (Table 13-14) indicate the regression equation and also the relationship of each construct based on the significance (i.e. p-value). So, it can be discerned whether sharing information through internal integration of supply chain positively influence on unit manufacturing cost or not. Also, the same analysis is performed to find the impact of sharing information through internal integration of supply chain on ordering costs. Therefore it can be understood by the results that what impact does sharing information through internal integration of supply chain puts on supply chain performance in term of cost.

**Table 13 Coefficients of information sharing through internal integration and unit manufacturing cost**

		Coefficients <sup>a</sup>				
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant) ( $\beta_1$ )	2,377	,177		13,425	,000
	Sharing information with purchasing department ( $X_1$ )	-,109	,056	-,107	-1,946	,052
	Sharing information with sales department ( $X_2$ )	,146	,054	,149	2,704	,007

a. Dependent Variable: Unit manufacturing cost

According to Table 13, estimated unit manufacturing cost is indicated as follows:

$$y_1 = 2.377 - 0.109 X_1 + 0.146 X_2$$

Where:

$y_1 =$  Unit manufacturing cost

$X_1 =$  Sharing information with purchasing department

$X_2 =$  Sharing information with sales department

The significance of the coefficients (i.e. p-value) indicates that the null hypothesis is rejected ( $p < 0.05$ ). It means that unit manufacturing costs decreased by increasing sharing information internally.

**Table 14 Coefficients of information sharing through internal integration and ordering costs**

		Coefficients <sup>b</sup>				
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant) ( $\beta_2$ )	2,262	,158		14,344	,000
	Sharing information with purchasing department ( $X_1$ )	-,099	,050	-,110	-1,984	,048
	Sharing information with sales department ( $X_2$ )	,150	,048	,172	3,105	,002

b. Dependent Variable: Ordering costs



According to Table 14, estimated unit manufacturing cost is indicated as follows:

$$y_2 = 2.262 - 0.099 X_1 + 0.150 X_2$$

Where:

$y_2 =$  Ordering costs

$X_1 =$  Sharing information with purchasing department

$X_2 =$  Sharing information with sales department

The significance of the coefficients (i.e. p-value) indicates that the null hypothesis is rejected ( $p < 0.05$ ). It means that ordering costs decreased by increasing sharing information internally. As a result, by adding  $y_1$  and  $y_2$  the estimated model for supply chain performance in term of cost is made.

$$y_1 + y_2 = 4.639 - 0.208 X_1 + 0.296 X_2$$

In order to find relationship of supply chain performance in term of costs (unit manufacturing cost and ordering cost) and internal integration of information sharing, analysis of variance (ANOVA) is carried out. ANOVA shows that whether there is a linear relationship between dependent and independent variable. ANOVA indicates a significant difference in the mean extent of each factor at a 0.05 level of significance.

**Table 15 ANOVA (information sharing through internal integration and supply chain performance in term of costs)**

ANOVA <sup>a</sup>						
Model	Sum of Squares	df	Mean Square	F	Sig.	
1	Regression	7,019	2	3,510	3,722	,025 <sup>b</sup>
	Residual	489,450	519	,943		
	Total	496,469	521			

a. Dependent Variable: Unit manufacturing cost

b. Predictors: (Constant), Sharing information with sales department, Sharing information with purchasing department

ANOVA<sup>c</sup>

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	7,228	2	3,614	4,824	,008 <sup>d</sup>
Residual	386,610	516	,749		
Total	393,838	518			

c. Dependent Variable: Ordering costs

d. Predictors: (Constant), Sharing information with sales department, Sharing information with purchasing department

The ANOVA in Table 15 indicates that the null hypothesis is rejected. So, there is not a significant difference between supply chain performance in term of cost and internal integration of supply chain ( $p < 0.05$ ). ANOVA table indicates that the regression model predicts the outcome variable significantly well. Overall, the applied model can statistically significantly predict the outcome variables. So, there is not statistically significant difference in the mean costs and internal integration of supply chain through information sharing. Therefore, it can be concluded that ***H1*** is accepted by the data.

#### 4.3.2 Internal integration and supply chain performance in term of time:

Descriptive statistics (see Table16) indicates that supply chain performance in term of time (Manufacturing lead time and procurement lead time) has slightly decreased. Internal integration of supply chain through sharing information has increased.

**Table 16 Descriptive statistics of supply chain performance in term of time and sharing information through internal integration**

Construct	N	Mean	Std. Deviation	Variance
Manufacturing lead time	543	2,82	,961	,923
Procurement lead time	539	2,71	,901	,811
Sharing information with purchasing department	541	3,57	,965	,931
Sharing information with sales department	541	3,54	1,004	1,008
Valid N (listwise)	517			

According to Table 16, it can be understood that sharing information is increased while supply chain performance is decreased. So, Pearson correlation and coefficient analysis can be performed to find the relationship of each construct to other construct.

**Table 17 Correlations of information sharing through internal integration and supply chain performance in term of time**

		<b>Manufacturing lead time</b>	Sharing information with purchasing department	Sharing information with sales department
Pearson Correlation	Manufacturing lead time	1,000	,080	,113
	Sharing information with purchasing department	,080	1,000	,611
	Sharing information with sales department	,113	,611	1,000
Sig. (1-tailed)	Manufacturing lead time	.	,033	,005
	Sharing information with purchasing department	,033	.	,000
	Sharing information with sales department	,005	,000	.

		<b>Procurement lead time</b>	Sharing information with purchasing department	Sharing information with sales department
Pearson Correlation	Procurement lead time	1,000	,019	,082
	Sharing information with purchasing department	,019	1,000	,617
	Sharing information with sales department	,082	,617	1,000
Sig. (1-tailed)	Procurement lead time	.	,331	,032
	Sharing information with purchasing department	,331	.	,000
	Sharing information with sales department	,032	,000	.

### **Pearson correlation analysis:**

Manufacturing lead time and sharing information with purchasing department are correlated. It correlates with sharing information with sales department also. According to significant analysis of sharing information with purchasing department ( $0.033 < 0.05$ ), the null hypothesis is rejected. It means that there is a statistically significant correlation between manufacturing lead time and sharing information with purchasing department. So, there is a significant correlation between manufacturing lead time decrease and enhancing sharing information with purchasing department. Specifically, the statistical significance of the correlation model is applied. Besides, There is a significant correlation between decreasing manufacturing lead time and enhancing sharing information with sales department (null hypothesis is rejected), so there is a positive correlation ( $0.005 < 0.05$ ).

The same results are calculated for decreasing procurement lead time and enhancing internal integration of supply chain through information sharing. According to Table 17, There is a significant difference ( $0.331 > 0.05$ ) between increasing sharing information with purchasing department and decreasing procurement lead time. It means that the significance of the correlation model is not applied while increasing sharing information with sales department has a positive correlation with ordering cost ( $0.032 < 0.05$ ).

In order to investigate estimated supply chain performance in term of time based on internal integration of supply chain coefficients tables are brought. Estimated manufacturing lead time and procurement are indicated. Coefficient tables (Table 18-19) indicate the regression equation and also the relationship of each construct based on the significance (i.e. p-value). So, it can be discerned whether sharing information through internal integration of supply chain positively influence on manufacturing lead time or not. Also, the same analysis is performed to find the impact of sharing information through internal integration of supply chain on procurement lead time. Therefore it can be understood by the results that what impact does sharing information through internal integration of supply chain puts on supply chain performance in term of time.

**Table 18 Coefficients of information sharing through internal integration and unit manufacturing lead time**

Model		Coefficients <sup>a</sup>				
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,419	,174		13,872	,000
	Sharing information with purchasing department ( $X_1$ )	,018	,055	,018	,332	,740
	Sharing information with sales department ( $X_2$ )	,098	,053	,101	1,843	,066

a. Dependent Variable: Manufacturing lead time

According to Table 18, estimated manufacturing lead time is indicated as follows:

$$y_3 = 2.419 + 0.18 X_1 + 0.098 X_2$$

Where:

$y_3 =$  Manufacturing lead time

$X_1 =$  Sharing information with purchasing department

$X_2 =$  Sharing information with sales department

The regression equation and coefficient table indicate that manufacturing lead time can predict from sharing information with purchasing and sales department. The significance of the coefficients (i.e. p-value) shows sharing information with purchasing department and sales department do not contribute significantly to the model.

**Table 19 Coefficients of information sharing through internal integration and unit procurement lead time**

Model		Coefficients <sup>a</sup>				
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,527	,164		15,407	,000
	Sharing information with purchasing department	-,047	,052	-,050	-,905	,366
	Sharing information with sales department	,102	,050	,113	2,024	,044

a. Dependent Variable: Procurement lead time

According to Table 19, estimated manufacturing lead time is indicated as follows:

$$y_4 = 2.527 - 0.047 X_1 + 0.102 X_2$$

Where:

$y_4$  = Procurement lead time

$X_1$  = Sharing information with purchasing department

$X_2$  = Sharing information with sales department

The regression equation and coefficient table indicate that procurement lead time can predict from sharing information with purchasing and sales department. The significance of the coefficients (i.e. p-value) shows that both the constant and sharing information with sales department contribute significantly to the model. On the other hand, sharing information with sales department does not contribute significantly to the model. As a result, by adding  $y_3$  and  $y_4$  the estimated model for supply chain performance in term of cost is made:

$$y_3 + y_4 = 4.946 + 0.227 X_1 + 0.2 X_2$$

In order to find relationship of supply chain performance in term of time (manufacturing lead time and procurement lead time) and internal integration of information sharing, analysis of variance (ANOVA) is carried out. ANOVA shows that whether there is a linear relationship between dependent and independent variable. ANOVA indicates a significant difference in the mean extent of each factor at a 0.05 level of significance.

**Table 20 ANOVA (information sharing through internal integration and supply chain performance in term of time)**

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6,291	2	3,146	3,397	.034 <sup>b</sup>
	Residual	481,563	520	,926		
	Total	487,855	522			

a. Dependent Variable: Manufacturing lead time

b. Predictors: (Constant), Sharing information with sales department, Sharing information with purchasing department

ANOVA<sup>c</sup>

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	3,495	2	1,748	2,143	,118 <sup>d</sup>
Residual	421,513	517	,815		
Total	425,008	519			

c. Dependent Variable: Procurement lead time

d. Predictors: (Constant), Sharing information with sales department, Sharing information with purchasing department

The ANOVA in Table 20 indicates that differences of decreasing manufacturing lead time and increasing internal integration of supply chain through information sharing are not significant ( $p < 0.05$ ). It means that the null hypothesis is rejected. While procurement lead time does not predict the internal integration of supply chain significantly well ( $p > 0.05$ ). So, increasing internal integration of supply chain through information sharing has slightly increase supply chain performance in term of time. Therefore, **H2** is accepted by the data.

#### 4.3.3 External integration and supply chain performance in term of Cost:

Descriptive statistics (see Table 21) indicates that supply chain performance in term of cost (Unit manufacturing cost and ordering costs) has slightly increased. Sharing information through external integration of supply chain has increased.

**Table 21 Descriptive statistics of supply chain performance in term of cost and sharing information through external integration**

Construct	N	Mean	Std. Deviation	Variance
Unit manufacturing cost	542	2,50	,976	,953
Ordering costs	538	2,44	,874	,765
Sharing information with key suppliers	536	3,32	,960	,921
Sharing information with key customers	532	3,14	1,128	1,273
Valid N (listwise)	507			

According to Table 21, it can be understood that sharing information is increased while supply chain performance is decreased. In order to find how sharing information through external integration influence on supply chain performance in term of cost, Pearson correlation and coefficient analysis can be performed to find the relationship of each construct to other construct.

**Table 22 Correlations of information sharing through external integration and supply chain performance in term of costs**

		Unit manufacturing cost	Sharing information with key suppliers	Sharing information with key customers
Pearson Correlation	Unit manufacturing cost	1,000	,024	-,006
	Sharing information with key suppliers	,024	1,000	,496
	Sharing information with key customers	-,006	,496	1,000
Sig. (1-tailed)	Unit manufacturing cost	.	,291	,450
	Sharing information with key suppliers	,291	.	,000
	Sharing information with key customers	,450	,000	.

		Ordering costs	Sharing information with key suppliers	Sharing information with key customers
Pearson Correlation	Ordering costs	1,000	,085	,054
	Sharing information with key suppliers	,085	1,000	,494
	Sharing information with key customers	,054	,494	1,000
Sig. (1-tailed)	Ordering costs	.	,028	,112
	Sharing information with key suppliers	,028	.	,000
	Sharing information with key customers	,112	,000	.



### **Pearson correlation analysis:**

Unit manufacturing cost and sharing information with key suppliers are correlated while it does not correlate with sharing information with key customers. According to significant analysis of sharing information with key suppliers ( $0.291 > 0.05$ ), the null hypothesis is not rejected. It means that there is not a statistically significant correlation between unit manufacturing cost and sharing information with key suppliers. So, there is a not significant correlation between unit manufacturing cost decrease and enhancing sharing information with key suppliers. Specifically, the statistical significance of the correlation model is not applied. Besides, There is a not significant correlation between decreasing unit manufacturing cost and enhancing sharing information with key customers, so there null hypothesis is not rejected ( $0.450 > 0.05$ ).

The same results are calculated for decreasing ordering costs and enhancing external integration of supply chain through information sharing. According to Table 22, There is a significant correlation ( $0.028 < 0.05$ ) between increasing sharing information with key suppliers and decreasing ordering costs (i.e. null hypothesis is rejected). It means that the significance of the correlation model is applied while increasing sharing information with key customers is not significantly correlated with ordering cost ( $0.112 > 0.05$ ).

In order to investigate estimated supply chain performance in term of cost based on external integration of supply chain coefficients tables are brought. Estimated manufacturing cost and ordering cost are indicated. Coefficient tables (Table 23-24) indicate the regression equation and also the relationship of each construct based on the significance (i.e. p-value). So, it can be understood whether sharing information through external integration of supply chain positively influence on unit manufacturing cost or not. Also, the same analysis is performed to find the impact of sharing information through external integration of supply chain on ordering costs. Therefore it can be discerned by the results that what impact does sharing information through external integration of supply chain puts on supply chain performance in term of cost.

**Table 23 Coefficients of information sharing through external integration and unit manufacturing cost**

Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,450	,165		14,881	,000
	Sharing information with key suppliers ( $X_3$ )	,037	,052	,036	,705	,481
	Sharing information with key customers ( $X_4$ )	-,020	,044	-,023	-,458	,647

a. Dependent Variable: Unit manufacturing cost

According to Table 23, estimated unit manufacturing cost through external integration of supply chain is indicated as follows:

$$Z_1 = 2.450 + 0.037 X_3 - 0.020 X_4$$

Where:

$Z_1 =$  Unit manufacturing cost

$X_3 =$  Sharing information with key suppliers

$X_4 =$  Sharing information with key customers

The regression equation and coefficient table indicates that unit manufacturing cost can predict from sharing information with key suppliers and customers. The significance of the coefficients (i.e. p-value) shows that both sharing information with key suppliers and customers do not contribute significantly to the model ( $p > 0.05$ ).

**Table 24 Coefficients of information sharing through external integration and ordering costs**

Coefficients <sup>a</sup>						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,163	,147		14,667	,000
	Sharing information with key suppliers	,070	,047	,077	1,513	,131
	Sharing information with key customers	,012	,039	,016	,314	,753

a. Dependent Variable: Ordering costs

According to Table 24, estimated procurement cost through external integration of supply chain is indicated as follows:

$$Z_2 = 2.163 + 0.070 X_3 + 0.012 X_4$$

Where:

$Z_2 = \text{Ordering costs}$

$X_3 = \text{Sharing information with purchasing department}$

$X_4 = \text{Sharing information with sales department}$

The regression equation and coefficient table indicates that procurement cost can predict from sharing information with key suppliers and customers. The significance of the coefficients (i.e. p-value) shows that both sharing information with key suppliers and customers do not contribute significantly to the model ( $p > 0.05$ ). It means that ordering costs do not decreased highly by increasing sharing information internally. As a result, by adding  $Z_1$  and  $Z_2$  the estimated model for supply chain performance in term of cost is made:

$$Z_1 + Z_2 = 3.613 + 0.107 X_3 - 0.008 X_4$$

In order to find relationship of supply chain performance in term of costs (unit manufacturing cost and ordering cost) and external integration of information sharing through information sharing, analysis of variance (ANOVA) is carried out. ANOVA shows that whether there is a linear relationship between dependent and independent variable. ANOVA indicates a significant difference in the mean extent of each factor at a 0.05 level of significance.

**Table 25 ANOVA (information sharing through external integration and supply chain performance in term of costs)**

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	,488	2	,244	,256	,774 <sup>b</sup>
	Residual	485,722	510	,952		
	Total	486,211	512			

a. Dependent Variable: Unit manufacturing cost

b. Predictors: (Constant), Sharing information with key customers, Sharing information with key suppliers

ANOVA<sup>c</sup>

Model	Sum of Squares	df	Mean Square	F	Sig.
1					
Regression	2,866	2	1,433	1,890	,152 <sup>d</sup>
Residual	384,498	507	,758		
Total	387,365	509			

c. Dependent Variable: Ordering costs

d. Predictors: (Constant), Sharing information with key customers, Sharing information with key suppliers

The ANOVA in Table 25 indicates that these differences are significant ( $p > 0.05$ ). ANOVA table indicates that the regression model does not predict the outcome variable significantly well. So, there is statistically significant difference in the mean costs and external integration of supply chain through information sharing. Therefore, it can be concluded that increasing external integration of supply chain through information sharing causes not to decrease supply chain performance in term of costs. So, **H3** is not accepted by the data.

#### 4.3.4 External integration and supply chain performance in term of Time:

Descriptive statistics (See Table 26) indicates that supply chain performance in term of time (Manufacturing lead time and procurement lead time) has slightly improved. Internal integration of supply chain through sharing information has increased. In order to find correlation of items, a Pearson correlation analysis is performed (see Table 27)

**Table 26 Descriptive statistics of supply chain performance in term of time and sharing information through external integration**

<b>Construct</b>	<b>N</b>	<b>Mean</b>	<b>Std. Deviation</b>	<b>Variance</b>
Manufacturing lead time	543	2,82	,961	,923
Procurement lead time	539	2,71	,901	,811
Sharing information with key suppliers	536	3,32	,960	,921
Sharing information with key customers	532	3,14	1,128	1,273
Valid N (listwise)	507			

According to Table 26, it can be understood that sharing information is increased while supply chain performance is decreased. In order to find how sharing information through external integration influence on supply chain performance in term of time, Pearson correlation and coefficient analysis can be performed to find the relationship of each construct to other construct.

**Table 27 Correlations of information sharing through external integration and supply chain performance in term of time**

		Manufacturing lead time	Sharing information with key suppliers	Sharing information with key customers
Pearson Correlation	Manufacturing lead time	1,000	,102	,042
	Sharing information with key suppliers	,102	1,000	,496
	Sharing information with key customers	,042	,496	1,000
Sig. (1-tailed)	Manufacturing lead time	.	,011	,171
	Sharing information with key suppliers	,011	.	,000
	Sharing information with key customers	,171	,000	.

		Procurement lead time	Sharing information with key suppliers	Sharing information with key customers
Pearson Correlation	Procurement lead time	1,000	,100	,145
	Sharing information with key suppliers	,100	1,000	,497
	Sharing information with key customers	,145	,497	1,000
Sig. (1-tailed)	Procurement lead time	.	,012	,000
	Sharing information with key suppliers	,012	.	,000
	Sharing information with key customers	,000	,000	.

**Pearson correlation analysis:**

Decreasing manufacturing lead time and enhancing sharing information with key suppliers are correlated. It correlates slightly with sharing information with key customers also. According to significant analysis of sharing information with key suppliers ( $0.011 < 0.05$ ), the null hypothesis is rejected. It means that there is a statistically significant correlation between manufacturing lead time and sharing information with key suppliers. Specifically, the

statistical significance of the correlation model is applied. while, There is no significant correlation between decreasing manufacturing lead time and enhancing sharing information key customers, so there is null hypothesis is not rejected ( $0.171 > 0.05$ ).

The same results are calculated for decreasing procurement lead time and enhancing internal integration of supply chain through information sharing. According to Table26, There is a significant correlation ( $0.012 < 0.05$ ) between increasing sharing information with key customers and decreasing procurement lead time. It means that the significance of the correlation model is applied (i.e. null hypothesis is rejected). Besides, increasing sharing information with sales department has a positive correlation with ordering cost ( $0.0004 < 0.05$ ).

In order to investigate estimated supply chain performance in term of time based on external integration of supply chain coefficients tables are brought. Estimated manufacturing lead time and procurement lead time are indicated. Coefficient tables (Table 28-29) indicate the regression equation and also the relationship of each construct based on the significance (i.e. p-value). So, it can be understood whether sharing information through external integration of supply chain positively influence on manufacturing lead time or not. Also, the same analysis is performed to find the impact of sharing information through external integration of supply chain on procurement lead time. Therefore it can be discerned by the results that what impact does sharing information through external integration of supply chain puts on supply chain performance in term of time.

**Table 28 Coefficients of information sharing through external integration and manufacturing lead time**

**Coefficients<sup>a</sup>**

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,499	,162		15,445	,000
	Sharing information with key suppliers ( $X_3$ )	,108	,051	,107	2,113	,035
	Sharing information with key customers ( $X_4$ )	-,009	,043	-,011	-,218	,827

a. Dependent Variable: Manufacturing lead time

According to Table 27, estimated manufacturing lead time through external integration of supply chain is indicated as follows:

$$Z_3 = 2.499 + 0.108 X_3 - 0.009 X_4$$

Where:

- $Z_3 =$  Manufacturing lead time
- $X_3 =$  Sharing information with key suppliers
- $X_4 =$  Sharing information with key customers

The regression equation and coefficient table indicates that manufacturing lead time can predict from sharing information with key suppliers and customers. The significance of the coefficients (i.e. p-value) shows that the sharing information with key suppliers contributes significantly to the model while it does not have contribution with key customers.

**Table 29 Coefficients of information sharing through external integration and procurement lead time**

Model		Coefficients <sup>a</sup>				
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	2,291	,151		15,128	,000
	Sharing information with key suppliers	,035	,048	,037	,738	,461
	Sharing information with key customers	,101	,040	,127	2,505	,013

a. Dependent Variable: Procurement lead time

According to Table 29, estimated procurement lead time through external integration of supply chain is indicated as follows:

$$Z_4 = 2.291 + 0.035 X_3 + 0.101 X_4$$

Where:

- $Z_4 =$  Procurement lead time
- $X_3 =$  Sharing information with key suppliers
- $X_4 =$  Sharing information with key customers



The regression equation and coefficient table indicates that procurement lead time can predict from sharing information with key suppliers and customers. The significance of the coefficients (i.e. p-value) shows that both the sharing information with key customers contributes significantly to the model ( $p > 0.05$ ) while sharing information with key suppliers does not. As a result, by adding  $Z_3$  and  $Z_4$  the estimated model for supply chain performance in term of time is made.

$$Z_3 + Z_4 = 4.79 + 0.143 X_3 - 0.092 X_4$$

In order to find relationship of supply chain performance in term of time (unit manufacturing cost and ordering cost) and external integration of information sharing through information sharing, analysis of variance (ANOVA) is carried out. ANOVA shows that whether there is a linear relationship between dependent and independent variable. ANOVA indicates a significant difference in the mean extent of each factor at a 0.05 level of significance.

**Table 30 ANOVA (information sharing through external integration and supply chain performance in term of time)**

**ANOVA<sup>a</sup>**

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	4,957	2	2,479	2,690	,069 <sup>b</sup>
Residual	469,947	510	,921		
Total	474,904	512			

- a. Dependent Variable: Manufacturing lead time
- b. Predictors: (Constant), Sharing information with key customers, Sharing information with key suppliers

**ANOVA<sup>c</sup>**

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	9,177	2	4,588	5,752	,003 <sup>d</sup>
Residual	404,392	507	,798		
Total	413,569	509			

- c. Dependent Variable: Procurement lead time
- d. Predictors: (Constant), Sharing information with key customers, Sharing information with key suppliers

According to Table 30, analyses of variances are indicated. It can be discerned that decreasing manufacturing lead time has a statistically significant difference with increasing external

integration of supply chain through information sharing ( $0.069 > 0.05$ ). While there is no significant difference between decreasing procurement lead time and increasing external integration supply chain through information sharing ( $0.003 < 0.05$ ).

Taking into consideration that increasing external integration of supply chain through information sharing causes to highly decrease procurement lead time, while it decreases manufacturing lead time slightly .ANOVA table indicates that the regression model predicts the outcome variable significantly well. Therefore, it can be concluded that external integration of supply chain through information sharing affects positively supply chain performance in term of time. So **H4** is accepted by the data.

**4.3.5 Information sharing through internal and external integration of supply chain and ROS:**

Descriptive statistics (see Table 31) indicates that sharing information through internal/external integration in last three years has increased and ROS has slightly enhanced.

**Table 31 Descriptive statistics of sharing information through internal/external integration and ROS**

Construct	N	Mean	Std. Deviation	Variance
Sharing information with purchasing department	541	3,57	,965	,931
Sharing information with sales department	541	3,54	1,004	1,008
Sharing information with key suppliers	536	3,32	,960	,921
Sharing information with key customers	532	3,14	1,128	1,273
ROS	570	2,71	1,314	1,727
Valid N (listwise)	527			

According to Table 31, it can be understood that both sharing information and ROS are increased. In order to find how sharing information through internal/external integration influence on ROS, Pearson correlation and coefficient analysis can be performed to find the relationship of each construct to other construct.

**Table 32 Correlations of information sharing through internal/external integration and ROS**

		ROS	Sharing information with purchasing department	Sharing information with sales department	Sharing information with key suppliers	Sharing information with key customers
Pearson Correlation	ROS	1,000	-,017	-,007	,023	,019
	Sharing information with purchasing department	-,017	1,000	,615	,443	,327
	Sharing information with sales department	-,007	,615	1,000	,400	,377
	Sharing information with key suppliers	,023	,443	,400	1,000	,510
	Sharing information with key customers	,019	,327	,377	,510	1,000
Sig. (1-tailed)	ROS	.	,350	,436	,297	,333
	Sharing information with purchasing department	,350	.	,000	,000	,000
	Sharing information with sales department	,436	,000	.	,000	,000
	Sharing information with key suppliers	,297	,000	,000	.	,000
	Sharing information with key customers	,333	,000	,000	,000	.
N	ROS	527	527	527	527	527
	Sharing information with purchasing department	527	527	527	527	527
	Sharing information with sales department	527	527	527	527	527
	Sharing information with key suppliers	527	527	527	527	527
	Sharing information with key customers	527	527	527	527	527

**Pearson correlation analysis:**

There is not a correlation between enhancing sharing information internally and externally and increasing ROS. It means that enhancing information sharing in a supply chain will not enhance ROS and vice versa. According to significant analysis of sharing information with purchasing department ( $0.350 > 0.05$ ), the null hypothesis is not rejected. It means that there is not a statistically significant correlation between ROS and sharing information with purchasing department. Specifically, the statistical significance of the correlation model is not applied. The same result is occurred for sharing information with sales department, key suppliers, and key customers. So, the null hypothesis is not rejected which shows that there is not a significant correlation between sharing information and ROS (See Table 31).

In order to investigate estimated ROS based on sharing information through internal/external integration of supply chain, coefficients tables are brought. Coefficient table (Table 33) indicates the regression equation and also the relationship of each construct based on the significance (i.e. p-value). So, it can be understood whether sharing information through internal/external integration of supply chain positively influence on manufacturing lead time or not. Therefore it can be discerned by the results that what impact does sharing information through internal/external integration of supply chain remains on ROS.

**Table 33 Coefficients of information sharing through internal/external integration and ROS**

Coefficients <sup>a</sup>					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	2,729	,256		10,649	,000
1 Sharing information with purchasing department	-,043	,077	-,033	-,567	,571
Sharing information with sales department	-,007	,073	-,006	-,097	,922
Sharing information with key suppliers	,043	,073	,032	,593	,553
Sharing information with key customers	,017	,059	,015	,291	,771

a. Dependent Variable: ROS

According to Table 33, estimated manufacturing lead time through external integration of supply chain is indicated as follows:

$$Z_5 = 2.729 - 0.043 X_1 - 0.007 X_2 + 0.043 X_3 + 0.017 X_4$$

Where:

$$Z_5 = ROS$$

$$X_1 = \text{Sharing information with purchasing department}$$

$$X_2 = \text{Sharing information with sales department}$$

$$X_3 = \text{Sharing information with key suppliers}$$

$$X_4 = \text{Sharing information with key customers}$$

The regression equation and coefficient table indicates that ROS cannot predict from sharing information through internal/external integration of supply chain. The significance of the

coefficients (i.e. p-value) shows that the sharing information does not contribute significantly to the model.

In order to find relationship of ROS and sharing information, analysis of variance (ANOVA) is carried out. ANOVA clarifies that whether there is a linear relationship between mean of dependent and mean independent variable. ANOVA indicates not a significant difference in the mean extent of each construct at a 0.05 level of significance.

**Table 34 ANOVA (Information sharing through internal/external integration and ROS)**

ANOVA <sup>a</sup>					
Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	1,403	4	,351	,212	,932 <sup>b</sup>
Residual	862,525	522	1,652		
Total	863,928	526			

- a. Dependent Variable: ROS
- b. Predictors: (Constant), Sharing information with key customers, Sharing information with purchasing department, Sharing information with key suppliers, Sharing information with sales department

According to Table 34, analyses of variances are indicated. It can be discerned that increasing ROS has a statistically significant difference with increasing internal/external integration of supply chain through information sharing ( $0.932 > 0.05$ ). So, taking into the consideration the result, it can be understood that information sharing has negative impact on ROS and therefore ROI. Therefore, research question two is empirically tested to indicate the negative influence.

As it is stated in chapter 1, in order to investigate the correlation of ROS and supply chain performance in terms of cost and time, next section is delivered.

#### 4.3.6 ROS and supply chain performance in term of cost:

Descriptive statistics (see Table 35) indicates that supply chain performance in term of cost (Unit manufacturing cost and ordering costs) has slightly increased. Sharing information through external integration of supply chain has increased.

**Table 35 Descriptive statistics of supply chain performance in term of cost and ROS**

Construct	N	Mean	Std. Deviation	Variance
Unit manufacturing cost	542	2,50	,976	,953
Ordering costs	538	2,44	,874	,765
ROS	570	2,71	1,314	1,727
Valid N (listwise)	537			

According to Table 35, it can be understood that ROS is increased while supply chain performance in term of cost is decreased. In order to investigate how ROS influence on supply chain performance in term of cost, Pearson correlation and coefficient analysis can be performed to find the relationship of each construct to other constructs.

**Table 36 Correlations of supply chain performance in term of cost and ROS**

		Unit manufacturing cost	ROS
Pearson Correlation	Unit manufacturing cost	1,000	,156
	ROS	,156	1,000
Sig. (1-tailed)	Unit manufacturing cost	.	,000
	ROS	,000	.
N	Unit manufacturing cost	542	542
	ROS	542	542

		Ordering costs	ROS
Pearson Correlation	Ordering costs	1,000	,124
	ROS	,124	1,000
Sig. (1-tailed)	Ordering costs	.	,002
	ROS	,002	.
N	Ordering costs	538	538
	ROS	538	538

**Pearson correlation analysis:**

Unit manufacturing cost and ROS are correlated. According to significant analysis of ROS ( $0.0001 < 0.05$ ), the null hypothesis is rejected. It means that there is a statistically significant correlation between unit manufacturing cost and ROS. So, there is a significant correlation between decreasing unit manufacturing cost and ROS. Specifically, the statistical significance of the correlation model is highly applied.

The same results are calculated for decreasing ordering costs and enhancing ROS. According to Table 35, There is a significant correlation ( $0.002 < 0.05$ ) between increasing ROS and decreasing ordering costs. It means that the significance of the correlation model is applied (i.e. null hypothesis is rejected). According to Pearson correlation analysis it can be discerned that ROS is highly correlated to supply chain performance in term of costs.

In order to investigate estimated supply chain performance in term of cost based on ROS, coefficients tables are brought. Coefficient tables (Table 37-38) indicate the regression equation and also the relationship of each construct based on the significance (i.e. p-value). So, it can be understood whether ROS positively impact on unit manufacturing cost and ordering costs or not. Therefore it can be understood by the results that what impact ROS puts on supply chain performance in term of cost.

**Table 37 Coefficients of ROS and unit manufacturing cost**

Coefficients <sup>a</sup>					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	2,173	,098		22,185	,000
ROS	,119	,032	,156	3,680	,000

a. Dependent Variable: Unit manufacturing cost

According to Table 37, estimated unit manufacturing cost is indicated as follows:

$$y_1 = 2.173 + 0.119 K_1$$

Where:

$y_1 = \text{Unit manufacturing cost}$

$K_1 = \text{ROS}$

The significance of the coefficients (i.e. p-value) indicates that the null hypothesis is rejected ( $p < 0.05$ ). It means that unit manufacturing costs decreased by increasing ROS.

**Table 38 Coefficients of ROS and ordering costs**

Coefficients <sup>a</sup>					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	2,206	,089		24,793	,000
ROS	,085	,029	,124	2,899	,004

a. Dependent Variable: Ordering costs

According to Table 38, estimated ordering costs are indicated as follows:

$$y_2 = 2.206 + 0.085 K_1$$

Where:

$y_2 = \text{Ordering costs}$



$$K_1 = ROS$$

The significance of the coefficients (i.e. p-value) indicates that the null hypothesis is rejected ( $p < 0.05$ ). It means that ordering costs decreased by increasing ROS. As a result, by adding  $y_1$  and  $y_2$  the estimated model for supply chain performance in term of cost is made.

$$y_1 + y_2 = 4.379 + 0.204 K_1$$

In order to find relationship of supply chain performance in term of costs (unit manufacturing cost and ordering cost) and ROS, analysis of variance (ANOVA) is carried out. ANOVA shows that whether there is a linear relationship between dependent and independent variable. ANOVA indicates a significant difference in the mean extent of each factor at a 0.05 level of significance.

**Table 39 ANOVA (ROS and supply chain performance in term of costs)**

ANOVA <sup>a</sup>					
Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	12,612	1	12,612	13,543	,000 <sup>b</sup>
Residual	502,888	540	,931		
Total	515,500	541			

a. Dependent Variable: Unit manufacturing cost

b. Predictors: (Constant), ROS

ANOVA <sup>c</sup>					
Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	6,339	1	6,339	8,404	,004 <sup>d</sup>
Residual	404,258	536	,754		
Total	410,597	537			

c. Dependent Variable: Ordering costs

d. Predictors: (Constant), ROS

The ANOVA in Table 39 indicates that the null hypothesis is rejected. So, there is not a significant difference between supply chain performance in term of cost and ROS ( $p < 0.05$ ). ANOVA table indicates that the regression model predicts the outcome variable significantly very well. Overall, the applied model can statistically significantly predict the outcome variables. So, there is not statistically significant difference in the mean costs and ROS.

Therefore, it can be understood that ROS and ROI as financial aspect of supply chain performance has positive impact on supply chain performance in term of costs.

**4.3.7 ROS and supply chain performance in term of time:**

Descriptive statistics (see Table 40) indicates that supply chain performance in term of cost (Unit manufacturing cost and ordering costs) has slightly increased. Sharing information through external integration of supply chain has increased.

**Table 40 Descriptive statistics of supply chain performance in term of time and ROS**

Construct	N	Mean	Std. Deviation	Variance
ROS	570	2,71	1,314	1,727
Manufacturing lead time	543	2,82	,961	,923
Procurement lead time	539	2,71	,901	,811
Valid N (listwise)	536			

According to Table 40, it can be understood that ROS is increased while supply chain performance in term of time is decreased. In order to investigate how ROS influence on supply chain performance in term of time, Pearson correlation and coefficient analysis can be performed to find the relationship of each construct to other constructs.

**Table 41 Correlations of supply chain performance in term of time and ROS**

		Manufacturing lead time	ROS
Pearson Correlation	Manufacturing lead time	1,000	,093
	ROS	,093	1,000
Sig. (1-tailed)	Manufacturing lead time	.	,015
	ROS	,015	.
N	Manufacturing lead time	543	543
	ROS	543	543

		Procurement lead time	ROS
Pearson Correlation	Procurement lead time	1,000	,037
	ROS	,037	1,000
Sig. (1-tailed)	Procurement lead time	.	,192
	ROS	,192	.
N	Procurement lead time	539	539
	ROS	539	539

**Pearson correlation analysis:**

Manufacturing lead time and ROS are correlated while procurement lead time is not correlated. According to significant analysis of ROS ( $0.015 < 0.05$ ), the null hypothesis is rejected. It means that there is a statistically significant correlation between manufacturing lead time and ROS. So, there is a significant correlation between decreasing manufacturing lead time and ROS. Specifically, the statistical significance of the correlation model is applied.

On the other hand, calculated results reveal that decreasing procurement lead time does not make by enhancing ROS. According to Table 40, There is not a significant correlation ( $0.192 > 0.05$ ) between increasing ROS and decreasing procurement lead time. It means that the significance of the correlation model is not applied (i.e. null hypothesis is rejected). According to Pearson correlation analysis it can be discerned that ROS slightly correlated with ROS.

In order to investigate estimated supply chain performance in term of time based on ROS, coefficients tables are brought. Coefficient tables (Table 42-43) indicate the regression equation and also the relationship of each construct based on the significance (i.e. p-value). So, it can be understood whether ROS positively impact on manufacturing lead time and procurement lead time or not. Therefore it can be understood by the results that what impact ROS puts on supply chain performance in term of time.

**Table 42 Coefficients of ROS and manufacturing lead time**

Coefficients <sup>a</sup>					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	2,630	,096		27,326	,000
ROS	,069	,032	,093	2,178	,030

a. Dependent Variable: Manufacturing lead time

According to Table 42, estimated manufacturing lead time is indicated as follows:

$$y_3 = 2.630 + 0.069 K_1$$

Where:

$y_3 = \text{Manufacturing lead time}$

$K_1 = \text{ROS}$

The significance of the coefficients (i.e. p-value) indicates that the null hypothesis is rejected ( $p < 0.05$ ). It means that manufacturing lead time decreased by increasing ROS.

**Table 43 coefficients of ROS and procurement lead time**

Coefficients <sup>b</sup>					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1 (Constant)	2,641	,090		29,202	,000
ROS	,026	,030	,037	,870	,385

b. Dependent Variable: Procurement lead time

According to Table 43, estimated procurement lead time are indicated as follows:

$$y_4 = 2.641 + 0.026 K_1$$

Where:

$y_4 = \text{Procurement lead time}$

$$K_1 = ROS$$

The significance of the coefficients (i.e. p-value) indicates that the null hypothesis is not rejected ( $p > 0.05$ ). It means that procurement lead time does not decrease by increasing ROS. As a result, by adding  $y_1$  and  $y_2$  the estimated model for supply chain performance in term of time is made.

$$y_3 + y_4 = 5.271 + 0.095 K_1$$

In order to find relationship of supply chain performance in term of time (manufacturing lead time and procurement lead time) and ROS, analysis of variance (ANOVA) is carried out. ANOVA shows that whether there is a linear relationship between dependent and independent variable. ANOVA indicates a significant difference in the mean extent of each factor at a 0.05 level of significance.

**Table 44 ANOVA (ROS and supply chain performance in term of time)**

**ANOVA<sup>a</sup>**

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	4,348	1	4,348	4,743	,030 <sup>b</sup>
Residual	495,965	541	,917		
Total	500,313	542			

a. Dependent Variable: Manufacturing lead time

b. Predictors: (Constant), ROS

**ANOVA<sup>c</sup>**

Model	Sum of Squares	df	Mean Square	F	Sig.
1 Regression	,614	1	,614	,756	,385 <sup>b</sup>
Residual	435,813	537	,812		
Total	436,427	538			

c. Dependent Variable: Procurement lead time

d. Predictors: (Constant), ROS

The ANOVA in Table 44 indicates that the null hypothesis is rejected for manufacturing lead time while it is not rejected. So, there is not a significant difference between supply chain

performance in term of time and ROS ( $p < 0.05$ ). ANOVA table indicates that the regression model predicts the outcome variable significantly well. Overall, the applied model can statistically significantly predict the outcome variables. So, there is not statistically significant difference in the mean manufacturing lead time and ROS while procurement lead time does. Therefore, it can be understood that ROS and ROI as financial aspect of supply chain performance has positive impact on supply chain performance in term of time.

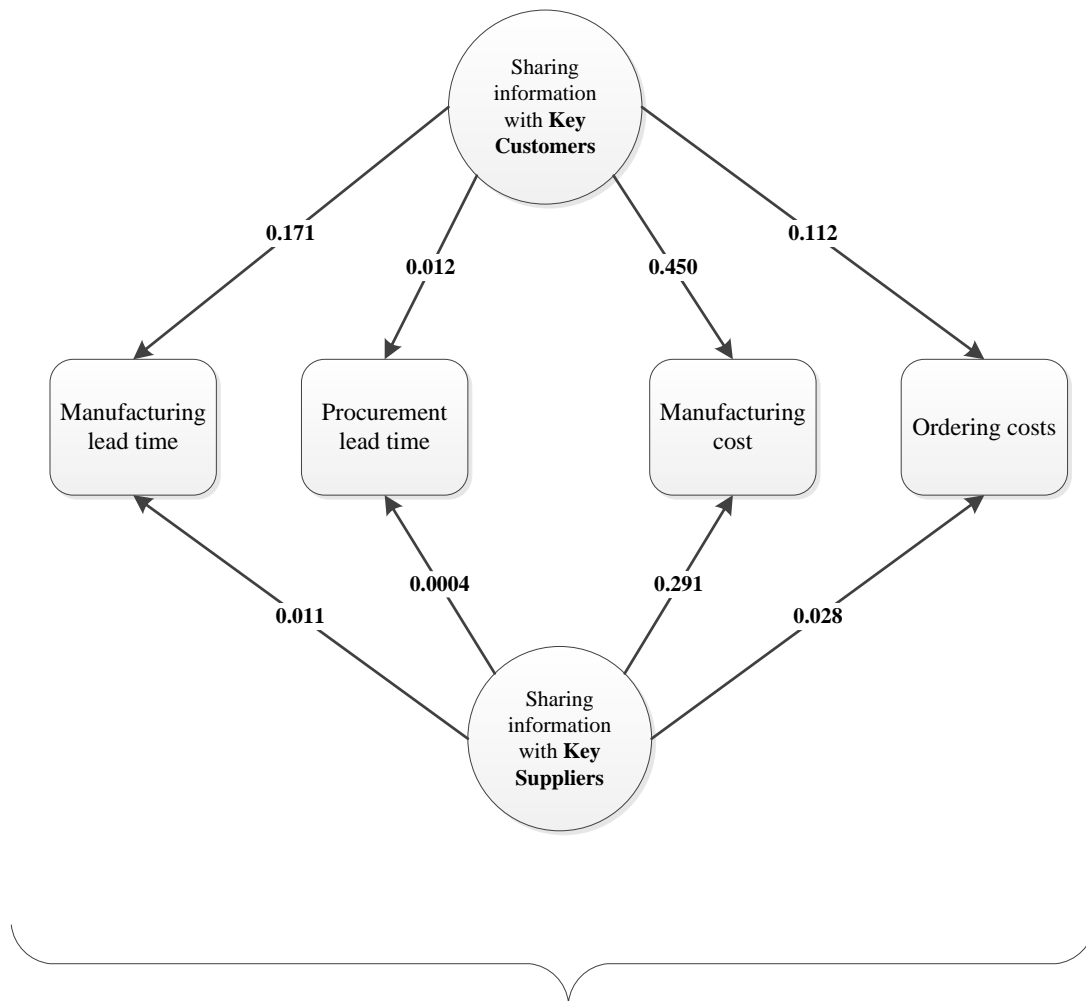
Taking the statistical results of ROS and supply chain performance into consideration, there is high positive relationship between ROS (and ROI) and supply chain performance. Also, according to chapter one, the relationship of ROI and supply chain performance is tested and the results reveals that there is high positive effect between them and they are totally correlated.

#### **4.4 Summary:**

This empirical study was conducted to answer the main research question through testing the four hypotheses and ROI analysis. Analyzing information sharing through internal and external integration of supply chain reveals that supply chain performance will be increased as information sharing enhances. Also, supply chain performance of SMEs has high positive relationship with ROS. According to Figure 31, three of the tested hypotheses are supported while one of the hypotheses is rejected based on IMSS-VI's data analysis. So, the role of information sharing through internal and external integration of supply chain and their positive impacts on supply chain performance and positive relationship of ROS with supply chain performance answer the designed research question and address the focus of this study.

Pearson correlation analysis figure indicates the p-value of each construct to determine whether each construct is significantly correlated or not (Figures 27-33). This means that sharing information is correlated significantly with supply chain performance in terms of costs and time. Although the Pearson correlation shows that information sharing is not significantly correlated with ROS, it indicates that ROS is significantly correlated with supply chain performance.

According to the Figure 27, it can be discerned that sharing information with key suppliers is significantly correlated with supply chain performance. On the other hand, sharing information with key customers is not highly correlated with supply chain performance. It is just significantly correlated with procurement lead time (based on 95 percent significant level). Therefore, it can be conceived that sharing information through external integration of supply chain is correlated with supply chain performance.

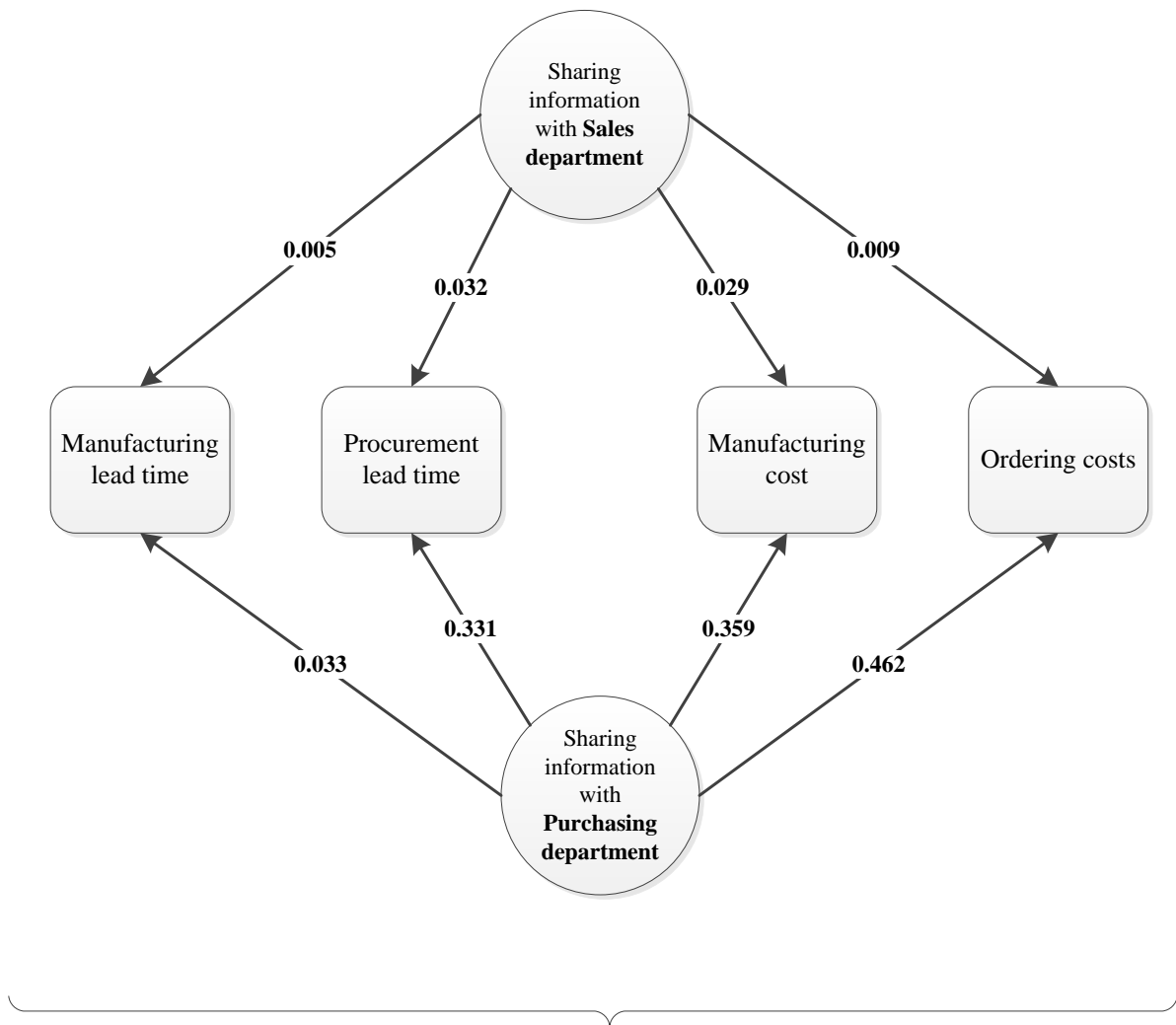


***EXTERNAL integration of supply chain through information sharing***

**Figure 27 Pearson correlations analysis (External Integration)**

In respect to analyzed with external integration, Pearson correlation is analyzed through internal integration of supply chain. Sharing information with sales department is significantly correlated to supply chain performance (p-value < 0.05). On the other hand, sharing information with purchasing department is not very significantly correlated to supply chain performance. It is just significantly correlated with manufacturing lead time. Therefore, it can be understood that sharing information through internal integration of supply chain is correlated with supply chain performance.

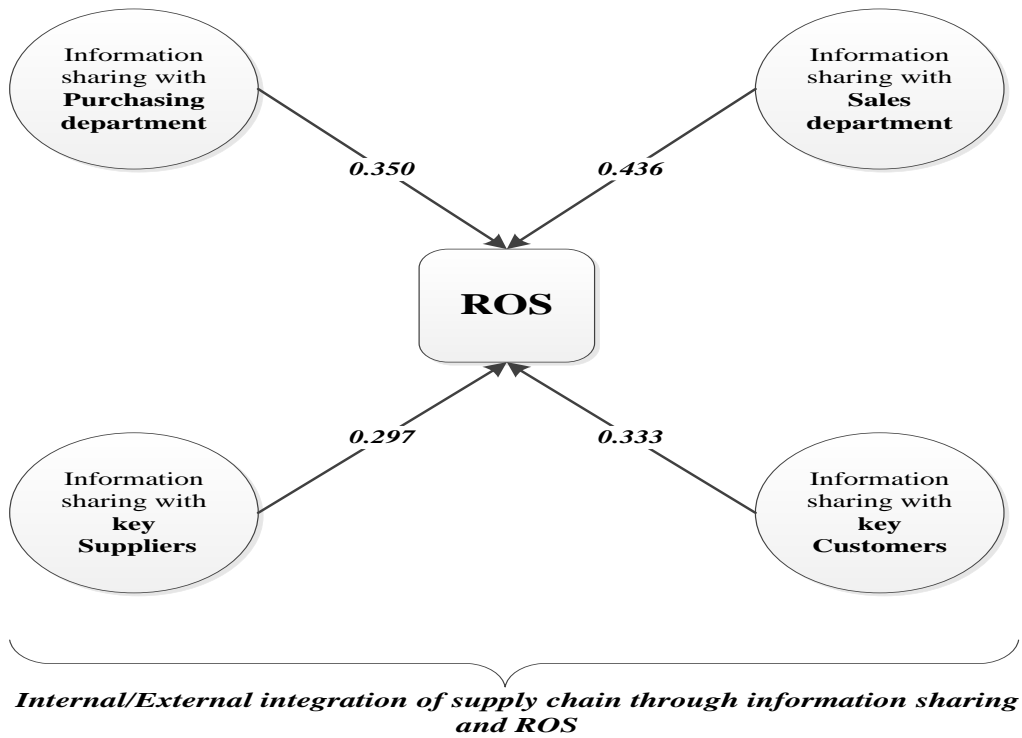




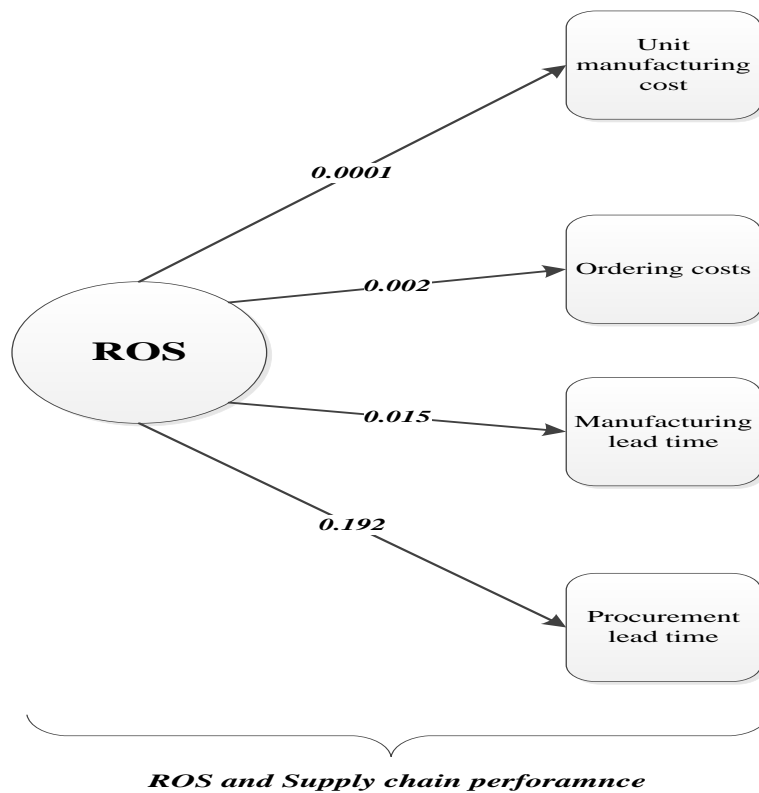
***INTERNAL integration of supply chain through information sharing***

**Figure 28 Pearson correlations analysis (internal Integration)**

According to figure 29, it can be discerned that information sharing is not significantly correlated with ROS. So, increasing information sharing cannot lead to increasing ROS and vice versa. On the other hand, ROS as an independent (See figure 30) factor have a highly significant correlation to supply chain performance. So, enhancing ROS leads to increase supply chain performance and vice versa. These two figures (Figure 29 and 30) clearly shows an important result of this study which will be discussed in chapter 5.



**Figure 29** Pearson correlations analysis (internal/external Integration and ROS)



**Figure 30** Pearson correlations analysis (ROS and supply chain performance)

ANOVA is conducted to identify any possible difference among mean of information sharing through supply chain integrations (i.e. externally and internally) and supply chain performance in terms of costs and time (See Figure 31). According to ANOVA, sharing information through external integration is not significantly different with supply chain performance in term of costs while it is significantly different with supply chain performance in term of time.

According to Figure 31, it can be discerned that sharing information through internal integration and supply chain performance does not have a significant difference. Only there is a significant difference with sharing information through internal integration and procurement lead time. Therefore, sharing information in supply chain integration whether internally and externally supports supply chain performance in terms of costs and time. So, there is a positive relationship between sharing information in supply chain supply chain performance in terms of cost and time.

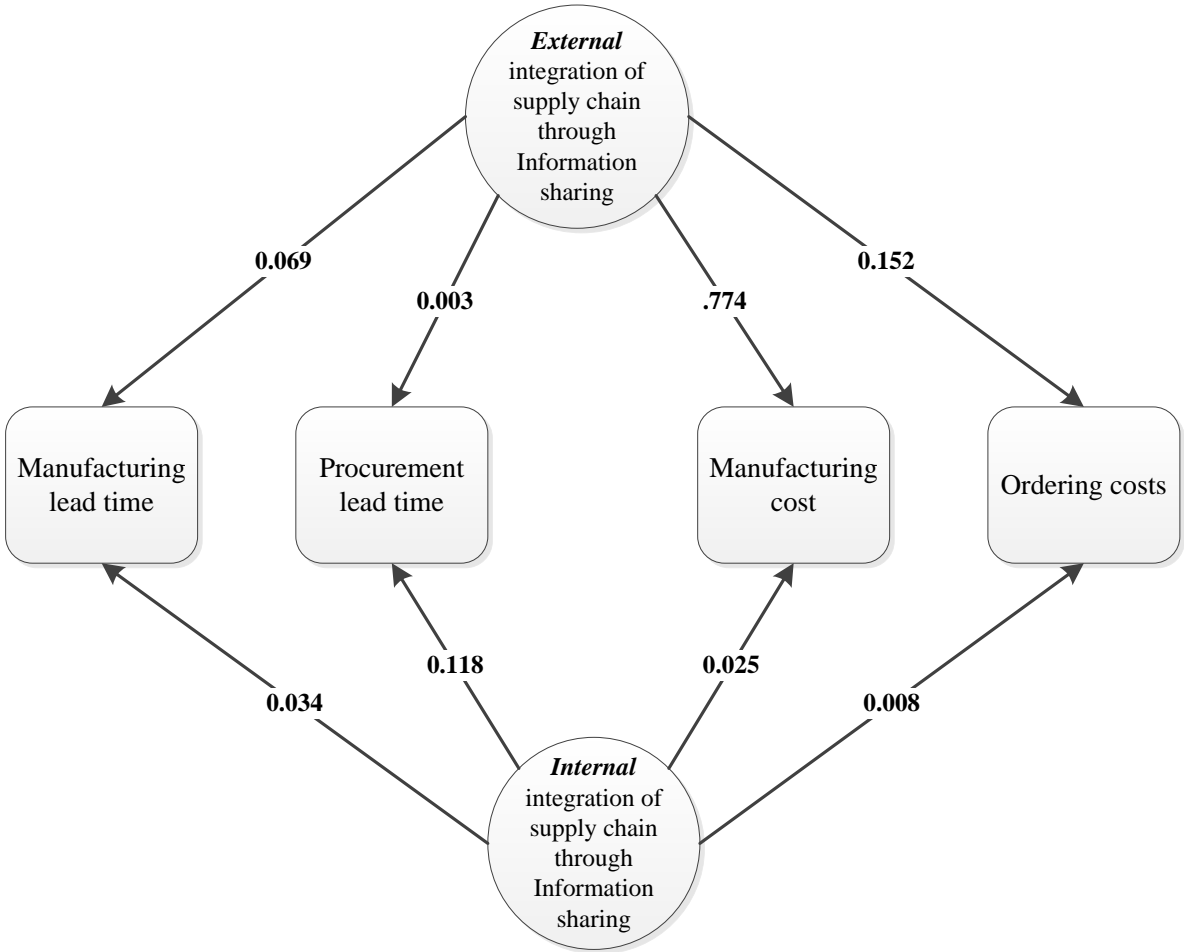


Figure 31 ANOVA (Information sharing and supply chain performance)

According to Figure 32, the mean of sharing have negative relationship on mean of ROS. So, enhancing of information sharing cannot support increasing of ROS. On the other hand, based on ANOVA analysis, ROS has positive relationship on supply chain performance (Figure 33). It means that there is not a significance difference between supply chain performance and ROS. Therefore, increasing sharing information in a supply chain can enhance supply chain performance while it cannot support ROS. Also, ROS has high positive relationship on supply chain performance (except procurement lead time).

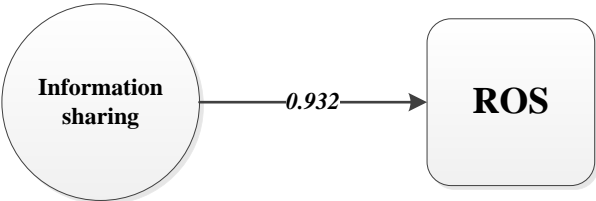


Figure 32 ANOVA (Information sharing and ROS)

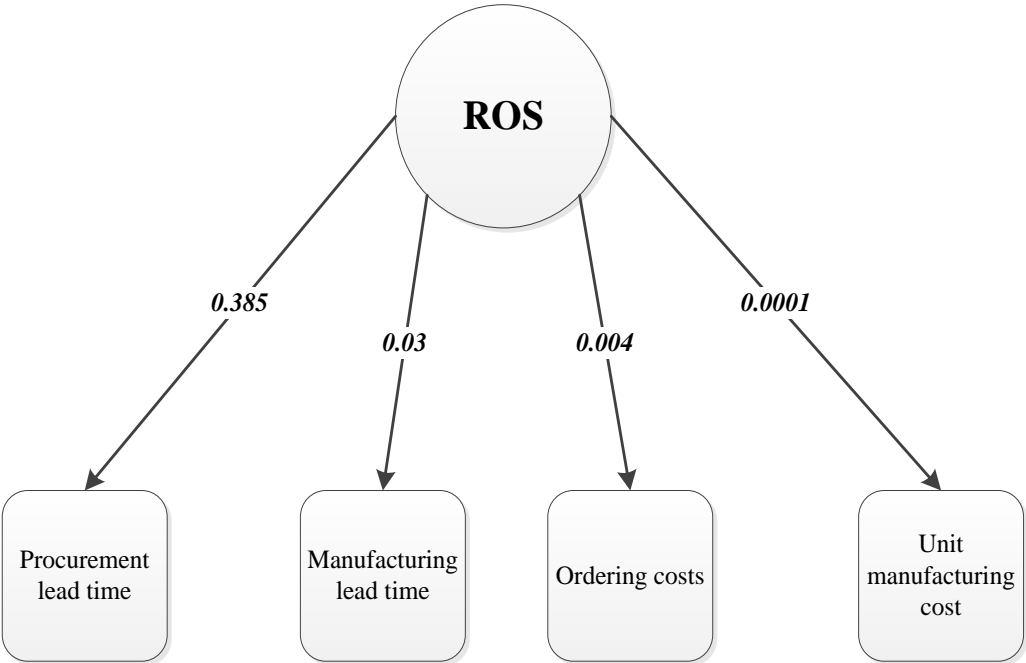
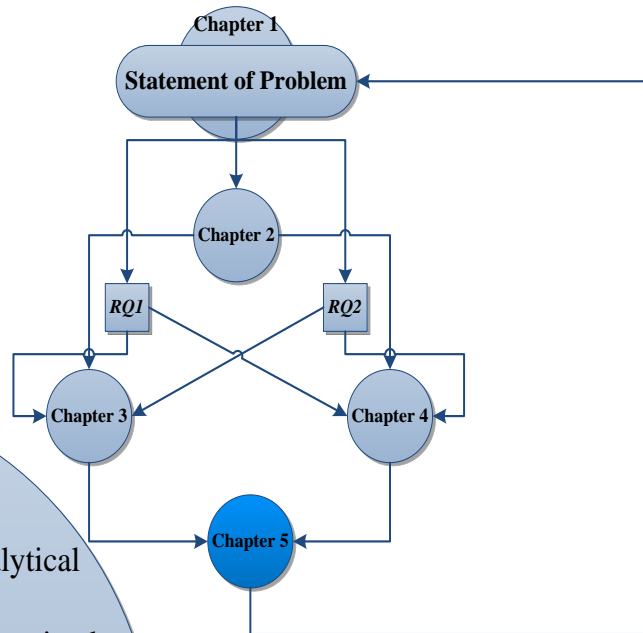


Figure 33 ANOVA (ROS and supply chain performance)

# Chapter 5 Discussion



## Chapter 5:

- Discuss results of empirical and analytical conceptual study
- Provide some reason to clarify the conceived empirical results
- Discuss why proposed hypotheses supported or not supported by empirical study
- Provide some topics for future researches

## 5.1 Discussion

Analyzing the relationships between approaches and technologies for information sharing and competitive advantage obtained by SMEs propels this study to conceptually and empirically test these relationships. By developing a model, this study sought to find analyze these relationships. Through this study, role of information sharing for gaining competitive advantage and using technologies as driver of information sharing and correlation of ROI and supply chain performance are discussed. By testing model 3 and ROI impact on supply chain performance, some valuable results achieved through analyzing the relationships.

According to model 3 which is developed for this study, information sharing can influence positively to gain high supply chain performance. Furthermore, technology can mediate in this process to streamline gaining competitive advantage (Model 4). The model 3 is analyzed both empirically (Through statistical analysis) and conceptually (Through analytical conceptual study). The upcoming results reveal that information sharing through supply chain integration support supply chain performance.

Testing conceptually and empirically the relationship between information sharing through internal and external integration of supply chain and the performance gained improvements are carried out for model 3. The empirical findings presented in this study support the claim that information sharing through internal and external integration reaps performance improvement benefits. While it is found that information sharing through external integration provides only minor performance improvement, sharing information through internal integration has the largest rates of improvement. Besides, using the technology (ERP) does not influence on enhancing supply chain performance across information sharing through external integration.

A key concept of this study for managers that set out to reap the benefits from information sharing through supply chain integration internally and externally is to gain competitive advantage by technologies as a driver of information sharing in a supply chain. Moreover, practitioners should be aware that a possible reason for the weak relationship between information sharing through external integration and supply chain performance may be the low level of supply chain collaboration. Indeed, it may be understood that several firms may

not have gained a minimum threshold in supply chain integration sufficient to yield underlying improvements. Therefore, as information sharing through supply chain integration gets more common and increasingly widespread, the relationship between information sharing through supply chain integration and supply chain performance improvement may become more prevalent in future research.

It should be taken into consideration that information integration in supply chain may encounter significant barriers. These may include type, scope, and security of information sharing (Chan & Felix TS, 2004; De Treville, 2004). According to (Harland, Caldwell, Powell, & Zheng, 2007), the major barrier to supply chain information integration is lack of strategic alignment of information strategies in the chain, firm size of some supply chain actors, lack of awareness of potential gains by technologies, lack of motivation, and being in less developed industry.

Bask and Juga (2001) claim that polarization in supply chain results to separation and increase semi-integration than full integration of information. Information sharing and interaction are substituted for administrative controls and transparency are enhanced through standardized technology for sharing information and supply chain performance evaluation is performed against internal and external integration (Bask & Juga, 2001).

Supply chain integration is generally conceived as an objective that has a positive performance concept. When the diction is come up with supply chain integration “More is better” seems to be a good idea. The challenge today is to combine integration, responsiveness, innovation, and flexibility (Bask & Juga, 2001). For some firms’ tight integration and for some others limited integration is an answer for enhancing supply chain performance. Therefore, increasing information sharing with business partners through external integration of supply chain may not lead to enhance supply chain performance.

Based on the statistical result of empirical study, information sharing has positive impact on supply chain performance while it cannot support ROI. This valuable result clarifies that enhancing sharing information for being responsive or being reliable and fast deliveries may incur SMEs high cost which decrease their ROI while across supply chain performance. So, ROI as financial aspect of supply chain performance which is highly related with costs may decrease through information sharing. Admittedly, as it is mentioned by both conceptual and

empirical ROI is highly related with supply chain performance and has a positive relationship with increasing supply chain performance.

Using technology like ERP which comprises the internal portion of enterprises (Hsu, 2013) can enhance information sharing through obtaining competitive advantage while it does not affect for external integration of supply chain. It can be understood that ERP organize mostly internal system through a supply chain by integrating operations processes and sharing information internally, so it may not affect directly on sharing information externally and supply chain performance is not decreased. Also, due to high cost of ERP system implementation for SMEs, it may push SMEs to increase their costs. Therefore, using technology for SMEs may not lead to enhance supply chain performance (costs) through external integration of supply chain.

There are significant challenges of co-operation between companies in attaining the required modifications in business culture, risk, and rewards (Boddy & David, 1998). Such difficulties takes place through implementation of information integration systems across firms' boundaries in a supply chain (Bagchi & Skjoett-Larsen, 2003). Sharing information is expected to decrease these difficulties through enhancing supply chain performance (Boddy & David, 1998).

Croom (2005) claims that one possible reason may be lack of practice. Based on (Harland et al., 2007) there are several researches on why SMEs are less likely to adopt technology to gain competitive advantage than larger firms. Few SMEs apply technologies as innovative tool (e.g. internet) (Levy, Powell, & Yetton, 2001). Mehrtens (2001) suggests that there are three main factors affecting SMEs decisions about implementing technologies (i.e. e-business): perceived benefits, organizational readiness, and external pressures. Firms adopting technologies seeks benefits which resulted in various forms. Besides, the firm should be ready for receiving technology (Mehrtens, 2001).

Although technology implementation is very significant in SMEs, there has been little empirical research within connected supply chains including SMEs seeking larger and smaller firms' perceptions if the value of supply chain information integration (Harland et al., 2007). Mohtadi and Kinsey (2005) has found that only large retailers are seeking to share information in the supply chain. It means that sharing information could be a Nash



equilibrium result. So, power strategy may lead to be a dominant player in supply chain to integrate (Cox, 2000). In this regards, T. M. Simatupang and Sridharan (2005) propose that market power imposes inventory cost and IT investment on business partners.

Information sharing strategies between parties in a supply chain are targeted at inventory management and decreasing of supply disorders. Mostly, information as retailer's strategic asset my increased the desire for implementing technologies (Mohtadi & Kinsey, 2005). Harland et al. (2007) have highlighted that smaller businesses are mostly less aware of full potential benefits of technologies (e.g. e-business and ERP). Moreover, SMEs have a great uncertainty in gaining competitive advantage through technology adoption for information sharing (Salmeron & Bueno, 2006). Therefore, managers of SMEs lead to compensate lack of information sharing through implementing technologies through their supply chain to gain competitive advantage(Cragg, 2002).

According to (Fisher, 1997), supply chains can be managed in accordance to the nature of the product being purchased, such as 'innovative' and 'functional' products. Taking into consideration the difference in managing between products types, it is reasonable to use technology for information sharing to get full potential benefits to obtain high supply chain performance. Therefore, implementing technology (e.g. ERP and e-business) can enhance information sharing through supply chain to gain competitive advantage. Also it may be wiser if firms implement integration of these two technologies (ERP and e-business) as one integrated tool to share information both internally and externally to achieve supply chain performance improvement.

## 6.1 Conclusion

This study is carried out to answer the main research question: Can SMEs enhance their supply chain performance based on information sharing? In order to address this question robustly two sub research questions are designed. Answering these questions propels this study to apply mixed research methods. Developing a model simplifies objectives of this study by indicating the competitive advantage obtained by SMEs through sharing information and using technologies as a driver of sharing information. It means that information sharing through supply chain of SMEs can lead to gain competitive advantage through accelerating information flow, minimizing respond time to customers, coordinating business partners, facilitating decision making, and therefore supply chain performance. A reason for indicating a relationship between information and competitive advantage is the information sharing undeniable role in supply chain through enhancing supply chain performance. Besides, approaches and technologies can play a significant role on gaining competitive advantage by providing information sharing through supply chain of SMEs. So, four outcomes can be delivered by this study: information sharing has a critical role in enhancing supply chain performance of SMEs, technologies and approaches play a considerable role in extending information sharing through SMEs' supply chain, replicating sharing information for gaining competitive advantage leads to decrease ROI, and ROI is highly correlated to supply chain performance. The reason for getting these outcomes is that importance of information sharing as one inseparable segment of supply chains seeking to gain competitive advantage and correlation of ROI to supply chain performance. Therefore, analyzing the developed model and through analytical conceptual and empirical study is managed.

**Table 45 Results**

<i>Information sharing through supply chain integration</i>	<i>SCP (Cost)</i>	<i>SCP (Time)</i>	<i>Results</i>
<i>Internal integration</i>	✓	✓	<i>Hypothesis 1 and 2 supported</i>
<i>External Integration</i>	x	✓	<i>Hypothesis 3 rejected, Hypothesis 4 supported</i>

Analytical conceptual and empirical study are carried out to address the first research question: Does information sharing influence supply chain performance? Analytical conceptual study provides several scholars who studied the relationship of information sharing through internal and external integration and supply chain performance through either by case or empirical study. Most of the articles offer a positive relationship between these two constructs. It means that increasing information sharing through internal (e.g. cross-functional team) and external (e.g. business partners) integration enhances supply chain performance (e.g. decreasing cost and time, developing flexibility, and enhancing quality). This study proposed four hypotheses based on these result in order to be tested by IMSS-VI's data empirically. Empirical Results (See Table, 45) clarify that information sharing through supply chain integration internally and externally positively affects supply chain performance. Therefore, it can be understood that research question one is answered both conceptually and empirically. Although information sharing through external integration does not positively influence supply chain performance in term of costs, this is addressed by several scholars as a positive impact. This important result indicates that there may be barriers for sharing information or lack of strategic alignment or tight integration which leads to decrease supply chain performance.

Under the flag of main research question, research question two is addressed: Does information sharing support return on investment? Analytical conceptual study reveals that ROS as indicator of financial aspect of supply chain performance can be increased through information sharing. While the empirical results reveals that increasing sharing information lead to decreasing ROS.

Coordinating business processes, timely respond to business partners and effective use of capabilities of SMEs is addressed as role of information sharing in a supply chain for gaining competitive advantage which may incur additional cost to SMEs and decrease their ROS rate. Empirical results indicate both the positive impact of ROS and information sharing on supply chain performance. Besides, results clarifies that there is a strong correlation between ROS and chain performance. So, information sharing can lead to enhance supply chain performance while ROS decrease. It means that Information sharing through internal and external integration of supply chain to gain competitive advantage by fast deliveries, responsive toward customers, and reliability enhance the supply chain performance and

decrease ROS. Therefore, ROS as financial aspect of supply chain decrease through information sharing in a whole supply chain while supply chain performance increases.

## **6.2 Avenues for future research**

While our research provides significant empirical insights in the information sharing through supply chain and supply chain performance relationship, further research would benefit from developing and empirically testing a model including barriers and conditions for information sharing through internal and external integration of supply chain. Also, more research is required to address some limitations of this study. First, this study is cross-sectional in nature and does not offer a longitudinal perspective on the relationship between information sharing through supply chain integration (internally and externally) and supply chain performance improvement.

Second, the results of this study are limited by the availability of data through participants who answer the last section of IMSS-VI which is about using technology. In the absence of precise performance measures and financial performance data, the demonstrated influence of information sharing through internal and external integration of supply chain is limited to developing measures. Since, it is not possible to demonstrate the relationship with information sharing and absolute level of supply chain performance.

An important extension that would be beneficial is to study impact of using ERP and Web-enabled ERP on improving supply chain performance to further enhance researchers' and practitioners' understanding. For instance, when manufacturer purchase a (new) ERP system, the ERP system per se does not differentiate the firm from its competitors since it is a tool which is readily available for purchase. What makes the difference is how the firm integrates the individual technology (e.g. RFID) with the ERP system and how firm reconfigures the existing processes (e.g. delivery and inventory management) with the ERP system to synergize actions and result (Y. Jin, Vonderembse, Mark, Ragu-Nathan, T. S., Smith, Joy

Turnheim, 2014). This integration facilitates information sharing and streaming connections within firm and its business partners, Therefore ERP could be strategic source of sustainable complete performance for the firm (Y. Jin, Vonderembse, Ragu-Nathan, & Smith, 2014; Kayworth, Chatterjee, & Sambamurthy, 2001).

Finally, ROI can be used through asking further question and specific questions about it in next IMSS round in order to gather more data through measuring financial part of the supply chain robustly. With the ROI results, ROI and supply chain performance relationship and how a research can be modelled and the method to find this relationship can be performed in future studies.

## **7. Epilogue**

SMEs try to provide information sharing through internal and external integration of supply chain to enhance supply chain performance to gain competitive advantage. The focus of this study was to analyze the relationship between approaches and technologies for replicating competitive advantage and information sharing in SMEs to address the main research question; can SMEs enhance their supply chain performance based on information sharing?

To address this question completely, two sub research questions are answered which addressed by chapter three and four. Four hypotheses are proposed based on understating of conceptual study and IMSS-IV's data. The analytical conceptual and empirical results clarify the undeniable role of information sharing to gain competitive advantage. These analyses indicate the relationship of information sharing and technology in obtaining competitive advantage by SMEs. According to Figure 30, relationships of each chapter and the resulting hypotheses are indicated. The important results and learning points that have been gained by this study are delivered through testing the hypotheses and discussion through empirical results.

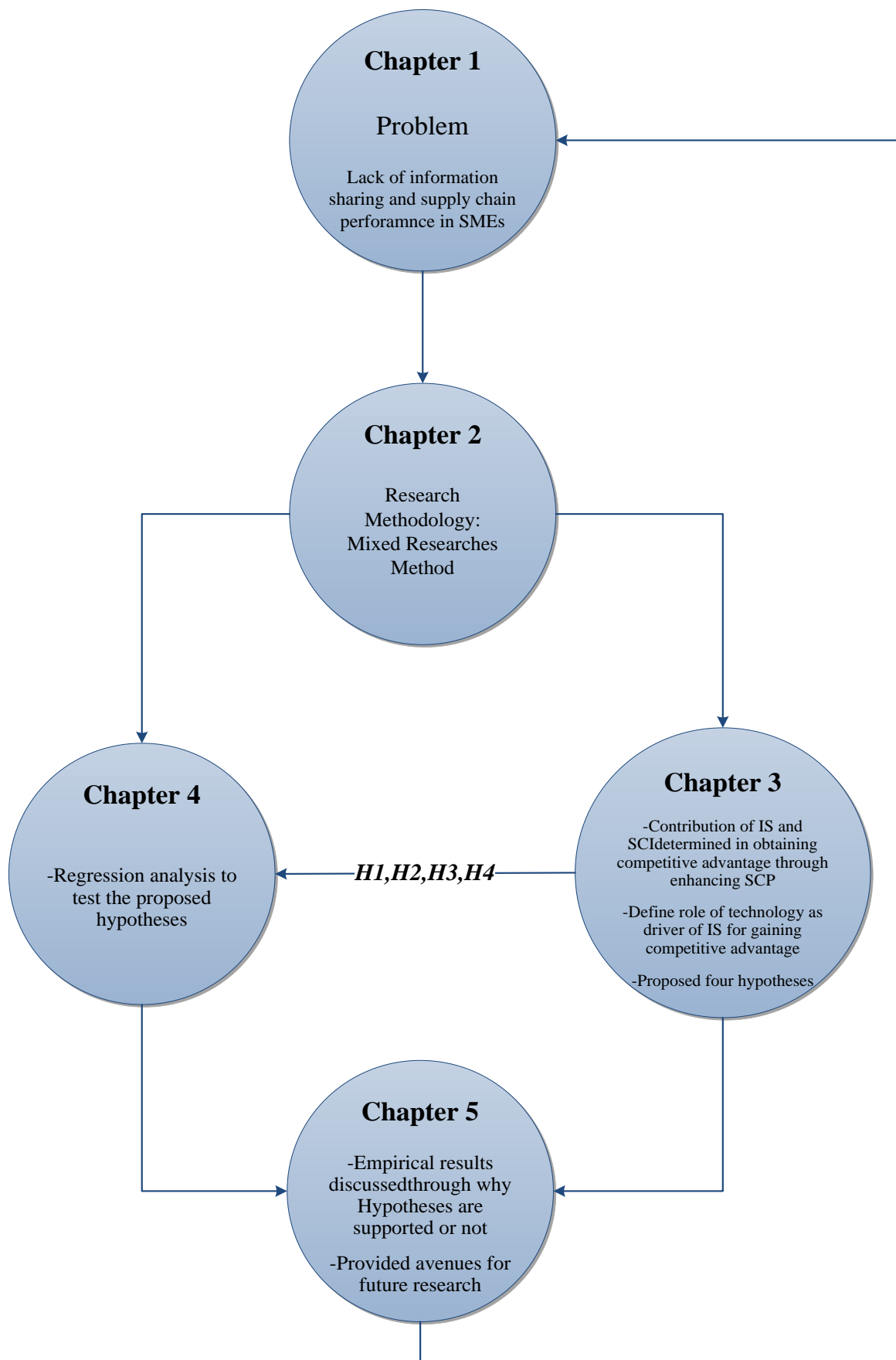


Figure 34 Epilogue

## 8. Thesis Plan

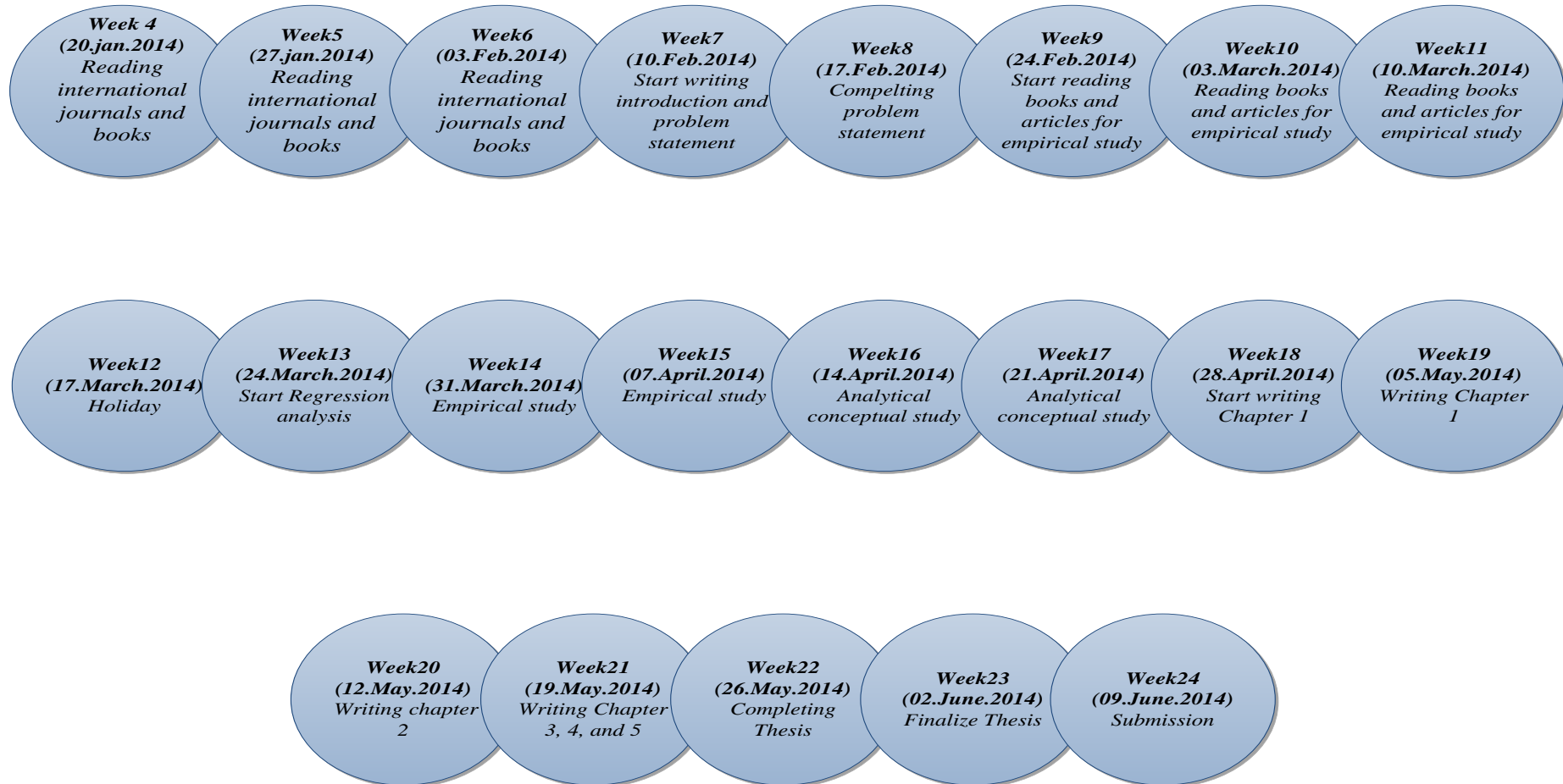


Figure 35 Thesis Plan

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## 10. Appendix

Supply chain performance (GFI):

**CMIN**

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	12	74,689	2	,000	37,344
Saturated model	14	,000	0		
Independence model	4	593,200	10	,000	59,320

**Baseline Comparisons**

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	,874	,370	,877	,377	,875
Saturated model	1,000		1,000		1,000
Independence model	,000	,000	,000	,000	,000

**RMSEA**

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	,098	,080	,118	,000
Independence model	,124	,116	,133	,000

**Result (Default model)**

Minimum was achieved

Chi-square = 74,689

Degrees of freedom = 2

[Probability level = ,000](#)

Information sharing (GFI):

**CMIN**

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	12	65,370	2	,000	32,685
Saturated model	14	,000	0		
Independence model	4	573,936	10	,000	57,394

**Baseline Comparisons**

Model	NFI	RFI	IFI	TLI	CFI
	Delta1	rho1	Delta2	rho2	
Default model	,886	,431	,889	,438	,888
Saturated model	1,000		1,000		1,000
Independence model	,000	,000	,000	,000	,000

**RMSEA**

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	,092	,073	,111	,000
Independence model	,122	,114	,131	,000



# International Manufacturing Strategy Survey

Sixth Edition - 2013

This survey is designed to explore and identify the manufacturing strategies, practices and performance of manufacturing firms around the world.

The survey is divided into three sections:

- SECTION A Description, strategy and performance of the business unit  
SECTION B Description, strategy and performance of the dominant activity of the plant  
SECTION C Current manufacturing and supply chain practices, and past action programs

Questions should be answered by the Director of Operations/Manufacturing (or equivalent).

If you cannot answer a question, please leave it blank and go to the next one.

Results will be distributed in 2014.

All responses will be treated with ABSOLUTE CONFIDENTIALITY. The names of companies, business units, products or individuals will not be released!

MANY THANKS FOR YOUR COOPERATION!

Please provide the following information:

The name of the business unit: \_\_\_\_\_

Please tick the industry code that best describes the activities of your business unit:

- 25 Manufacture of fabricated metal products, except machinery and equipment
- 26 Manufacture of computer, electronic and optical products
- 27 Manufacture of electrical equipment
- 28 Manufacture of machinery and equipment n.e.c.
- 29 Manufacture of motor vehicles, trailers and semi-trailers
- 30 Manufacture of other transport equipment

Country: \_\_\_\_\_

Your name: \_\_\_\_\_

Your email address: \_\_\_\_\_ Your phone number: \_\_\_\_\_

What is your job title? \_\_\_\_\_

How long have you been working in this company? (number of years) \_\_\_\_\_

How long have you been working in operations/manufacturing in this company? (number of years) \_\_\_\_\_

In what year was the plant established \_\_\_\_\_

**Please return this questionnaire to:**

\_\_\_\_\_

## Section A

### Description, strategy and performance of the business unit

#### Description of the business unit

A1. What are the name, origin, size and sales of the business unit your plant belongs to?

Name \_\_\_\_\_ Origin (headquarters' country) \_\_\_\_\_

Size of the business unit (# of employees): \_\_\_\_\_

A2. How do you perceive the following characteristics of the environment in which your firm operates?

Market size	Declining rapidly	1	2	3	4	5	Growing rapidly
Rate of technological change	Very low	1	2	3	4	5	Very high
Market span	Few segments	1	2	3	4	5	Many segments
Market concentration	Few competitors	1	2	3	4	5	Many competitors
Competitive rivalry within industry	Very low	1	2	3	4	5	Very high
Market entry	Closed to new players	1	2	3	4	5	Open to new players
Threat that your products will become substituted	Very low	1	2	3	4	5	Very high
Bargaining power of suppliers	Very weak	1	2	3	4	5	Very strong
Bargaining power of customers	Very weak	1	2	3	4	5	Very strong
Environmental pressure (e.g. stakeholders call for environmentally friendly products and processes)	Very weak	1	2	3	4	5	Very strong
Social pressure (e.g. stakeholders pay attention to companies' commitment on ethical issues, human rights respect, labour conditions)	Very weak	1	2	3	4	5	Very strong

#### The business unit's competitive strategy

A3. Consider the importance of the following attributes to win orders from your major customers.

	Importance in the last three years				
	Not important				Very important
Lower <u>selling prices</u>	1	2	3	4	5
Better <u>product design and quality</u>	1	2	3	4	5
Better <u>conformance to customer specifications</u>	1	2	3	4	5
More <u>dependable deliveries</u>	1	2	3	4	5
<u>Faster deliveries</u>	1	2	3	4	5
Superior <u>product assistance/support</u> (after-sales and/or technical support)	1	2	3	4	5
Superior <u>customer service</u> (training, information, help-desk)	1	2	3	4	5
Offer more <u>product customization</u>	1	2	3	4	5
Wider <u>product range</u>	1	2	3	4	5
Offer <u>new products more frequently</u>	1	2	3	4	5
Offer <u>products that are more innovative</u>	1	2	3	4	5
Greater <u>order flexibility</u>	1	2	3	4	5
More <u>environmentally sound products and processes</u>	1	2	3	4	5
Higher contribution to the <u>development and welfare of the society</u>	1	2	3	4	5
More <u>safe and health respectful processes</u>	1	2	3	4	5

## Business unit performance

A4. Please indicate your Sales and Return On Sales of the business unit in 2012:

	< 10 m€	10-50 m€	50-100 m€	100-500 m€	> 500 m€	Compared to the three years ago the indicator is				
						Much lower		Much higher		
Sales	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1	2	3	4	5
Return on Sales (ROS) <sup>1</sup>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	1	2	3	4	5

<sup>1</sup> ROS = Earnings before interests and taxes / Total sales

A5. Approximately what proportion of the business unit annual sales is invested in (average % of total sales):

Product/service related research and development	Investment/improvement of process equipment	Workforce/staff training and education	Strategic initiatives (sustainability, globalization, servitization, etc.)
_____ %	_____ %	_____ %	_____ %

## Organization of the plant

O1. How many organizational levels do you have (from plant manager to workers included)? \_\_\_\_\_

O2. At the end of the last fiscal year, you had:

- a. \_\_\_\_\_ Number of workers, of which:
- b. \_\_\_\_\_ % permanent workers      \_\_\_\_\_ % work in functional teams  
 \_\_\_\_\_ % temporary workers      \_\_\_\_\_ % work in cross-functional teams  
 100 % Total

O3 How many workers are under the responsibility of one of your line supervisors (on average)?

\_\_\_\_\_ in Fabrication      \_\_\_\_\_ in Assembly

O4. On average, what proportion of your workers' compensation is based on incentives for production and improvement results?

Individual incentives \_\_\_\_\_ % of compensation      Work group incentives \_\_\_\_\_ % of compensation

O5. How many hours of training per year are given to the regular workers? \_\_\_\_\_ hours per worker per year

O6. How many of your production workers do you consider as being multi-skilled? \_\_\_\_\_ % of the production workers  
 1 A multi-skilled worker is skilled in several operational tasks.

O7. Indicate the effort put into implementing, and the current level of adoption of, action programs related to:

Effort in the last 3 years					Current level of adoption									
None				High	None				High					
1	2	3	4	5	<u>Delegation and knowledge of your workers</u> (e.g. empowerment, training, encouraging solutions to work related problems, pay for competence or incentives for improvement results)					1	2	3	4	5
1	2	3	4	5	<u>Open communication between workers and managers</u> (information sharing, encouraging bottom-up open communication, bi-directional communication flows)					1	2	3	4	5
1	2	3	4	5	<u>Lean organization</u> (e.g. few hierarchical levels and broad span of control)					1	2	3	4	5
1	2	3	4	5	<u>Continuous improvement programs</u> through systematic initiatives (e.g. kaizen, improvement teams, improvement incentives)					1	2	3	4	5
1	2	3	4	5	<u>Autonomous teams</u> (e.g. team responsible for planning, execution and control, workers sharing experience, knowledge and skills, formalization of team composition and responsibilities, work group incentives)					1	2	3	4	5
1	2	3	4	5	Workers flexibility (e.g. multi-tasking, multi-skilling, job rotation)					1	2	3	4	5
1	2	3	4	5	<u>Use of flexible forms of work</u> (e.g. temporary workers, part time, job sharing, variable working hours)					1	2	3	4	5

## Shifting manufacturing towards services

S1. To what extent does your business unit/plant offer the following services alongside with the products?

	None					High				
Maintenance and repair of products sold to customers	1	2	3	4	5	1	2	3	4	5
Installation and implementation services	1	2	3	4	5	1	2	3	4	5
Rental/lease of products (with responsibility for maintenance, repair and operation)	1	2	3	4	5	1	2	3	4	5
Product upgrades (software, product modifications)	1	2	3	4	5	1	2	3	4	5
Help desk/customer support centre	1	2	3	4	5	1	2	3	4	5
Training in using the products	1	2	3	4	5	1	2	3	4	5
Consultancy services	1	2	3	4	5	1	2	3	4	5
Spare-parts/consumables provision for customers	1	2	3	4	5	1	2	3	4	5

S2. How much of your turnover is based on sales of:

Parts and components	Assembled products	Services	Total
_____ %	_____ %	_____ %	100 %

S3. Indicate the effort put into implementing, and the current level of adoption of, action programs related to:

Effort in the last 3 years					Current level of adoption					
None	1	2	3	High	None	1	2	3	High	
1	2	3	4	5	Expanding the service offering to your customers (e.g. by investing in new service development)	1	2	3	4	5
1	2	3	4	5	Developing the skills needed to improve the service offering	1	2	3	4	5
1	2	3	4	5	Designing products so that the after sales service is easier to manage/offer (e.g. design for maintenance)	1	2	3	4	5

## Section B

### Description, strategy and performance of manufacturing for the dominant activity of the plant

From now on, please refer always to the dominant activity of your plant. Dominant activity concerns the activity, which is considered to best represent the plant.

#### Description of the plant's dominant activity

B1. Describe the most important product of your plant: \_\_\_\_\_

B2. How would you describe the complexity of the dominant activity?

Modular product design	1	2	3	4	5	Integrated product design
Very few parts/materials, one-line bill of material	1	2	3	4	5	Many parts/materials, complex bill of material
Very few steps/operations required	1	2	3	4	5	Many steps/operations required

B3. Estimate the present cost structure in manufacturing (percentages should add up to 100 %).

Direct labour costs	Direct materials <sup>1)</sup>	Indirect materials <sup>2)</sup>	Manufacturing overhead <sup>3)</sup>	Total
_____ %	_____ %	_____ %	_____ %	100 %

1 Direct material includes all materials, parts, components and all outsourced/contract work that is performed outside the company, but necessary for and incorporated into the final products.

2 Indirect materials includes energy, cooling, lubricants

3 Manufacturing overheads include salary costs of manufacturing management, indirect production personnel (for example transportation, handling), production planning, maintenance and depreciation of plant and equipment.

### Manufacturing process design

B4. To what extent do you use the following process types (% of volume)? (Percentages should add up to 100%):

One of a kind production	Batch production	Mass production	Total
_____ %	_____ %	_____ %	100 %

B5. What proportion of your customer orders are (percentages should add up to 100 %):

Designed/ engineered to order	Manufactured to order	Assembled to order	Produced to stock	Total
_____ %	_____ %	_____ %	_____ %	100 %

### Manufacturing performance

B6. How has your manufacturing performance changed over the last three years? How does your current performance compare with that of your main competitor(s)<sup>1</sup>?

Compared to three years ago the indicator has					Relative to our main competitors, our performance is					
deteriorated (- 5% or worse)	stayed about the same (-5%/ +5%)	slightly improved (+5- +15%)	improved (+15-25%)	strongly improved (+25% or better)		much worse	equal	much better		
1	2	3	4	5		1	2	3	4	5
1	2	3	4	5	Manufacturing conformance	1	2	3	4	5
1	2	3	4	5	Product quality and reliability	1	2	3	4	5
1	2	3	4	5	Volume flexibility	1	2	3	4	5
1	2	3	4	5	Mix flexibility	1	2	3	4	5
1	2	3	4	5	Product customization ability	1	2	3	4	5
1	2	3	4	5	New product introduction ability	1	2	3	4	5
1	2	3	4	5	Product assistance/support	1	2	3	4	5
1	2	3	4	5	Customer service quality (e.g. training, information, help-desk)	1	2	3	4	5
1	2	3	4	5	Delivery speed	1	2	3	4	5
1	2	3	4	5	Delivery reliability	1	2	3	4	5
1	2	3	4	5	Unit manufacturing cost	1	2	3	4	5
1	2	3	4	5	Procurement costs	1	2	3	4	5
1	2	3	4	5	Manufacturing lead time	1	2	3	4	5
1	2	3	4	5	Procurement lead time	1	2	3	4	5
1	2	3	4	5	Materials, water and/or energy consumption	1	2	3	4	5
1	2	3	4	5	Pollution emission and waste production levels	1	2	3	4	5
1	2	3	4	5	Workers' motivation and satisfaction	1	2	3	4	5
1	2	3	4	5	Health and safety conditions	1	2	3	4	5

<sup>1</sup> Consider the average performance of the group of competitors that are the direct benchmark for the plant

B7. What is the current performance level on the following dimensions?

Throughput time efficiency (the time the products are worked on as a % of the total manufacturing lead time)? \_\_\_\_\_%

Late deliveries to customers (as percentage of orders delivered)? \_\_\_\_\_%

Order-to-delivery lead time (days) \_\_\_\_\_ days for products in stock \_\_\_\_\_ days for products not in stock

Scrap and rework costs (as percentage of sales) \_\_\_\_\_%

Customer complaints (as percentage of orders delivered) \_\_\_\_\_%

## Section C

### Current manufacturing and supply chain practices, and past action programs

Remember to answer considering the plant's dominant activity identified in the previous section.

#### Planning and control of the plant's dominant activity

PC1. How do you cope with demand fluctuations?

	Degree of use				
	None				High
Slack and redundancies (e.g. inventories, equipment overcapacity)	1	2	3	4	5
Change the balance between outsourcing and insourcing of production	1	2	3	4	5
Workforce flexibility (e.g. flexible working hours, temporary workers, overtime, lay-off)	1	2	3	4	5
Adjust ordering policies (MTO, MTS, etc.) and warehousing levels to demand changes	1	2	3	4	5
Eliminate or reduce the need for adjustments in system capacity (level production)	1	2	3	4	5
Demand management (change in prices, promised delivery times, customer service)	1	2	3	4	5

PC2. How many days of production (on average) do you carry in the following inventories:

\_\_\_\_\_ Raw material/components      \_\_\_\_\_ Work-in-process      \_\_\_\_\_ Finished goods

PC3. Indicate the effort put into implementing, and the current level of adoption of, action programs related to:

Effort in the last 3 years						Current level of adoption				
None				High		None				High
1	2	3	4	5	Restructuring manufacturing processes and layout to obtain <u>process focus</u> and streamlining (e.g. reorganize plant-within-a-plant; cellular layout)	1	2	3	4	5
1	2	3	4	5	Undertaking actions to implement <u>pull production</u> (e.g. reducing batches, setup time, using kanban systems)	1	2	3	4	5
1	2	3	4	5	Improving <u>forecasting and planning accuracy</u> (methods, software, frequency...)	1	2	3	4	5
1	2	3	4	5	Increasing <u>information integration</u> (monitoring and control the processes in real time by a dedicated information system)	1	2	3	4	5
1	2	3	4	5	Engaging in product/part <u>tracking and tracing</u> programs (bar codes, RFID)	1	2	3	4	5

#### Technology of the plant's dominant activity

T1. Indicate the effort put into implementing, and the current level of adoption of, action programs related to:

Effort in the last 3 years						Current level of adoption				
None				High		None				High
1	2	3	4	5	Use of <u>advanced processes</u> , such as laser and water cutting, 3D printing, high precision technologies	1	2	3	4	5
1	2	3	4	5	Development towards "the factory of the future" (e.g. smart/digital factory, adaptive manufacturing systems, scalable manufacturing)	1	2	3	4	5
1	2	3	4	5	Engaging in <u>process automation</u> programs (e.g. automated machine tools and handling/transportation equipment, robots)	1	2	3	4	5

#### Quality of the plant's dominant activity

Q1. Indicate the effort put into implementing, and the current level of adoption of, action programs related to:

Effort in the last 3 years						Current level of adoption				
None				High		None				High
1	2	3	4	5	<u>Quality improvement</u> and control (e.g. TQM programs, six sigma projects, quality circles)	1	2	3	4	5
1	2	3	4	5	Improving <u>equipment availability</u> (e.g. Total Productive Maintenance programs)	1	2	3	4	5
1	2	3	4	5	<u>Benchmarking/self-assessment</u> (e.g. quality awards, EFQM model)	1	2	3	4	5

## Environmental and social sustainability management of the plant's dominant activity

SM1. Indicate the effort put into implementing, and the current level of adoption of, action programs related to:

Effort in the last 3 years						Current level of adoption				
None		High				None		High		
1	2	3	4	5	<u>Environmental certifications</u> (e.g. EMAS or ISO 14001)	1	2	3	4	5
1	2	3	4	5	<u>Social certifications</u> (e.g. SA8000 or OHSAS 18000)	1	2	3	4	5
1	2	3	4	5	Formal <u>sustainability oriented</u> communication, training programs and involvement	1	2	3	4	5
1	2	3	4	5	Energy and water <u>consumption</u> reduction programs	1	2	3	4	5
1	2	3	4	5	Pollution emission <u>reduction and waste recycling</u> programs	1	2	3	4	5
1	2	3	4	5	Formal <u>occupational health and safety</u> management system	1	2	3	4	5
1	2	3	4	5	<u>Work/life balance</u> policies	1	2	3	4	5
1	2	3	4	5	<u>Suppliers' sustainability performance assessment</u> through formal evaluation, monitoring and auditing using established guidelines and procedures	1	2	3	4	5
1	2	3	4	5	<u>Training/education</u> in sustainability issues for suppliers' personnel	1	2	3	4	5
1	2	3	4	5	<u>Joint efforts with suppliers</u> to improve their sustainability performance	1	2	3	4	5

## Product development of the plant's dominant activity

PD1. Indicate the effort put into implementing, and the current level of adoption of, action programs to coordinate your new product development and manufacturing processes, related to:

Effort in the last 3 years						Current level of adoption				
None		High				None		High		
1	2	3	4	5	<u>Informal mechanisms</u> , such as direct, face-to-face communication, informal discussions, ad-hoc meetings	1	2	3	4	5
1	2	3	4	5	<u>Design integration</u> between product development and manufacturing through e.g. platform design, standardization and modularization, design for manufacturing, design for assembly	1	2	3	4	5
1	2	3	4	5	<u>Organizational integration</u> between product development and manufacturing through e.g. cross-functional teams, job rotation, co-location, role combination, secondment and co-ordinating managers	1	2	3	4	5
1	2	3	4	5	<u>Technological integration</u> between product development and manufacturing through e.g. CAD-CAM, CAPP, CAE, Product Lifecycle Management	1	2	3	4	5
1	2	3	4	5	<u>Integrating tools and techniques</u> , such as Failure Mode and Effect Analysis, Quality Function Deployment, and Rapid Prototyping	1	2	3	4	5
1	2	3	4	5	<u>Communication technologies</u> such as teleconferencing, web-meetings, intranet and social media	1	2	3	4	5
1	2	3	4	5	Forms of <u>process standardization</u> , such as a stage-gate process, design reviews and performance management	1	2	3	4	5

## Supply chain of the plant's dominant activity

The following questions refer to the suppliers of goods that you use to perform your dominant activity

SC1. What is the percentage of spending on the following categories of goods purchased (your answers should add up to 100%)?

Raw materials	Parts/components	Subassemblies/systems	Total
_____ %	_____ %	_____ %	100 %

SC2. Indicate the percentage of your spending that concerns customized/special goods \_\_\_\_\_ %

The following questions refer to the direct customers of your dominant activity

SC3. Indicate the percentage of sales in the following categories of customers (your answers should add up to 100%):

Manufacturers of subassemblies	Manufacturers of finished products	Wholesalers / distributors	End users	Total
_____ %	_____ %	_____ %	_____ %	100 %

SC4. To what extent do you agree with the following statements?

	Not at all		To a great extent		
	1	2	3	4	5
Your demand fluctuates drastically from week to week.	1	2	3	4	5
Your total manufacturing volume fluctuates drastically from week to week.	1	2	3	4	5
The mix of products you produce changes considerably from week to week.	1	2	3	4	5
Your supply requirements (volume and mix) vary drastically from week to week.	1	2	3	4	5
Your products are characterized by a lot of technical modifications.	1	2	3	4	5
Your suppliers frequently need to carry out modifications to the parts/components they deliver to your plant.	1	2	3	4	5

SC5. Where do you source the raw materials, parts/components, subassemblies/systems and sell the finished products/services resulting from your plant's dominant activity (answers should add up to 100% of the value):

	Sourcing	Sales
This country	_____ %	_____ %
Outside the country but within the continent <sup>1</sup>	_____ %	_____ %
Outside this continent <sup>1</sup>	_____ %	_____ %
<b>Total</b>	<b>100 %</b>	<b>100 %</b>

<sup>1</sup> Referring to South America, North America, West Europe, East Europe, Middle East, Far East, Oceania, Africa.

SC7. Indicate the effort put into implementing, and the current level of adoption of, action programs related to:

Effort in the last 3 years						Current level of adoption				
None	High					None	High			
1	2	3	4	5	<u>Sharing information with purchasing department</u> (about sales forecast, production plans, production progress and stock level)	1	2	3	4	5
1	2	3	4	5	<u>Joint decision making with purchasing department</u> (about sales forecast, production plans and stock level)	1	2	3	4	5
1	2	3	4	5	<u>Sharing information with sales department</u> (about sales forecast, production plans, production progress and stock level)	1	2	3	4	5
1	2	3	4	5	<u>Joint decision making with sales department</u> (about sales forecast, production plans and stock level)	1	2	3	4	5
1	2	3	4	5	<u>Sharing information with key suppliers</u> (about sales forecast, production plans, order tracking and tracing, delivery status, stock level)	1	2	3	4	5
1	2	3	4	5	Developing <u>collaborative approaches with suppliers</u> (e.g. supplier development, risk/revenue sharing, long-term agreements)	1	2	3	4	5
1	2	3	4	5	<u>Joint decision making with suppliers</u> (about product design/modifications, process design/modifications, quality improvement and cost control)	1	2	3	4	5
1	2	3	4	5	<u>System coupling with key suppliers</u> (e.g. vendor managed inventory, just-in-time, kanban, continuous replenishment)	1	2	3	4	5
1	2	3	4	5	Developing <u>an international sourcing strategy</u> (e.g. supplier scouting at the international level, develop an international purchasing office)	1	2	3	4	5
1	2	3	4	5	<u>Sharing information with key customers</u> (about sales forecast, production plans, order tracking and tracing, delivery status, stock level)	1	2	3	4	5
1	2	3	4	5	Developing <u>collaborative approaches with customers</u> (e.g. risk/revenue sharing, long-term agreements)	1	2	3	4	5
1	2	3	4	5	<u>System coupling with key customers</u> (e.g. vendor managed inventory, just-in-time, kanban, continuous replenishment)	1	2	3	4	5
1	2	3	4	5	<u>Joint decision making with customers</u> (about product design/modifications, process design/modifications, quality improvement and cost control)	1	2	3	4	5
1	2	3	4	5	Developing <u>an international distribution strategy</u> (e.g., open foreign sales office, develop an international distribution network)	1	2	3	4	5



### Risk management of the plant's dominant activity

R1. Please evaluate the probability of occurrence and impact of the following risks:

Probability						Impact				
Low		High				Low		High		
1	2	3	4	5	A key supplier fails to supply affecting your operations	1	2	3	4	5
1	2	3	4	5	Your manufacturing operations are interrupted affecting your shipments	1	2	3	4	5
1	2	3	4	5	Your shipment operations are interrupted affecting your deliveries	1	2	3	4	5

R2. Indicate the effort put into implementing, and the current level of adoption of, action programs related to:

Effort in the last 3 years						Current level of adoption				
None		High				None		High		
1	2	3	4	5	<u>Preventing</u> operations risks (e.g. select a more reliable supplier, use clear safety procedures, preventive maintenance)	1	2	3	4	5
1	2	3	4	5	<u>Detecting</u> operations risks (e.g. internal or supplier monitoring, inspection, tracking)	1	2	3	4	5
1	2	3	4	5	<u>Responding</u> to operations risks (e.g. backup suppliers, extra capacity, alternative transportation modes)	1	2	3	4	5
1	2	3	4	5	<u>Recovering</u> from operations risks (e.g. task forces, contingency plans, clear responsibility)	1	2	3	4	5

R3. Please provide the following figures

Number of days of lost production last year due to supply failures or operations disruption \_\_\_\_\_ days

Percentage of customer deliveries affected by operational failures \_\_\_\_\_%

### Manufacturing network

G1. What type of configuration has your manufacturing network?

Stand-alone: only this plant belongs to the company <input type="checkbox"/>	Domestic: all the plants are located in one country <input type="checkbox"/>	Regional: all the plants are located in one continent <sup>1</sup> <input type="checkbox"/>	Global: plants are located in different continents <input type="checkbox"/>
<b><u>If you selected this option you can skip to the end the questionnaire</u></b>			

<sup>1</sup> Referring to South America, North America, West Europe, East Europe, Middle East, Far East, Oceania, Africa.

G2. What is the role of your plant?

Your plant has the sole responsibility to produce your product/product portfolio	1	2	3	4	5	Your product is produced at multiple plants within the network
Your plant serves just a specified surrounding geographic area/market	1	2	3	4	5	Your plant serves the whole world / global market
Your plant covers only some specific production steps (the others are performed by other plants in the network)	1	2	3	4	5	Your plant covers the full production process
The role of your plant in the network (product, market and process focus) is stable	1	2	3	4	5	The role of your plant in the network (product, market and process focus) is revised and changed flexibly if needed
Your product is tailored to the local needs	1	2	3	4	5	The product you produce is the same for all over the world

G3. To what extent is your plant responsible for the following activities?

	No responsibility		Full responsibility		
Production (e.g., production, process improvement, technical maintenance)	1	2	3	4	5
Supply Chain (e.g., procurement, logistics, supplier development)	1	2	3	4	5
Development (e.g., Product improvement, Introduction of new product or process technologies)	1	2	3	4	5
Serving as a <u>hub for product / process knowledge</u> (e.g. showroom for good practice, sending out experts to share knowledge)	1	2	3	4	5

**G4. How do you coordinate with other plants in the network?**

You can make your own strategic decisions	1	2	3	4	5	The strategy is set centrally
This plant is autonomous in defining the production plan	1	2	3	4	5	Production plans are coordinated by the main plant or an international division
Your information system is not integrated in the company-wide network	1	2	3	4	5	Your information system is fully integrated in the company-wide network

**G5. To what extent do you agree with the following statements about the current advantages of your plant's location?**

	Strongly disagree					Strongly agree
Your current advantage is to access to <u>low cost resources</u> (labour, materials, energy)	1	2	3	4	5	
Your current advantage is <u>the proximity to market</u> (rapid/reliable delivery, customization, fast service and support)	1	2	3	4	5	
Your current advantage is to <u>access to knowledge and skills</u> (skilled workers and managers, technological know-how)	1	2	3	4	5	
Currently you have <u>no advantage</u>	1	2	3	4	5	

**G6. Please provide an estimate of the distribution of value of inputs (materials, components, sub-assemblies products) and outputs exchanged with other partners:**

Inputs (materials, components, sub-assemblies)		Outputs (components, sub-assemblies, products)	
From other units in the network	_____ %	To other units in the network	_____ %
From external suppliers	_____ %	To external customers	_____ %

Total

100 %

Total

100 %

*G7. Indicate the effort put into implementing, and the current level of adoption of, action programs related to:*

Effort in the last three years						Current level of adoption				
None	High			None		High				
1	2	3	4	5	Improve <u>information sharing</u> for the coordination of the flow of goods between your plant and other plants of the network (e.g. through exchange information on inventories, deliveries, production plants, etc.)	1	2	3	4	5
1	2	3	4	5	Improve <u>joint decision making</u> to define production plans and allocate production in collaboration with other plants in the network (e.g. through shared procedures, shared forecasts)	1	2	3	4	5
1	2	3	4	5	Improve <u>innovation sharing / joint innovation</u> with other plants (through knowledge dissemination and exchange of employees inside the network)	1	2	3	4	5
1	2	3	4	5	Improve the <u>use of technology</u> to support communication with other plants of the network (e.g. ERP integration, shared databases, social networks)	1	2	3	4	5
1	2	3	4	5	Developing a comprehensive <u>network performance management system</u> (e.g. based on cost, quality, speed, flexibility, innovation, service level)	1	2	3	4	5

Thank you for  
your help!