



IT ADOPTION MODEL DEVELOPMENT FOR SUPPLY CHAIN
MANAGEMENT: CASE OF ETHIOPIAN MANUFACTURING FIRMS

MSc THESIS

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IT ADOPTION MODEL DEVELOPMENT FOR SUPPLY CHAIN
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LIST OF ACRONYMS

ADLI	-	Agricultural Development Led Industrialization
B2B	-	Business to Business
B2C	-	Business to Customer
C2C	-	Customer 2 Customer
CRM	-	Customer Relationship Management
CSA	-	Central Statistics Agency
CSFs	-	Critical Success Factors
DOI	-	Diffusion of Innovation
DRP	-	Distribution Requirement Planning
DTI	-	Department of Trade and Industry
EDI	-	Electronic Data Interchange
ERP	-	Enterprise Resource Planning
e-SCM	-	electronic Supply Chain Management
FDRE	-	Federal Democratic Republic of Ethiopia
GDP	-	Gross Domestic Product
GPRS	-	Global Position Reference System
GPS	-	Global Positioning System
GTP	-	Growth and Transformation Plan
ICC	-	International Chamber of Commerce
ICT	-	Information and Communication Technology
IMF	-	International Monetary Fund
IOT	-	Institute of Technology
IS	-	Information System
IT	-	Information Technology
JIT	-	Just In Time
LAN	-	Local Area Network
MES	-	Manufacturing Execution System

MLSM	-	Medium and Large Scale Manufacturing
MRP I	-	Material Requirement Planning
MRP II	-	Manufacturing Resource Planning
PEOU	-	Perceived Ease of Use
POS	-	Point of Sale
PU	-	Perceived Usefulness
R&D	-	Research and Development
RFID	-	Radio Frequency Identification
SC	-	Supply Chain
SCM	-	Supply Chain Management
SCOR	-	Supply Chain Operations Reference
SCP	-	Supply Chain Performance
SCT	-	Supply Chain Technology
TAM	-	Technology Adoption Model
TMS	-	Transportation Management System
TOE	-	Technology, Organization and Environment
UK	-	United Kingdom
VMI	-	Vender Managed Inventory
VRM	-	Vender Relationship Management
WAN	-	Wide Area Network
WMS	-	Warehouse Management System
XML	-	Extensible Markup Language

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ABSTRACT

In the 21st century companies are required to continuously upgrade and improve their business activities in order to survive and achieve their business goal. One of the competition areas is an effective and efficient information flow along supply chain (SC). The information technology (IT) is one of the biggest enablers of the modern Supply Chain Management (SCM). However, SC systems in Ethiopian Medium and Large-Scale Manufacturing (MLSM) Firms found as fragmented SC, poor information exchanges, outdated systems and paper work. The purpose of this study is to examine IT adoption status and to develop its adoption model to Ethiopian MLSM firms. Cross-sectional survey was conducted on 438 samples from total 2,758 Ethiopian MLSM firms. Both a qualitative and quantitative data were collected using questionnaire survey, interview and document investigation, then descriptive and inferential statistical analysis were conducted by using Statistical Packages for Social Science (SPSS) version 21 and Microsoft office excel. The results indicated that the IT adoption status among Ethiopian MLSM firms was inadequate at all, despite good improvements in adopting some IT tools such as the Internet, Intranet and Barcode Scanner. The result also shows positive and strong correlation between the role of IT adoption and SC performance with correlation coefficient $r = 0.824$, even though a weakness to accept sophisticated IT tools, such as ERP, EDI, RFID, etc. The study suggests firms to exploit CSFs and reduce associated challenges to adopt IT, government to support these firms by policies, infrastructure, subsidies, incentives and training and universities to focus on producing IT skilled professionals. Finally, study proposes a model of IT adoption for Ethiopian MLSM firms to enhance their competitive advantage and improve firms' performance.

Keywords: *Supply Chain Management, Information Technology, Adoption Model, Medium and Large-Scale Manufacturing Firms*

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

In the 21st century, in which globalization is leading world businesses to ever competition, companies are required to continuously upgrade and improve their business activities in order to survive and achieve their business goal. One of the competition areas is an effective and efficient information flow management along one's supply chain (SC). Organization which is engaged in both global and domestic market strives to dominate market with quality product delivery, reliable customer service and accurate information flow to its partners by the success of Supply Chain Management (SCM).

Thus, managing the SC in the business environment has a major impact on performance of all parties involved in the chain (Refu, 2016). Better information exchange between SC partners is perhaps the key advantage for integration. As Levary (2000) reviewed, some of the benefits of electronic based SC integration include minimizing the bullwhip effect, maximizing the efficiency of conducting activities, minimizing inventories, minimizing cycle times and achieving an acceptable level of quality along the SC.

In age of paper-based transaction and communication, the information flow in SC networks was time consuming and error prone. Due to globalization, organizations had started to change the way of communication, implementation of technology, growing diversity of business transactions and process improvement for sharpening the business performance through information technology (IT) application in their SC network. Vickery *et al.* (2003) pointed out that today's organizations view SCM as a global organization strategy for achieving organizations competence and, companies are changing the way they operate by implementing SCM paradigm and IT in order to improve their flexibility and responsiveness. The market nowadays is electronically connected and dynamic in nature (Vickery *et al.*, 2003).

Gustin *et al.* (1995) showed that IT innovation provides the capabilities to transfer more accurate and up-to-date information resulting in better visibility of demand and inventory throughout the

SC, effective management of strategic alliances, extensive data management capabilities, advanced inter-organizational information systems and generally successful SCM. Hence, the upstream through downstream integration in SC network is the basic requirement to fulfill the objectives of SCM. The IT-enabled SCM can easily manage the flow of information with key business processes, materials, money within and outside the networks and contributes to firm profits by improving quality and by reducing coordination costs and transaction risks (Mabert *et al.*, 2001; Sanders & Premus, 2002).

According to Peterson (2003), IT is a SCM enabler whose importance cannot be understated and that SC technology and SCM is complementary in nature. Previously with no Internet application companies having difficulty to obtain information because they were not able to receive or to send updates, feedback, or other important information in a timely manner (Ravendran, 2002). Thus, to keep on competition, firms within SC routinely communicate with each other. The development of SCM concept requires that members of the chain co-ordinate their production and logistics activities. This type of co-ordination can be facilitated by adoption of technology, particularly when these technologies are used to span the traditional boundaries of firms' SC.

Ejiaku (2014) also claimed that IT adoption propels the economies of nations to greater productivity and job opportunities, and the modern global economy is built on IT and telecommunication infrastructure, which now serves as a platform for national and global development. Thus, IT has such great potential to improve business operations, education, technology and economic growth which could help contribute to poverty alleviation in developing economies if used to meet local and national needs (Ejiaku, 2014).

1.1.1. Overview of Ethiopian manufacturing sector

In comparison with the agriculture and service sectors, the manufacturing sector has a limited share in terms of production, employment, and exports. Thus, the Ethiopian economy needs a more dynamic growth so that it can reduce its dependence on the fragile, rainfall dependent, and climate change vulnerable agricultural sector. However, the government has initiated a new push towards creating framework to ensure economic and social development. The International Monetary Fund (IMF) ranks Ethiopia as among the five fastest growing economies in the world. After a decade of continuous expansion (during which real GDP growth averaged 10.8% per

annum), in 2013/14 the economy grew for its 11th consecutive year posting 10.3% growth (Manufacturing Survey Analysis, 2014). Figure 1 shows the contribution of country's three sectors such as agriculture, industry and service sectors in the following ten consecutive years. Ethiopia's economy is based on agriculture, which accounts 34.1 % of GDP, the industrial sector accounts 22.9% of GDP and the service sector accounts for 36.9% of GDP.

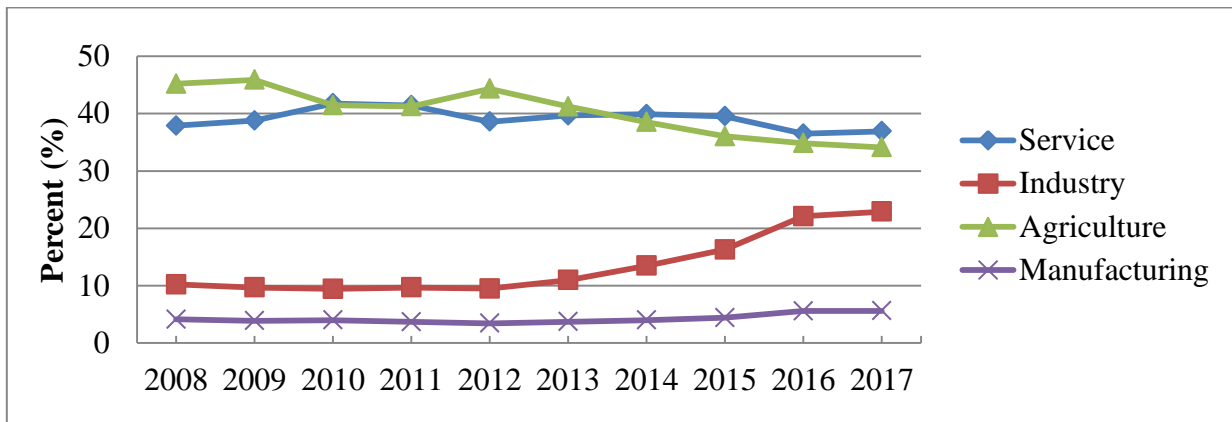


Figure 1: GDP Contribution by Service, Industry, Agriculture and Manufacturing sectors (own computation of data from World Development Indicators, 2018)

Manufacturing sector contributed 5.6% to the country GDP in 2017 and showed better improvements since 2012/13 as illustrated in Figure 1. The sector also accounts for 70% of the industrial sector. Within the manufacturing sector, the food and beverage subsector is the largest subsector, accounting for 36% of the total gross value of production (GVP) and 38% of the value added at basic price (VABP) of MLSM industry (CSA, 2014).

1.1.2. SC performance of Ethiopian manufacturing sector

Dametew and Ebinger, (2017) called SC integration as the strategic integration of both intra and inter-organizational processes and gauges the extent to which SC partners work collaboratively together to gain reciprocally beneficial outcomes. Georgise *et al.* (2014) studied the level of inter-organizational and intra-organizational SC integration practices and the challenges faced in the Ethiopian manufacturing firms. They found that, in Ethiopia SC system is characterized by fragmented SC, rigid business process, skill man problems, outdated technology, poor information exchanges, outdated systems and paper work and the lack of a relevant literature on

practical experience in SC integration have been the current trends and the challenges of Ethiopia manufacturing firms.

1.1.3. IT adoption and global competitiveness status of Ethiopia

The Global Information Technology report in Figure 2 reveals that the firm level technology adoption, capacity for innovation, B2B Internet use, B2C Internet use and the extent of staff training was very weak as compared to the adoption level by other four developing countries, such as South Africa, Kenya, China and Kuwait, which all have scored higher index value than Ethiopia.

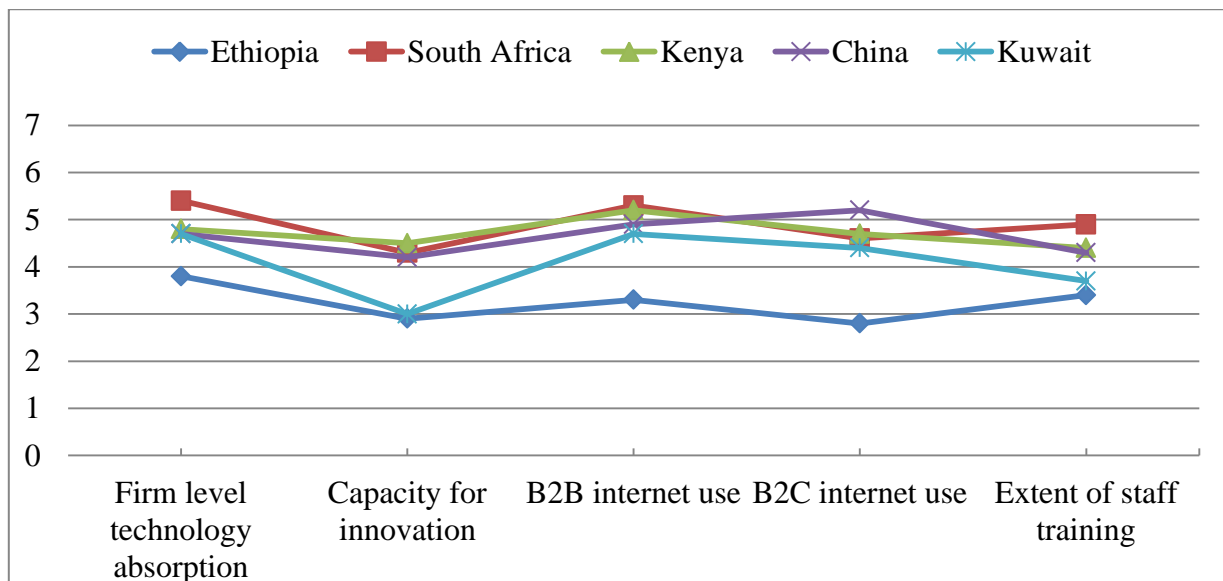


Figure 2: IT adoption comparison of Ethiopia with other four developing countries (own computation of data from the Global Information Technology Report, 2015)

Figure 3 shows the level of IT adoption of Ethiopia in various areas in terms of Networked Readiness Index as reported by the Global Information Technology (Dutta *et al.*, 2015). According to the result, the IT adoption in areas such as political and regulatory environment, business and innovation environment, infrastructure, affordability, skills, individual usage, business usage, government usage, economic and social impacts was very poor. Hence, Ethiopia ranked 130th out of 143 countries in Networked Readiness Index scoring 2.9 in the index range 1-7. Remarkably, the report has also ranked Ethiopia below the low-income group average

specifically for the scores in infrastructure, affordability, skills, individual usage, business usage and economic impact as illustrated in Appendix Figure 1.

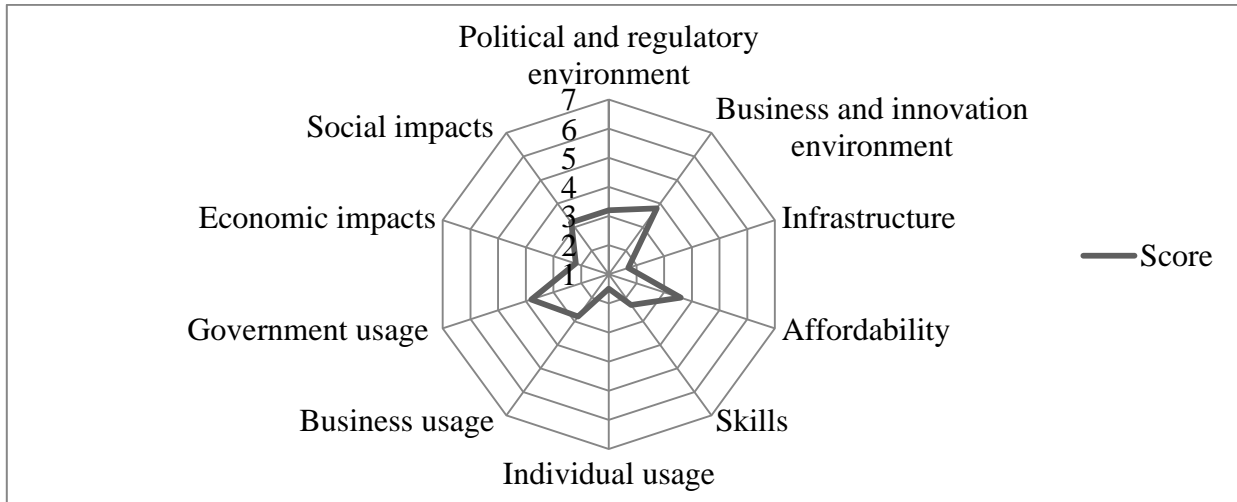


Figure 3: Networked Readiness Index for Ethiopia (own computation of data from the Global Information Technology Report, 2015)

According to the Global Competitiveness report (2017-2018), Ethiopia ranks the Global Competitiveness Index (GCI) 108th out of 137 countries and the GCI report in various sub-index components shows very poor score particularly in technological readiness, infrastructure, higher education and training, business sophistication and innovation as shown in Appendix Figure 2.

1.2. Statement of the problem

Ethiopia, as a developing country, has adopted a national economic policy that focuses mainly on implementing the Agricultural Development Led Industrialization (ADLI) strategy. Similarly, with the objective of bringing rapid, sustainable and equitable growth thereby ensuring structural change in Ethiopia, ten year (2010/11-2019/20) “Growth and Transformation Plan (GTP), GTP-I & GTP-II” has been implemented. The plan comprises seven strategic issues, among which the agricultural sector is expected to continue as a major source of growth while the industrial sector plays an increasingly key role in the economy (FDRE, 2010).

However, Muzeyin (2014) characterized Ethiopian economy by lowest level of industrialization and technological capability being core manufacturing sectors are least developed in many

aspects such as, technology employed, technology commercialization, technology adoption, production volume, product quality, labor skills and export capacity. In addition, the technological capability of local industries to adopt, modify and improve a given technology is infant and very weak, (Lemma *et al.*, 2014).

Studies indicate that the industrial sector in Ethiopia has to develop capability and create competitive advantage by making a differentiation, in which the customers can see their better products and services. Cost leadership and quick response are also the ways to create differentiation. Arkebe (2015) described as the government efforts to put the Ethiopian economy on a high growth path, the share of manufacturing in GDP remains low and the sector is characterized by many structural constraints such as low productivity, low value and lack of international competitiveness.

The other study by Dametew and Ebinger (2017) indicated that the technological capability of local industries to invention, adoption, modification, improving and use of a given innovative technology is very poor. As the result, these poor technological innovations were occurred due to improper innovation and technology transfer framework, non-collaborative operating environment between foreign and local industries, very weak national technology policies, and problems of research and innovation centers. They suggest that to tackle such problems, adopting flexible innovative and sustainable technological innovation systems to manufacturing industries used as a vehicle for improving the performance and competitiveness of the firms.

IT applications in organizational departments such as product development, material procurement, inventory management, production planning and control, logistics management and customer service management did not yet practiced satisfactorily in Ethiopia. For example, Georgise *et al.* (2014) found that SC integration amongst Ethiopian manufacturing firms is limited to ad hoc functional based boundaries within the firms and the SC integration enablers are also restricted to the traditional way of communications such as telephone, fax, and letters. They suggest that firms need to focus on pursuance of greater SC integration and to adopt appropriate ICT tools to leverage their business advantage.

Although the IT importance for efficient SCM is widely acknowledged in previous articles, empirical researches on its effect and adoption for the purposes of SCM are narrow in the

country. Furthermore, there is no explicit IT adoption framework developed to help manufacturing firms adopt new technologies. Therefore, this study is sought to fill the gap by examining the problems in a scientific way. More specifically, the purpose of this research is to explore empirically the effect of IT adoption on SC performance and to model its adoption system for Ethiopian medium and large-scale manufacturing (MLSM).

1.3. Objectives of study

1.3.1. General objective

The overall objective of the research is to examine the current IT adoption status and to develop an IT adoption model for SCM in Ethiopian MLSM firms.

1.3.2. Specific objectives

The study was guided by the following specific objectives:

- To investigate current status of IT adoption in Ethiopian MLSM firms
- To study barriers and critical success factors to adopt IT among MLSM firms
- To examine the effect of IT use on SC performance in MLSM firms and
- To develop a model of IT adoption for SCM in Ethiopian MLSM firms

1.4. Significance of the study

A number of bodies such as government, MLSM firms, and interested bodies can use the findings of the thesis. The study is expected to provide pertinent information to all stakeholders on the subject of IT roles in SCM practices of the manufacturing firms. It would also contribute as an empirical study to the future researches. The study identifies different functional areas of IT for the firms' SC performance and provides guidance for managers to improve and strengthen the profitability of the firms by applying IT tools in SCM system. Moreover, it will give an insight to policy makers, researchers and others who have interest to undertake further study on the similar area.

1.5. Scope of the study

As the title points out, this thesis focuses mainly on the MLSM enterprises in Ethiopia. It did not include micro and small scale enterprises. This was due to less tendency, motivation and capability to adapt IT system because they are in infant stage for a SCM. The research also focused only on manufacturing industry rather than other sectors due to considering a priority given by the country's development strategy. Its scope covers only the effect of IT adoption in SCM for SC performance of manufacturing firms even though it was necessary to study its effect on overall firms' performance also. In addition, the research was conducted on gathering information solely from manufacturing firms even though there were several partners along SC (suppliers, distributors, retailers and end users). This was due to a time constraint to attain all constituents.

1.6. Organization of the thesis

In addition to this introductory part the research is organized with the following consecutive chapters. Chapter two reviews both theoretical and empirical literatures available in the area of IT adoption in SCM for SC performance. Chapter three describes different aspects of the materials and methods used to carry out this study. Chapter four covers the result presentation, analysis and interpretation of the survey questionnaire. Chapter five presents development of proposed IT adoption model. Finally, chapter six deals with result summary, conclusion and recommendations.

CHAPTER TWO

LITERATURE REVIEW

This chapter presents theoretical and empirical literature reviews. The theory parts cover the topics of SCM, SC performance, IT applications in SCM, barriers and critical success factors during IT adoption process and various models of IT adoption. It also presents the previous empirical studies conducted on the same area, the adoption of IT system in SCM. The purpose of literature review is to enable the researcher understand the previous researches done on the subject matter.

2.1. Theoretical literature review

2.1.1. Supply chain management (SCM)

According to Bolmole (2000), SCM is an effort by suppliers to develop and implement SC that are as efficient and economical as possible. SC covers everything from raw material sourcing, to production, to product development, to the information systems needed to direct these undertakings. SCM is the combination of art and science that goes into improving the way your company finds the raw components it needs to make a product or service and deliver it to customers (Bolmole, 2000). Without a doubt, technology has had the effect of increasing profitability and efficiency for most parties in a SC.

The SC network supports three types of flows that require careful planning and close coordination that is essential in logistics. One type of flow is the material flow that represents physical product flows from suppliers to customers as well as reserve flows for product returns, recycling and servicing. Information flow involves order transmissions and order tracking which coordinate physical flows and financial flows that represent credit terms, payment schedules and consignment and title ownership arrangements. Jonathan *et al.* (2015) in Figure 4 define the SC as a sequence or network of different companies or individuals that produce, handle, or distribute commodities or specific products with a transaction of money and information visibility along the chain.

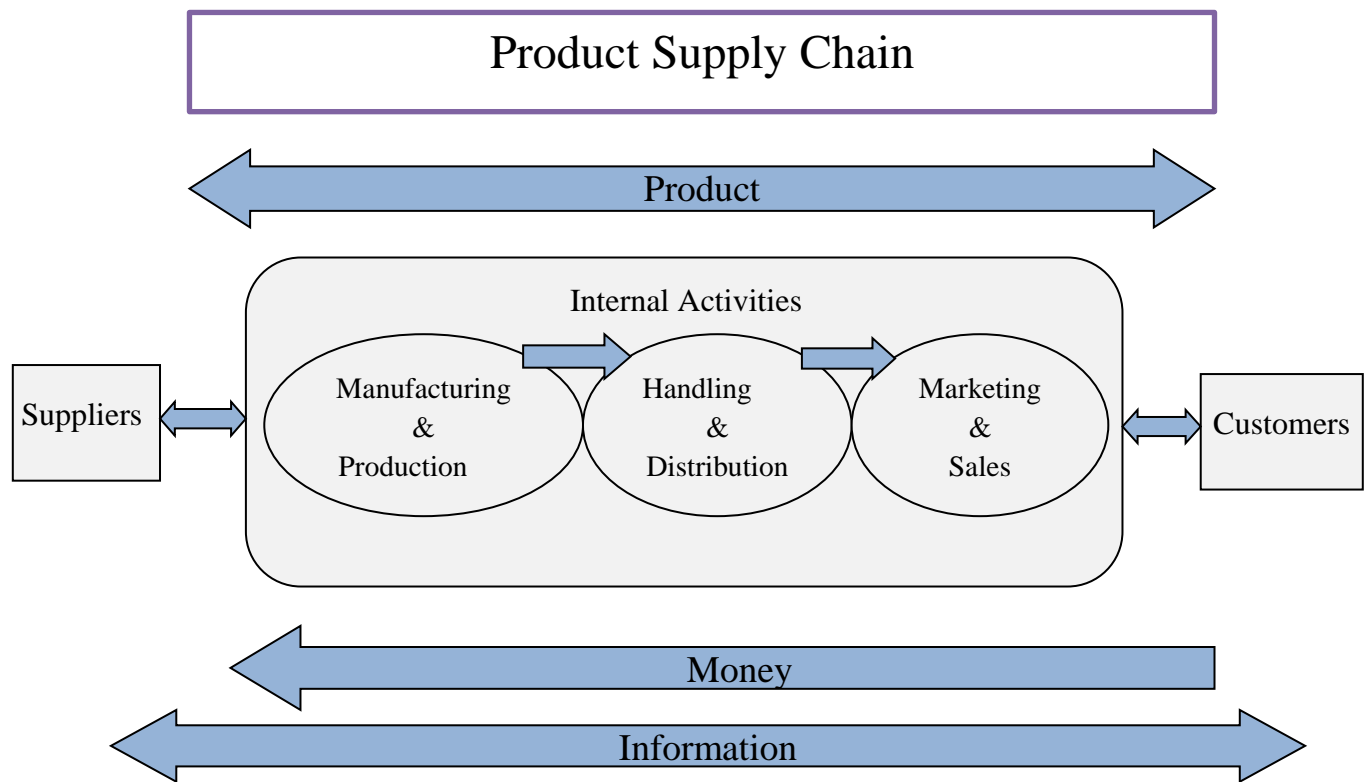


Figure 4: General SC Schematic (Jonathan *et al.*, 2015)

From the previous definitions, it is clear that the SCM concept reflects the reality of SCM as a strategic, managerial philosophy, and practice containing all SC partners from suppliers, manufacturers, to customers achieving better performance, gaining competitive advantage, and increasing customer satisfaction.

2.1.2. SC performance (SCP)

SCP has become a critical source of sustainable advantage in many industries. SCP is defined by Banomyong and Supatn (2011) as “the efficiency which takes into account multiple performance measures related to SC members, as well as the integration and coordination of members’ performance”. According to Harland *et al.* (1999), most of the traditional performance measures are oriented towards economic performance. Various studies have suggested and used a set of new measures to respond to the current requirements for SCP measurement. Stevens (1990) presents SCP measurement in terms of service level, cost, throughput efficiency, inventory level and supplier performance; on the other hand, SCP measures according to Pittigilio and Todd

(1994) fall into one of the following four categories: customer satisfaction/quality, cost, time and assets. Other qualitative SCP measures such as flexibility, information and material flow integration, customer satisfaction, supplier performance, and effective risk management were identified by Beamon (1999).

However, the SC Council introduced the SC operations reference (SCOR) model in 1996, which is a global organization of firms interested in SCM. The SCOR model advocates hundreds of performance metrics used in conjunction with five performance attributes: reliability, responsiveness, flexibility, cost, and asset metrics. SC Council (2006) presents five attributes of SC performance as quoted by (Sillanpää, 2011). As in practice, it is not feasible to consider all the SCP dimensions found in the academic literature, those metrics suggested by SC Council (2006) were adopted for this study as they are comprehensive and include all the dimensions of interest.

- A) SC reliability:** The performance of the SC in delivering correct product to the correct place, at the correct time, in the correct condition and packaging, in the correct quantity, with the correct documentation, to the correct customer.
- B) SC responsiveness:** The speed at which SC provides products to the customer
- C) SC flexibility:** The agility of a SC in responding to marketplace changes to gain or maintain competitive advantage.
- D) SC costs:** The costs associated with operating the SC.
- E) SC asset management:** The effectiveness of an organization in managing assets to support demand satisfaction; this includes the management of the both assets: fixed and working capital.(Sillanpää, 2011)

2.2. Information technology (IT)

The main functions of information technology is to store, retrieve, manipulate, and send information and transmit information, especially the development, installation, implementation, and management of the information for conducting business through the integration of telecommunications equipment and computers application (American Heritage dictionary online, 2011). IT will cover Information System (IS), Information and Communication Technology

(ICT) and the Internet, as well as and their infrastructure, including computer hardware and software, and those technologies that process or transmit information to enhance the effectiveness of individuals and organizations. The further discussions of information system and information and communication technology are presented in Figure 5. Furthermore, Lee *et al.* (2014) have developed the following conceptual relationship between IT, IS, ICT and SCT for better understanding.

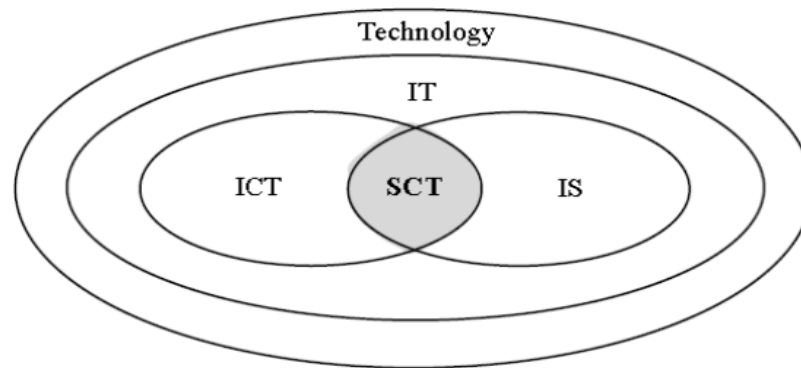


Figure 5: Conceptual relationship between IT, IS, ICT and SCT (Lee *et al.*, 2014)

- 1. Information system (IS):** McLaren *et al.* (2004) defined that the information system is an “enterprise or internal organizational systems used to coordinate information between the manufacturers, suppliers, distributors, and other partners in the SC” to minimize costs and improve the responsiveness of the SC.
- 2. Information and communication technology (ICT):** Information and communication technology applications can be generally categorized into three, which are decision support to public administrators (i.e. geographical information system), improving service to citizens, and empowering citizens to access information and knowledge.
- 3. SC technology (SCT):** Comprehensively, SC technology is defined as a technology or a system that used to coordinate and integrating information flow electronically throughout the internal and external SC to generate effectiveness and efficiency of business processes.

IT plays a vital role in managing the SC in which intelligently provides connection between people, processes, data, and things. All companies are aiming to higher benefits such as offering

new methods to create value by greater and more efficiently organizing the use of physical, financial, information, and human resources. In this context, SC technology is one of the most popular adoptions that lead companies to the direction of success.

2.3. Evolution of SC technology

The introduction of SC technology leads to increase the innovation of operation within the industry. Nowadays, the SC technologies are becoming an essential management tool for companies in the SC to lock their competitiveness.

Lee *et al.* (2014) pointed out that the concept of SCM started to emerge in the mid-1960s, and the first publication took place in 1982. In the Figure 6, they illustrated the evolution of the SC technology from 1970s to 2010s. Based on the evolution, initially, the SC technology is only applied for a single function which is information processing. However, there are increasing numbers of SC technology introduced since 1980s, which include scanner systems, bar code systems, electronic cash register, and just-in-time (JIT).

SC technology has attracted attention of researchers and practitioners since SC technology can make major reduction in costs (Lee *et al.*, 2014). Thus, the number of SC technology has increased dramatically. Vendor managed inventory (VMI), Electronic data interchange (EDI), continuous replenishment systems, computer assisted ordering, e-commerce, cross docking, and direct store delivery in 1990s, while SC reinvention, transportation management systems (TMS), warehouse management systems (WMS), customer relationship management (CRM), SC communication systems, radio frequency identification (RFID), vendor relationship management (VRM), and global positioning systems (GPS) in 2000s. Nowadays, SC technology such as cloud computing has to become a common management tool in assisting firms expand their competitiveness in the global and multinational market (Lee *et al.*, 2014).

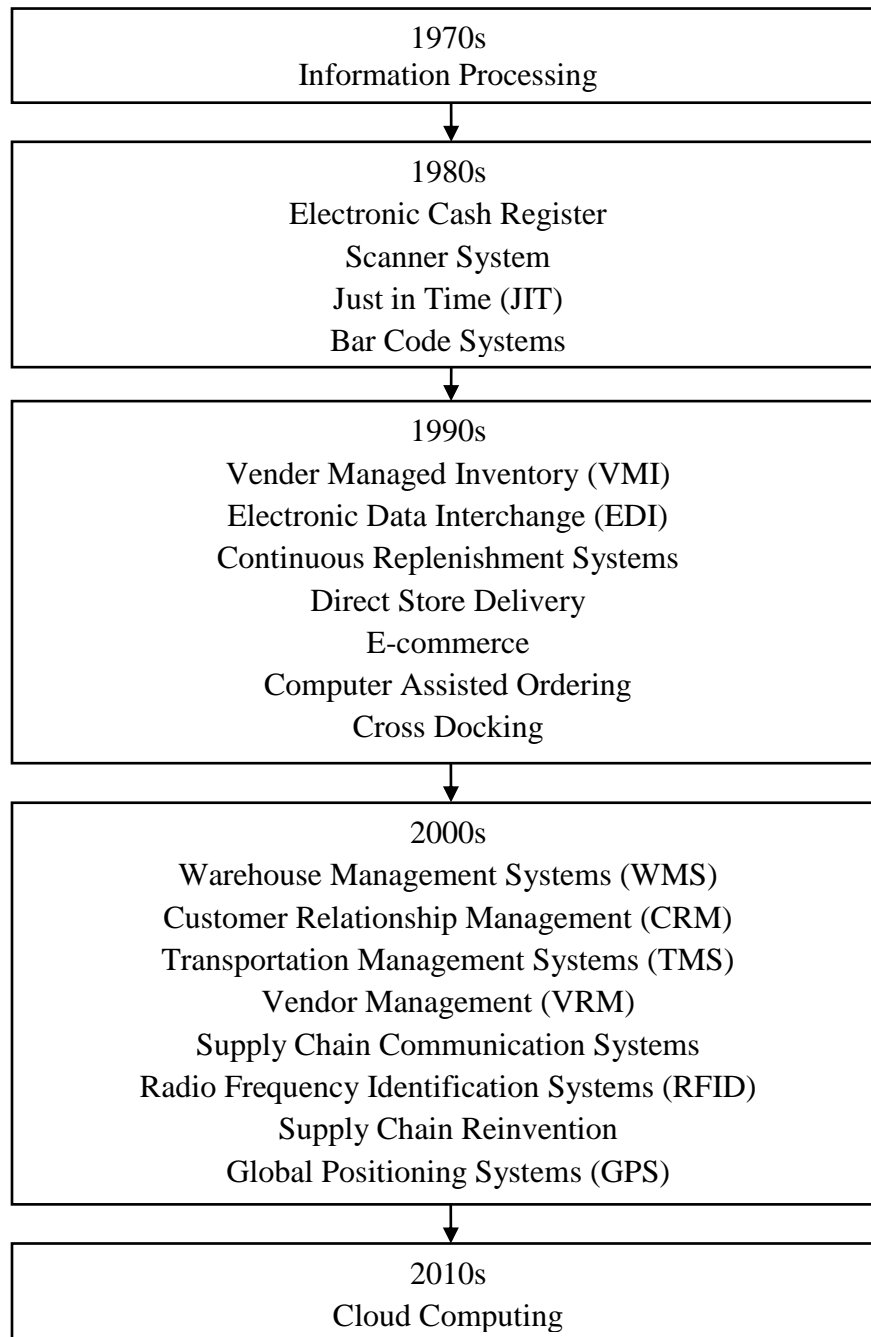


Figure 6: Evolution of SCT tools (Collins *et al.*, 2010)

Some of the names of different IT applications for SCM with their intended use and application area in industrial organizations have been depicted in Table 1.

Table 1: Category of SCTs and their intended function

Name of SCT	Intended functions	Source
Product Data Management (PDM)	PDM features such as revision tracking, document workflow, redlining and other tools help make the design engineering and manufacturing process integration easier. Examples: Windchill, Documentum, SDRC	Patterson <i>et al.</i> (2003)
Customer Relationship Management (CRM)	CRM is an intelligent relationship management tool that can offer Web-based analytic and operation systems to unify all inbound and outbound sales, service, and marketing customer interactions. CRM solutions analytically help a company better understand and proactively serve customers in real time. Examples: Siebel, Vantive	Patterson <i>et al.</i> (2003)
Automated Quality Control (AQC)	Monitor quality assurance process, inspection procedures, specifications, and gauge calibration statistics. Examples: Power Way, Pilgrim Software	Patterson <i>et al.</i> (2003)
Computer Aided Design (CAD)	CAD systems are generally used to design everything from parts to tools and fixtures. Examples: AutoCAD, PTC	Patterson <i>et al.</i> (2003)
Enterprise Resource Planning (ERP)	ERP offers a centralized system to control information flow through a manufacturing environment. ERP covers functions such as capacity planning, cost and accounting, order entry, production management, inventory, and finance. Examples: SAP, Oracle, JD Edwards, PeopleSoft	Patterson <i>et al.</i> (2003)
Material Requirement Planning (MRP I)	Is a computerized production and inventory control systems which inputs bills of material (BOM), item master, requirement, order and outputs master production schedules (MPS)	Varma & Khan, (2014)
Manufacturing Resource Planning (MRP II)	Is a production planning system that converts a Master Production Plans (MPS) into planned order releases	Varma & Khan, (2014)
Distribution Requirement	DRP provides a linkage between warehouse operations (store, distribution center, or warehouse that carries product for sale) and transportation	Varma & Khan,

Planning (DRP)	requirement that ensures supply sources (third party supplier, a regional distribution point, or a factory) which be able to meet the demand.	(2014)
Warehouse Management Systems (WMS)	WMS track and control the movement of inventory through the warehouse, from receiving to shipping. WMS manages utilization of resources such as space and personnel. It also offers systematic management of material handling to optimize and shorten fulfillment cycle time reducing cost. Examples: Catalyst, EXE, Manhattan, Optum	Patterson <i>et al.</i> (2003)
Manufacturing Execution Systems (MES)	MES can deliver real-time visibility and control of manufacturing operations from equipment, materials, and people to the manufacturing processes. It assists companies in responding effectively to unexpected customer requirement changes. Examples: CAMSTAR, CINCOM, Intellution, Kronos	Patterson <i>et al.</i> (2003)
Transportation Management Systems (TMS)	TMS allows companies to address the complex requirements of transportation and can offer sophisticated planning algorithms to optimize different shipping scenarios. Examples: i2, Manugistics, Descartes, nPassage, Capstan	Patterson <i>et al.</i> (2003)
Radio Frequency Identification (RFID)	RFID is a technology or tools that support wireless communication to read and transmit data from data points such as bar codes. Example: NORAND, Intermec, Symbol	Patterson <i>et al.</i> (2003)
Electronic Data Interchange (EDI)	Is the computer to computer interchange of business documents or information in standard, structured, machine retrievable data format between trading partners. Example: EDIFACT and the ANSI X.12.	Varma & Khan, (2014)
Intranet	Is a network of computers, similar to the Internet, only accessed by staffs within a particular company or organization	Varma & Khan, (2014)
Extranet	A system of computers networked together that makes possible for particular organizations to communicate with each other and share information	Varma & Khan, (2014)
Internet	It provides instant and global access to an amazing number of organizations, individuals, and information sources.	Varma & Khan,

		(2014)
Smart Cards	A plastic card with dimensions similar to traditional credit/debit cards, into which an electronic device has been incorporated to allow information storage	Varma & Khan, (2014)
Digital Signatures	Used to submit documents in electronic form in order to ensure the security and authenticity of the documents filed electronically	Varma & Khan, (2014)
Geographic Positioning System (GPS)	Used in trucks or trailers to ascertain position and feed the information to ancillary systems such as TMS, Routing or WMS	Patterson <i>et al.</i> (2003)
Bar Code and Scanner	Systems or products that are used in conjunction with other systems to produce bar codes for any purpose. Example: Intermec, NORAND, Zebra Technologies, Symbol	Varma & Khan, (2014)
World Wide Web (WWW)	Is the Internet system for hypertext linking of multimedia documents, allowing users to move from one Internet site to another without having to use complicated commands and protocols	Varma & Khan, (2014)
Data Warehouse (DW) and Data Mining	Provides a combination of many different databases across an entire enterprise & combines data analysis techniques such as statistical analysis and modeling respectively	Varma & Khan, (2014)
Electronic Procurement (e-Procurement)	Creating and approving purchasing requisitions, placing purchase orders and receiving goods and services by using a software system based on The Internet technology	Varma & Khan, (2014)
Extensible Markup Language (XML)	Defines a standard way of adding markup to documents and data to be processed with relatively little human intervention and exchanged across diverse hardware, operating systems and applications which are so richly structured documents could be used over the Internet	Varma & Khan, (2014)
Decision Support System (DSS)	DSS is a computer-based application that collects, organizes and analyzes business data to facilitate quality business decision-making for management, operations and planning.	Varma & Khan, (2014)

2.4. Role of IT adoption in SCM

According to Simchi-Levi *et al.* (2003), objectives of IT in SCM are providing information availability and visibility, enabling single point of contact of data, allowing decisions based on total SC information and enabling collaboration with SC partners. Shah (2009) noted that IT in an organization has various functions. It increases scale efficiencies of the firms operations, processes basic business transactions, collects, provides information relevant to managerial decisions, also maintain records of status and change in the fundamental business functions within the organization and maintaining communication channels. Such functionalities are also expected in a SC. IT links can connect all the processes of a SC into an integrated and coordinated system that is fast, responsive, flexible and able to produce a high volume of customized products at low costs (Shah, 2009). For better elaboration of the role of IT in SCM, this study focuses on the following categorical classification; Transaction Execution, Collaboration & Coordination and Decision Support (Cross, 2000).

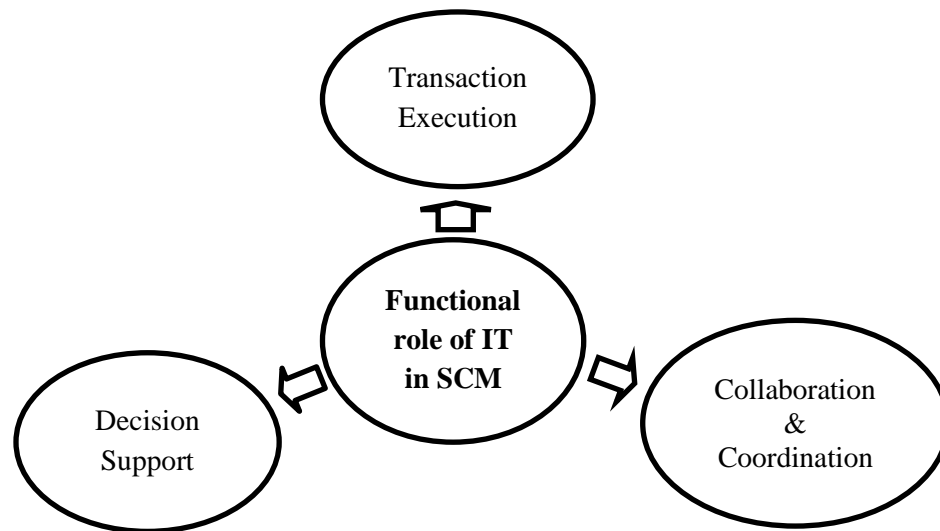


Figure 7: Functional roles of IT in SCM (Cross, 2000)

2.4.1. Transaction execution

The most typical role of IT in SCM is reducing the friction in transactions between SC partners through cost-effective information flow. In this type of IT use, the exchanged information is typically related to such tasks as order processing, billing, delivery verification, generating and

sending dispatch advices, and producing order quotes. Transaction execution processes involve both buy-side (procurement) and sell-side (marketing) transaction. With a good e-procurement process, contracts are in place, and the product has been designed, the buyer and suppliers engage in procurement transactions that begin with the buyer placing the order and end with the buyer receiving and paying for the order electronically, thereby reducing paper based operation and transaction costs. E-commerce has brought about cost savings in a business. There is less paper transactions, the order cycle time is short. The speedy transactions of purchase orders have led to subsequent inventory reduction and there is improved partnership between buyers and suppliers through the introduction of website of business-to-business communication networks. With E-commerce, organizations are also known to reach new markets and segments and then improve their core processes (McIvor *et al.*, 2000).

The Point of sale (POS) tracking system is another application used in SC management. Shah (2009) presents as POS system is known as a customer facing IT application where the scanning system and the retailer's inventory management systems are connected. The goods are usually marked with a bar code and are scanned by a reader that recognizes the goods. The POS provides an instant record of transaction because the items are noted, tallied and a transaction is recorded. Replenishment of products can be coordinated in real time to ensure that stock outs in the retail store are avoided (Shah, 2009). In addition, EDI used for the paperless communication to share transactional data, order processing, inventory controlling, accounting, transportation, quick access to information, better customer service, increased productivity, improved tracing and expediting, cost efficiency, competitive advantage, and improved invoicing within in bound and out bound SC.

2.4.2. Collaboration and coordination

IT is more importantly viewed to have a role in supporting the collaboration and coordination of SC through information sharing. This represents the use of IT for sharing planning-related information such as demand forecasts and other demand information, inventory information, and production capacity information, with the intention of increasing the effectiveness of the SC. It also refers the use of IT to the monitoring of individual orders or shipments, which may consist of components or final products, with the aim of coordinating their delivery or conveying timely

information of their location. For example, IT is one of the key cures for bullwhip effect along SC. It integrates one department with another department within an organization and different organizations with its partners.

According to Graham *et al.* (2013), IT has enabled companies to coordinate in streamline logistics flows, reduce inventory and improving customer service thus improving efficiency in information transfer. The use of the Internet has made it easier to share information along the SC. This has led to improved operational performance, good customer service and solution development. SC relationships and collaborations have also evolved as a result of information technology and the information sharing along the SC. A good case is seen in the industries that deal with Fast Moving Consumer Goods (FCMG). The collaboration has been articulated through the efficient Consumer Response Movement (Graham *et al.*, 2013).

Vendor-Managed Inventory (VMI) has enabled sharing of information between buyer and seller. Buyers are able to share their information on demand to their supplier. The supplier in turn manages this information and can be able to do forecasting based on the data received. This is mostly seen in supermarkets (Graham *et al.*, 2013). This data is also transmitted from warehouse inventory reports and orders information. Lim and Palvia (2001) stated that successful companies have developed focused e-business integration solutions for improving customer service elements that are success factors in their business operations. EDI for example contributes positively to order cycle time, product availability, and distribution flexibility among other things.

IT is used in SC to manage supply and demand. As Muriuki (2013) stated, managers control demand by capturing all the end user requirements and consolidate their demands and needs, preparing records required to provide future forecast of demand verses trend and consumption reports through transaction in the system that provide information on consumption trends on use of products. Consolidating demand ensures that there is competitive pricing, cheap transport/shipping costs, good handling and clearing and contracted supplier's regular identified requirements.

IT systems such as ERP and EDIs, on the other hand, manages supply by capturing all information in the database on suppliers and deliveries, recording of previous suppliers used to forecast supplies, approval of purchase orders, managing suppliers by vetting them and

blacklisting of suppliers through evaluation. Supplier details such as lead times, cost of production, shipping time, cost and point of sourcing are also determined.

2.4.3. Decision support

IT can be used for decision support. In these instances, the analytical power of computers are used to provide assistance to managerial decisions such as sourcing decision, transportation decision, network design and etc. As Shah (2009) noted out, IT is also useful in SC decision support. Transaction system captures data on orders, stock, shipments among others. There is collaboration and coordinated system that ensures all SC data is available in a timely manner to all entities in a SC. Decision Support Systems (DSS) is a computer-based application that collects, organizes and analyzes business data to facilitate quality business decision-making for management, operations and planning. DSS use the data captured to create feasible and economical plans dealing with different stages of the SC. Thus, the management is able to decide and answer important questions as what should be produced, when and where (Shah, 2009).

According to Muriuki (2013), the logistics managers track shipments to gather detailed information about a specific shipment while it is in transit. They are able to check on the status of a shipment and its routing information. When they track shipments, there is better control of the entire shipping process. Through the shipment tracking function, they can locate shipments according to the carrier that is transporting the shipment. Additionally, carriers can provide tracking information through the Internet, telephone, or some other means. It is possible to track shipments to know exactly where the shipments are, both physically and within the system. This information enables the logistics managers to make the right decision on certain shipment system and report on the product as it travels to customers. Technologies used to track the cargo that is enroute from suppliers place include; GPS & GPRS, RFID, E-commerce such as waybills, bill of lading, and dispatch notes

2.5. Models of IT adoption

There are a few reviews in the literature about the comparison of IT adoption models at the individual level, and there are even fewer at the firm level. According to study by Oliveira and Martins (2011), the most used theories at the individual level are the Technology Acceptance

Model (TAM), Theory of Planned Behavior (TPB) and Unified Theory of Acceptance and Use of Technology (UTAUT). The theories for adoption models at the firm level are two prominent models: Diffusion on Innovation (DOI) theory, and the Technology, Organization, and Environment (TOE) framework. Some of these models are presented below.

2.5.1. Technology acceptance model (TAM)

The TAM model originally proposed by Davis (1989) contains two core elements, namely perceived ease of use (PEOU) and perceived usefulness (PU). PEOU is defined as “the degree to which a person believes that using a particular system would be free of effort”. On the other hand, if users perceive an IT to be useful to support their current and long-term job performance, they are more likely to adopt the system in their daily practice. PU is hence referred to as “the degree to which a person believes that using a particular system would enhance his or her current and continuous job performance”. The original version of TAM consists of combinations of these two core factors (i.e. PU and PEOU). However, other essential elements including External Variables, Attitude, Behavioral Intention and Actual Use, have been synthesized by Legris *et al.* (2003) and shown in Figure 8. The user acceptance and actual use of technology is assumed to depend on the intention of users. In turn, the attitude of users, which influences the users’ intention, is formed by the users’ beliefs.

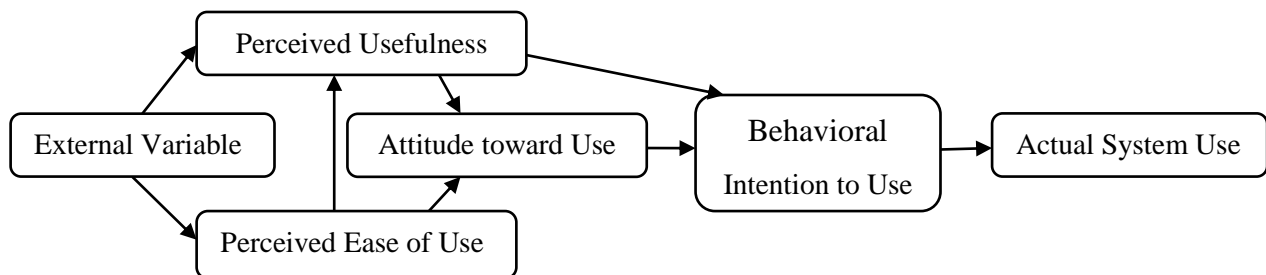


Figure 8: Technology acceptance model (TAM) (Legris *et al.*, 2003)

According to Davis *et al.* (1989), the two base elements of perceived ease of use and perceived usefulness are the components of these users’ beliefs. However, these beliefs are also constructed by development processes, personal experiences, professional experiences, organizational factors, social and political influences as well as the perceptions of the tasks to be performed using the technology. These latter influencing factors are known in TAM as external variables.

2.5.2. Diffusion of innovation (DOI)

According to Rogers (1995), DOI is a theory of how, why, and at what rate new ideas and technology spread through cultures, operating at the individual and firm level. DOI theory sees innovations as being communicated through certain channels over time and within a particular social system. Individuals are seen as possessing different degrees of willingness to adopt innovations, and thus it is generally observed that the portion of the population adopting an innovation is approximately normally distributed over time. Breaking this normal distribution into segments leads to the segregation of individuals into the following five categories of individual innovativeness (from earliest to latest adopters): innovators, early adopters, early majority, late majority and laggards. The innovation process in organizations is much more complex. It generally involves a number of individuals, perhaps including both supporters and opponents of the new idea, each of whom plays a role in the innovation-decision. Based on DOI theory at firm level innovativeness is related to such independent variables as individual (leader) characteristics, internal organizational structural characteristics, and external characteristics of the organization (Figure 9).

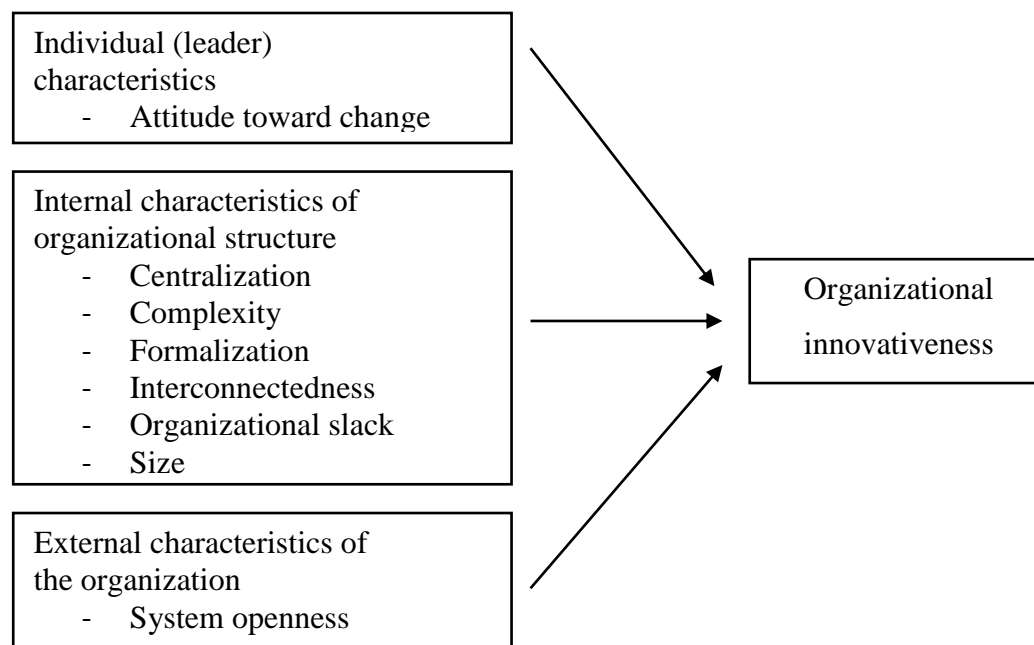


Figure 9: Diffusion of Innovations (DOI) (Rogers, 1995)

Individual characteristics: describes the leader attitude toward change

Internal characteristics: of organizational structure includes observations such as: Centralization—the degree to which power and control in a system are concentrated in the hands of a relatively few individuals, Complexity—the degree to which an organization’s members possess a relatively high level of knowledge and expertise, Formalization—the degree to which an organization emphasizes its members’ following rules and procedures, Interconnectedness—the degree to which the units in a social system are linked by interpersonal networks, Organizational slack—the degree to which uncommitted resources are available to an organization, and Size—the number of employees of the organization

External characteristics of organization: refers to system openness.

2.5.3. Technology, organization, and environment (TOE)

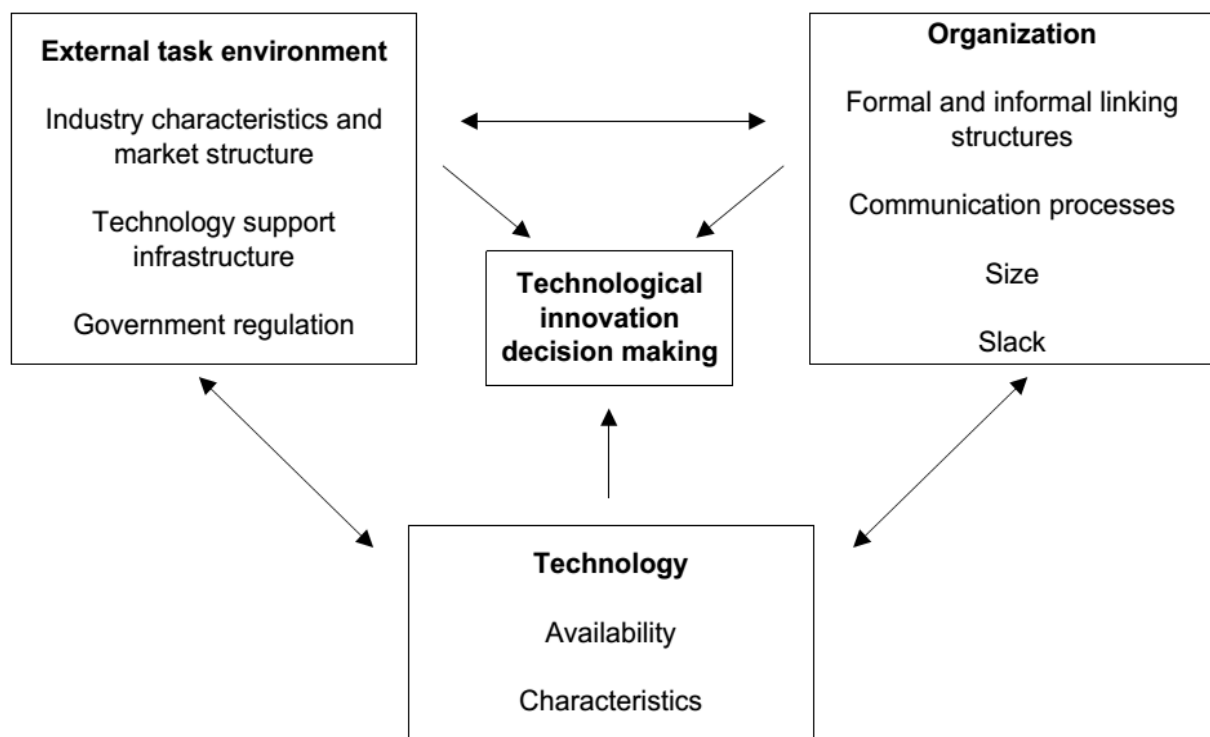


Figure 10: TOE framework (Tornatzky and Fleischer, 1990)

The TOE framework was developed in 1990 (Tornatzky and Fleischer, 1990). It identifies three aspects of an enterprise's context that influence the process by which it adopts and implements a

technological innovation: technological context, organizational context, and environmental context (Figure 10).

- (a) Organizational context refers to descriptive measures about the organization such as scope, size, and managerial structure.
- (b) Technological context describes both the internal and external technologies relevant to the firm. This includes current practices and equipment internal to the firm, as well as the set of available technologies external to the firm.
- (c) Environmental context is the arena in which a firm conducts its business—its industry, competitors, and dealings with the government (Tornatzky and Fleischer, 1990).

2.5.4. DTI adoption ladder approach

According to Parida *et al.* (2010), this adoption ladder approach has been used by the UK government's Department of Trade and Industry (DTI) for better understanding of the adoption of ICT by existing small firms. Figure 11 provides an illustration of this ICT adoption model. The main idea behind this model is that a small firm approaches ICT adoption through a series of stages, in a well-planned and sequential manner.

The business benefits associated with ICT drive the adoption process and results in increased organizational change and ICT sophistication at each step. Small firms' usage of ICT ranges from basic technology such as emails and fixed lines to more advanced technology such as e-commerce, and information processing systems. Using advanced ICT to improve business processes falls into the category of e-business and finally representing a transformed small firm.

This particular study adapted all necessary parts of this ladder approach starting from the first step-using e-mail (adapted as the internet for this study) to step five-transformed organization (using sophisticated IT tools such as ERP, EDI, SCM, RFID, etc.). As Figure 11 illustrates firms should start from an efficient internal and external communication to open systems information for customers, suppliers and partners in order to increase change and sophistication of manufacturing firms.

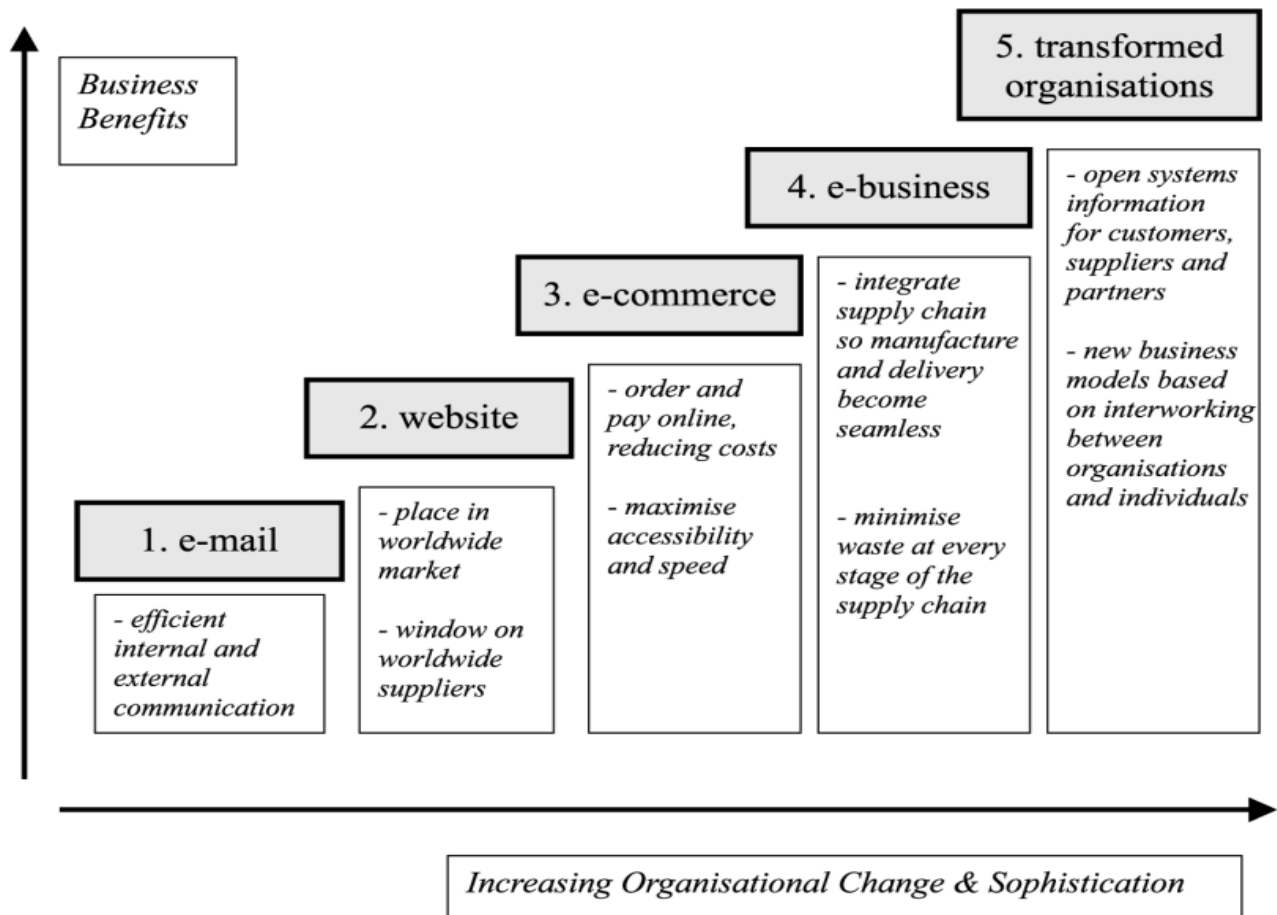


Figure 11: DTI adoption ladder approach (Parida *et al.*, 2010)

Several authors suggested that in today's dynamic business environment the combined use of different IT adoption models would be more dependable to organizations than using single models. Oliveira and Martins (2011) recommended that for more complex new technology adoption it is important to combine more than one theoretical model (DOI with TOE or other) to achieve a better understanding of the IT adoption phenomenon (e.g. Institutional theory and Iacovou *et al.* 1995 model).

2.6. Critical success factors (CSFs) and barriers of IT adoption

Organizations could experience either supportive opportunities and CSFs or challenges during IT adoption process. CSFs are driving forces or opportunities that companies might exploit them for

successful change and sophistication to their organization. Despite constructive CSFs, some barriers and challenges could resist organizations against IT adoption process.

2.6.1. Critical success factors (CSFs)

CSFs are the few key areas where things must go right for the business to flourish and for the manager's goals to be attained. CSFs bring a concept that helps an organization identify the critical issues that affect the process of IT implementation. Through a better understanding of the CSFs, an organization can determine the corresponding solution to eliminate or avoid the most common causes of failure in IT implementation.

In various articles, top management support was one of the most frequently cited CSFs for IT implementation. Ngai *et al.* (2008) presented that every project must receive an approval and support from the top management before it can be implemented. Top management must be willing to become involved and to allocate valuable resources to the implementation effort. All of the studies in every region or country were highly agreed on the critical role played by top management support in the successful IT implementation (Ngai *et al.*, 2008). This showed that top management support is widely recognized as necessary for IT adoption, and that this factor may be independent across regions and countries.

As Ngai *et al.* (2008) reviewed, the clear and effective communication at all levels of an organization is necessary before and during the implementation of IT. Communication includes the formal promotion of IT project teams and advertisements on the project's progress to the rest of the organization. Effective communication is one of the success factors that influence the acceptance of technology in organizations.

Raut *et al.* (2017) stated that organizational readiness is the managers' evaluation and perception of the degree to which they believe that their enterprise has the governance, commitment, resources, and awareness to adopt an IT innovation. It can be classified into two segments: firstly, technological readiness, which includes the availability of human resources, infrastructure for IT management and usage, and secondly, financial readiness, which involves the availability of the capital for IT implementation and expenses, expected to incur during its usage. Additionally, Raut *et al.* (2017) pointed out various CSFs in their article such as employee knowledge and

training, government support in IT infrastructure, firm size and firm age, strategic planning to IT adoption, good innovation culture, etc.

2.6.2. Barriers to IT adoption

As Hollenstein (2004) reviewed, the barriers that are negatively related to IT adoption refer to anticipated challenges to the adoption of IT. From the literature, some of main types of hindrances were identified. They found that investment costs and unfavorable financial conditions (high price of technology, large investment requirements, liquidity constraints, etc.) are potential barriers to IT adoption investment in general. They also reveal that adoption of IT may be hampered by human capital restrictions such as the shortage of highly skilled workers, lack of IT specialists, insufficient IT-oriented training etc. Problems related to IT training are also main challenges for better implementation.

IT adoption often is impeded by information barriers reflecting, for example, uncertainties with respect to the performance of IT or the future development of these technologies; for the case of e-transactions, the role played by uncertainty is highlighted in Eurostat (2002). As Hollenstein (2004) reviewed, the adoption of IT is also negatively affected by managerial barriers (e.g. insufficient awareness of managers on the potential gains of IT, deficient strategic orientation of IT management, etc.). Thus, importance of management involvement and strategic thinking at this level of decision-making is highly emphasized.

The security assurance from the service provider is a key driver for the IT adoption. Raut *et al.* (2017) pointed out that the security in IT adoption is not just about accountability, authorization, and authenticity, but more concerned with business continuity, disaster recovery and data protection. Security directly contributes to the IT systems reliability and a reliable software system can give a sound security. The service providers need to ensure the adequate data availability, adequate supporting staff for the purpose of maintenance, or resolving issues as per the demand of the service seekers (Raut *et al.*, 2017). Therefore, designing and development of a highly secured IT system is necessary for increasing the IT adoption rate.

2.7. Related previous work

There are empirical studies in literature, mostly studied in developed countries and a few studies in developing countries regarding the role and effect of IT adoption in SCM. Despite the acknowledged importance of the use of IT in SCM, the number of empirical studies assessing the use of IT in SC context is limited. Some related studies were presented below.

From the developed world, Auramo *et al.* (2005) conducted a study in Finland based on empirical data from 16 Finnish industrial and service companies. The paper presented a classification of the ways in which companies use IT in SCM, and examined the drivers for these different utilization types. According to the finding, the use of IT for SCM purposes were divided into transaction processing, SC planning and collaboration, and order tracking and delivery coordination.

The study by Ejiaku (2014), investigated the challenges in IT adoption in emerging nations, mainly African countries. He described that sustainable development and the role of IT make it imperative for developing nations to acquire and adopt the use of IT. Ineffective government policies, poor infrastructure and inadequate training and qualification are contributory factors in creating challenges in IT transfer and adoption in this region. He suggested that developing countries should encourage privatization as a way of attracting investors and alleviating capital expenditure since the cost of IT is high, so a large capital outlay is needed for the initial acquisition, development and maintenance. He added that these countries should focus on training and developing IT professionals who can manage IT projects and be able to analyze and adapt the innovative experience of developed countries.

Muriuki (2013) conducted a research to determine the benefits of IT on SC performance and to investigate various IT applications used in SC operations in Kenyan firm called International Energy Technik Limited (IET), which has fully implemented IT in its operations and has achieved good results. The result showed IT has improved the processes of transactions across the various functions and is integrated in such a way that information flows along the various functions between procurement and planning, logistics and warehouse. The various technologies used have reduced the costs of operations in the SC, achieved many savings, reduced lead-time,

and improved customer service where both internal and external customers are happy due to faster response from the SC.

Lin *et al.* (2008) studied to develop a research model for the determinants of e-business diffusion based on the technology diffusion theory and the technology–organization–environment (TOE) framework. The research model examined the influence of technological context (information system (IS) infrastructure and IS expertise), organizational context (organizational compatibility and expected benefits of e-business) and environmental context (competitive pressure and trading partner readiness) on e-business diffusion. E-business diffusion was characterized by two dimensions: internal integration and external diffusion. Data was gathered from 163 IS executives in large Taiwanese firms to test the relationships between the research model constructs. Among the TOE factors, the results reveal that IS infrastructure, IS expertise, expected benefits of e-business, and competitive pressure are important factors shaping e-business diffusion.

Lin (2014) also studied to investigate the determinants of electronic SCM (e-SCM) system adoption across non-adopters and adopters based on TOE framework. The research model examined the influence of technological context (perceived benefits and perceived costs), organizational context (firm size, top management support, and absorptive capacity), and environmental context (trading partners and competitive advantage) on e-SCM adoption. Data gathered from 283 IS managers (127 for non-adopters and 156 for adopters) in large Taiwanese firms were employed to test the relationships between the research model constructs. The results revealed that firms with certain perceived benefits, perceived costs, top management support, absorptive capacity, and competitive pressure are more likely to adopt e-SCM. While technological context was a major determinant of the decision to adopt, it had no direct effect on the extent of e-SCM adoption. The extent of e-SCM adoption is mainly determined by organizational and environmental contexts.

Mzoughi *et al.* (2008) investigated the impact of SCM and ERP on organizational performance and competitive advantage in Tunisia by conducting a survey on 216 Tunisian managers. The result showed the importance of SCM and ERP adoption and the positive impact on organizational performance and competitive advantage in Tunisians companies.

Mathu & Tlare (2017) studied the impact of IT adoption in SMEs SC in South Africa by taking sample size of 300 manufacturing and service companies. The finding indicated that IT adoption enhanced integration and collaboration of SMEs SC. The other benefits that emerged from the increased use of IT in the SC include enhancement of customer service, inventory management, lead time, and relationship building.

As stated in above empirical literature review, the more emphasis was given to empirical reviews from developing countries than from developed world. This is because the research under study was being done in developing country Ethiopia. Thus, researcher was intentionally sought to adopt their experience on IT adoption for successful SCM and organizational performance as benchmarking in the country.

2.8. Justification of the literature

In this chapter, it was attempted to investigate pertinent theoretical and empirical literature backgrounds to the study. All previous archives, regarding the role of IT in organizational level, clearly and strongly assert its importance for the purposes of competitive strategy, organizational performance, collaboration and coordination, transaction execution and decision support. Beside IT roles, various documents regarding its adoption models have been explored and some models were found with different determinants and perceptions toward adoption processes.

As described earlier, original TAM focuses on two basic elements, PEU and PU as adoption factors, however, other essential elements including External Variables, Attitude, Behavioral Intention and Actual Use, have been added by other authors later. DOI theory at firm level innovativeness deals about independent variables, such as individual (leader) characteristics, internal organizational structural characteristics, and external characteristics of the organization. TOE model identifies three aspects of an enterprise's context that influence IT adoption and implementation, such as technological context, organizational context, and environmental context. DTI adoption ladder approach presents step by step system for small firms' usage of ICT that ranges from basic technology such as emails and fixed lines to more advanced technology such as website, e-commerce, e-business and finally a transformed small firm.

However, as the literature review showed all these models were lacking one basic concept, IT security, and almost all were developed in more industrialized nations' perspective. In developing nations like Ethiopia, companies do face different challenges to adopt IT system as well as there would be vulnerability of its usage due to deficiency of IT security experts. Therefore, it needs such an explicit IT adoption framework worthy for firms in developing nations to keep in this ever innovative global competition track. Hence, this study generally considers those literature limitations and seeks to narrow this gap by developing and analyzing a systematic IT adoption model. The model thoroughly considers special contexts from different theories mentioned so far and intended to be a proper framework to explain IT adoption process to the manufacturing firms in developing nations, like Ethiopia.

2.9. Conceptual framework of the study

Based on the literature review and the objectives of the study the following conceptual framework was developed. This framework is organized based on research objectives as well as the following three basic themes. First, the focus was given to the role of IT in the critical SCM areas such as transaction execution, collaboration and coordination, and decision support thoroughly with careful literature investigation. Some contents were adapted from Auramo *et al.* 2005, who developed two priori constructs for the purposes of examining the use of IT in SCM.

Second, the barriers and CSFs during the adoption process were also emphasized. Various articles have also been reviewed regarding the firms' opportunities/CSF during IT adoption (e.g., Ngai *et al.*, 2008; Raut *et al.*, 2017) and the associated challenges that hinder IT adoption among organizations (Hollenstein, 2004; Eurostat, 2002). Third, the effect of the adopting IT on SC performance was analyzed. SC performance is one of the categories of firms' performance areas. Indeed, decisions rendered at the firm level regarding resource allocation/IT investments are not based on SC operational efficiencies but instead on implications for overall firm performance (Collins *et al.*, 2010). Therefore, the IT investment for firm's SC performance should not overlooked by managers during strategic planning and resource allocation.

Finally, the IT adoption model for Ethiopian MLSM firms would be developed based on the analysis of its functional role and the findings obtained from survey result.

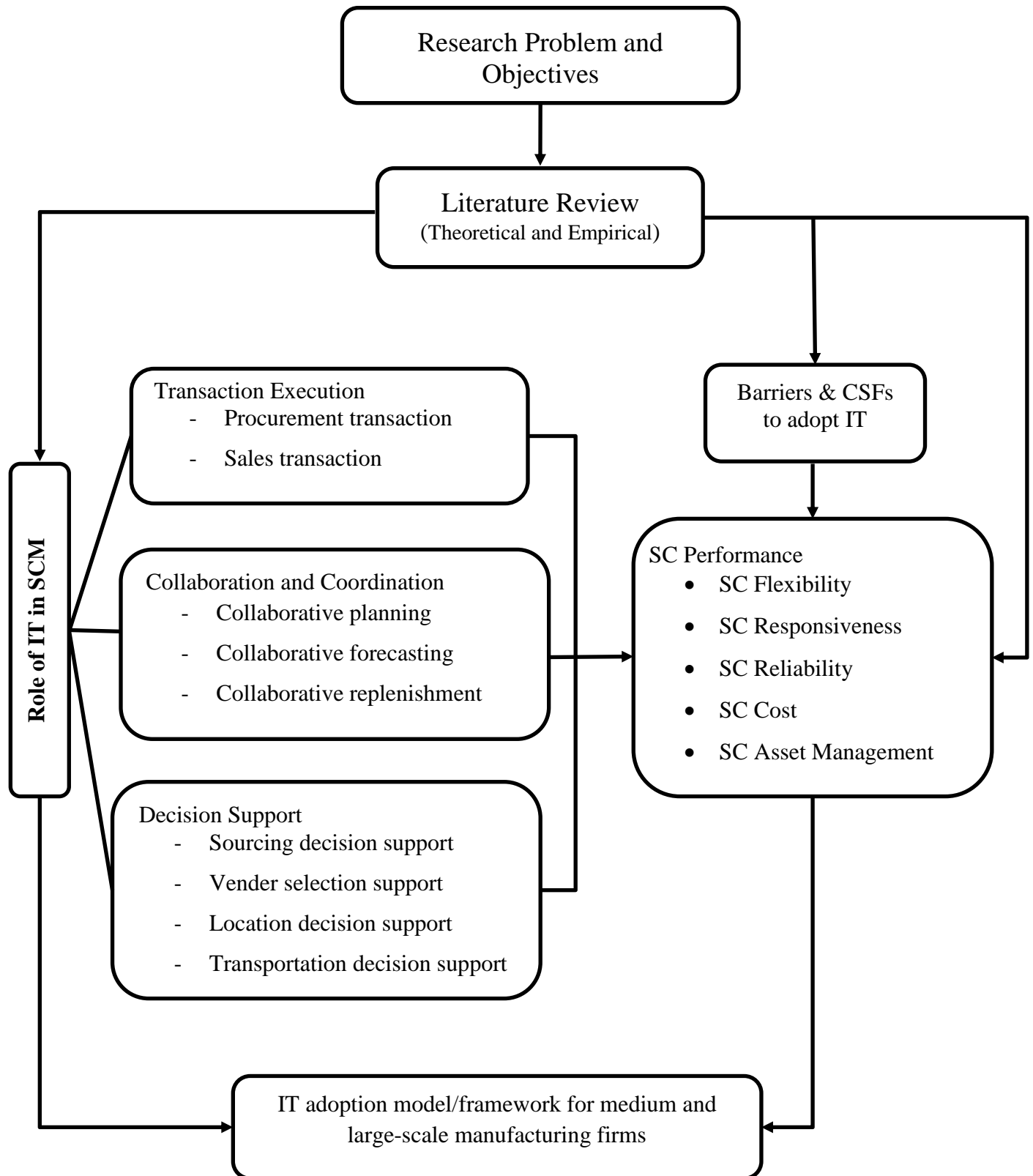


Figure 12: Conceptual framework of the study

CHAPTER THREE

MATERIAL AND METHODS

Research methodology is a way to solve the research problem systematically. It is a science of studying how research is done scientifically (Kothari, 2004) and, in which one can study the various steps that are generally adopted by researcher in studying research problems along with the logic behind them. Therefore, the main purpose of the research methodology is to explain how the research was accomplished, what knowledge was required, what information was needed and how it was collected and analyzed. This chapter presents the research approach, sample design, sampling technique, sample size, source and instruments of data collection, methods of data analysis, ethical issues, validity and reliability of the study.

3.1. Description of the study area

The study was conducted in Ethiopian manufacturing firms specifically in MLSM firms because the firms with greater numbers of employees adopt more technologies perhaps to improve information management and activity coordination. Large organizations have greater volumes of transactions, more geographically dispersed operations, more SC partners, and more information to manage and are thus would be more likely to adopt information technology systems to improve operational efficiency and very often lower cost.

Consequently, a periphery of three regions – Addis Ababa city administration, Oromia region and SNNPR region were selected for the purpose of study convenience and time and resource limitations to address other regions. Besides, the number of MLSM firms registered in these regions was also very large (comprising 73% of national register) as shown by Ethiopian Central Statistics Agency (CSA, 2015). According to the CSA's report, about 33% of MLSM firms in Ethiopia are concentrated in and around Addis Ababa city, 30% in Oromia region and 10% in SNNP region. These data was taken from Ethiopian Central Statistical Agency (CSA) surveys report undertaken on the Large and Medium Scale Manufacturing and Electrical Industries Survey (LMMIS) that covers all establishments with 10 or more employees that use power-driven

machinery, often manufacturing firms. Consequently, those regions were selected being larger industry centers and for the appropriateness of finding IT implementing MLSM firms.

3.2. Research design

A research design is a procedural plan for researcher to answer questions validly, objectively, accurately and economically. Kumar (2011) described “through a research design you decide for yourself and communicate to others your decisions regarding what study design you propose to use, how you are going to collect information from your respondents, how you are going to select your respondents, how the information you are going to collect is to be analyzed and how you are going to communicate your findings” (p.96). This study adopted a survey research design, particularly cross-sectional, because it is useful in describing the characteristics of a large population, makes use of large samples, and thus making the results statistically significant even when analyzing multiple variables.

According to Abdullah & Raman (2001), there are two types of survey methods – cross-sectional survey and the longitudinal survey. In the cross-sectional survey, data are collected from a sample from a predetermined population at one point in time although the actual time required to complete may take more than a day or a month. Generally, it can be analyzed in two ways, i.e. descriptions of single variables and exploration of relationships. In the longitudinal survey, data are collected at different points in time and its purpose is to enable changes or time-ordered associations to be studied. While the cross-sectional study is limited by time factors, the longitudinal survey is not (Abdullah & Raman, 2001). The study used the cross-sectional field survey method to investigate IT application status in large number of firms, its roles with respect to SCM and the relationship between IT adoption and SC performance in these firms.

The research also followed a correlational approach in order to address the aforementioned objectives. Correlation approach aims to ascertain if there is a significant relationship between two variables (Reid, 1987). Hence, after the data were collected, then was analyzed by using correlation, particularly Pearson’s correlation coefficient to show the relationship of functional roles of IT adoption and the SC performance of MLSM firms.

3.3. Research approach

Both qualitative and quantitative approach was used to investigate the problem under study. Mixed approach neutralizes the biases of applying any of a single approach (Creswell, 2005).

Quantitative research, as asserted by Creswell (2005), is a type of educational research in which researcher decides what to study, asks specific, narrow questions, collects numeric (numbered) data from participants, analyzes these numbers using statistics, and conducts the inquiry in an unbiased, objective manner. This approach was applied in this study to analyze responses to Likert scale questions.

Qualitative approach is concerned with subjective assessment of attitudes, opinions and behavior. Research in such a situation is a function of researcher's insights and impressions. Such an approach to research generates results either in non-quantitative form or in the form that are not subjected to rigorous quantitative analysis. Therefore, while conducting the research qualitative approach was employed to gather respondents' perception towards IT role in SCM and to analyze IT adoption status in firms with respect to their age, entrepreneurial level, sector and geographic range of operation.

3.4. Data type and source of data

For this particular study, the required data was collected by using both primary and secondary types of data collection methods. Primary data was collected from sample firms by using a self-administered questionnaire that consist both open and more of closed ended questions that is designed to collect responses for qualitative and quantitative analysis respectively. Data were gathered via survey questionnaire and interview from different level managers as well as owners of manufacturing firms. For literature review, online databases and library services such as Taylor & Francis (www.tandfonline.com), Emerald (www.emeraldinsight.com), ELSEVIER (www.elsevier.com), www.sciencedirect.com and other related sources were used to search published or unpublished articles, academic journals, dissertations, thesis, conference proceedings, government reports, and books have been tapped that are related to the nature of the problem.

3.5. Sample design

Kothari (2004) described that when field studies are undertaken in practical life, considerations of time and cost almost invariably lead to a selection of respondents i.e., selection of only a few items. The respondents selected should be as representative of the total population as possible in order to produce a miniature cross-section. The selected respondents constitute what is technically called a 'sample' and the selection process is called 'sampling technique.' The survey so conducted is known as 'sample survey'. Therefore, a sample design is a definite plan for obtaining a sample from a given population. It refers to the technique or the procedure the researcher would adopt in selecting items for the sample (Kothari, 2004).

3.5.1. Sampling technique

There are two types of sampling techniques — probability and non-probability. Probability sampling is known as 'random sampling' or 'chance sampling' under which every item of the universe has an equal chance of inclusion in the sample (e.g. simple random sampling, cluster sampling, systematic sampling, stratified sampling, etc.). Non-probability sampling is that sampling procedure which does not afford any basis for estimating the probability that each item in the population has of being included in the sample and is known by different names such as deliberate sampling, purposive sampling and judgment sampling (Kothari, 2004).

For the purpose of this study, the researcher used probability sampling particularly disproportionate stratified sampling technique since the total population of the study is large, heterogeneous in type and stratified sampling results in more reliable and detailed information (Kothari, 2004). There are about 16 (sixteen) manufacturing sub-sectors in Ethiopia, which is very large to study. Then, the target population for the study was classified into eight (8) strata (sub-sectors) based on merging some homogeneous sub-sector firms. Then the samples were selected from each stratum by simple random sampling method. Since the information required for the study needs firms that have an experience, knowledge and awareness about SCM, the role of IT and SC performance of the firm, stratified sampling technique was used to have the right proportion of firms from every concerned sub-sector of MLSM firms. The sub-sectors considered as strata, from which data were collected were: Chemical and Chemical Products, Food and

Beverage Products, Leather and Leather Products, Metal and Engineering Products, Other Non-Metallic Mineral Products, Rubber and Plastic Products, Textiles and Apparel Products and Wood, Paper and Pulp Products.

3.5.2. Sample size

There are about totally 2,758 registered MLSM firms from all regions in Ethiopia both private and public owned (CSA, 2015) and among these 2,277 firms were found under the selected eight (8) sub-sectors. The three regions (Addis Ababa, Oromia & SNNPR) also account for 73% of total national register (more than 2000 MLSM firms) so that researcher was convinced to conduct study in these regions.

The larger the sampling size of a research, the more accurate the data generated. However, due to time and resource limitations and the nature of the population, sample determination method developed by Carvalho, "Archival application of mathematical sampling techniques", (as cited by National Archive Report Richmond, 2005), was preferred by researcher as a method to determine a sample size. Accordingly, about 438 MLSM firms were disproportionally selected as a sample size for this study that shows even more sample size than the number (200) prescribed as a large in the category in which the total population size 2,785 found as depicted in Table 2.

Table 2: Sampling size selection guideline table

Population size	Small	Medium	Large
51-90	5	13	20
91-150	8	20	32
151-280	13	32	50
281-500	20	50	80
501-1200	32	80	125
1201-3200	50	125	200
3201-10,000	80	200	315
10,001-35,000	125	315	500
35,001-150,000	200	500	800

Source: (Carvalho, 1984) as quoted by (National Archive Report Richmond, 2005)

3.5.3. Sectorial distribution of firms

According to the subsequent report by CSA, there are about 16 (sixteen) sub-sectors in manufacturing industry sector in Ethiopia. Due to the data heterogeneous and large size of sectors it has been merged to 8 (eight) sub-sectors by using stratification method. Figure 13 illustrates the result of sectorial distribution of these firms. According to the result, the majority of firms selected for survey were from two sub-sectors such as food and beverage products and wood, paper and pulp products with respective percentages of 21.9% (96 firms) and 21% (92 firms). These two sub-sectors also accounts for larger percent of manufacturing industry sector in the country than the others. The next two larger sub-sectors as shown in the Figure 13 were rubber and plastic products and other non-metallic mineral products accounting for 13% (57 firms) and 12.3% (54 firms) respectively. The rest of others such as leather and leather products, textiles and apparel products, chemical and chemical products and metal and engineering products have been selected with the respective percentage of 10%, 8.7%, 8% and 5%.

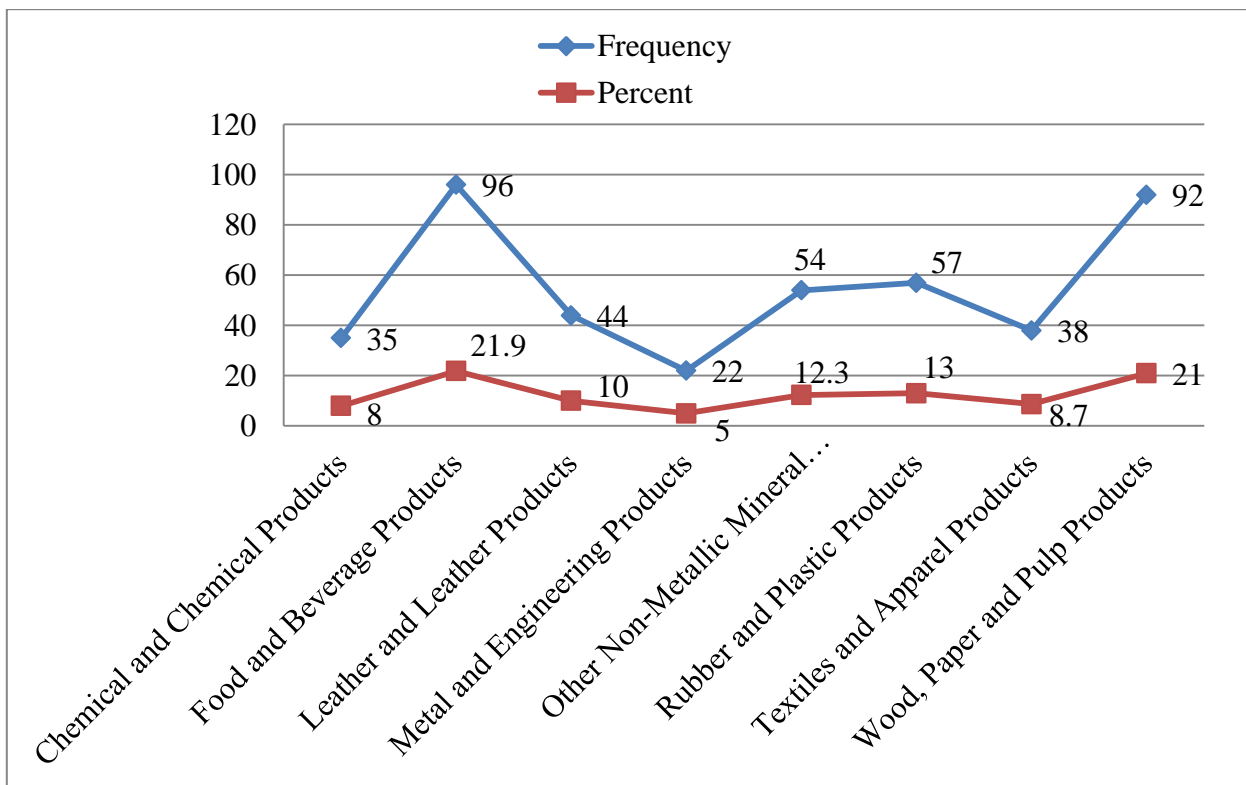


Figure 13: Sectorial distribution of firms (Survey Data, 2018)

3.5.4. Distribution of firms by scale, region and ownership

Table 3 elaborates the distribution of survey firms by their manufacturing scale, the region where they found in and the type of ownership. Among 438 total number of survey firms 113 were medium-scale, all were private owned, and of which 50 firms were from Addis Ababa, 43 firms from SNNPR and 20 firms from Oromia region. Other 325 firms were large-scale firms, of which 254 firms were private firms, 60 were governmental and 11 were share companies, and they were regionally distributed as 251 firms in Addis Ababa, 43 firms in Oromia and 31 firms in SNNPR.

Generally, as depicted in the Table 3, among 438 total sample size 367 firms were private owned, 60 firms were government owned and 11 firms were share companies. The 301 firms were found in Addis Ababa, 63 firms found in Oromia region and 74 firms found in SNNPR from total sample size. The majority of firms were from Addis Ababa followed by SNNPR.

Table 3: The cross tabulation of firms' scale, region and type of ownership (Survey Data, 2018)

Manufacturing scale			Type of ownership			Total
			Private	Governmental	Share Company	
Medium-Scale	The region where	Addis Ababa	50			50
	the firm found in	Oromia	20			20
		SNNPR	43			43
	Total		113			113
Large-Scale	The region where	Addis Ababa	196	51	4	251
	the firm found in	Oromia	34	9	0	43
		SNNPR	24	0	7	31
	Total		254	60	11	325
Total	The region where	Addis Ababa	246	51	4	301
	the firm found in	Oromia	54	9	0	63
		SNNPR	67	0	7	74
	Total		367	60	11	438

3.5.5. Firms distribution by category of suppliers, customers and employees

According to the Figure 14, the large number of firms, 67.6% and 43.4% have the larger number of suppliers and customers respectively in the range 100-500 than in the other ranges. The next higher numbers of firms (24.4%) have suppliers in between 10-100 range and 25.1% of firms have customers above 1000 followed by 22.4% firms in 500-1000 range.

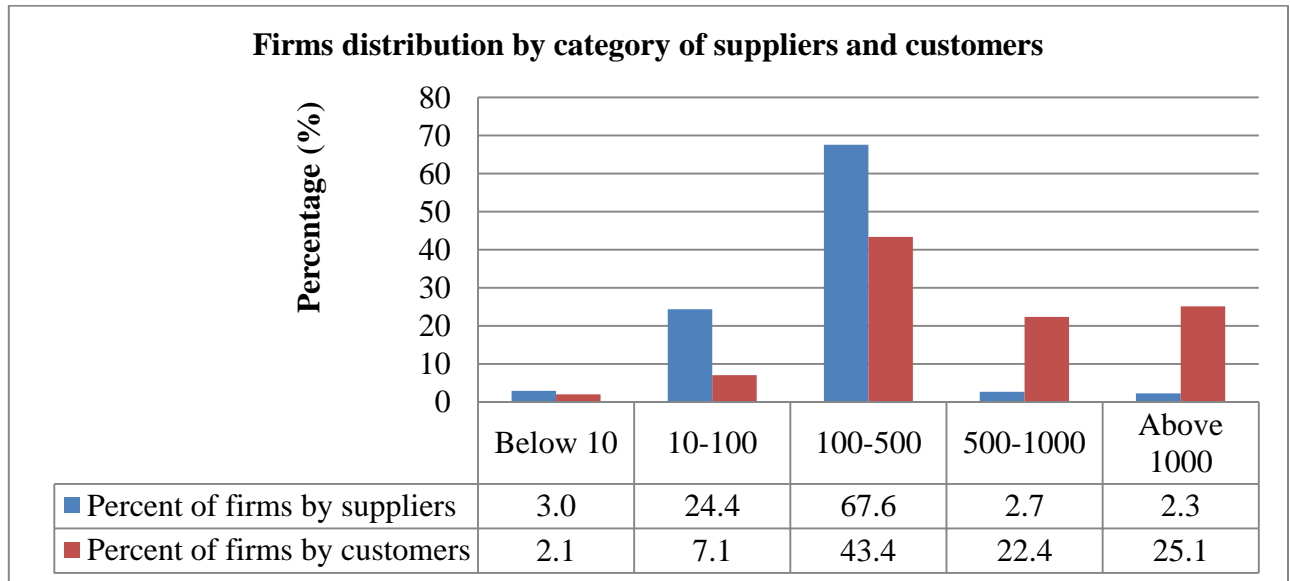


Figure 14: Number of suppliers and customers of the firms (Survey Data, 2018)

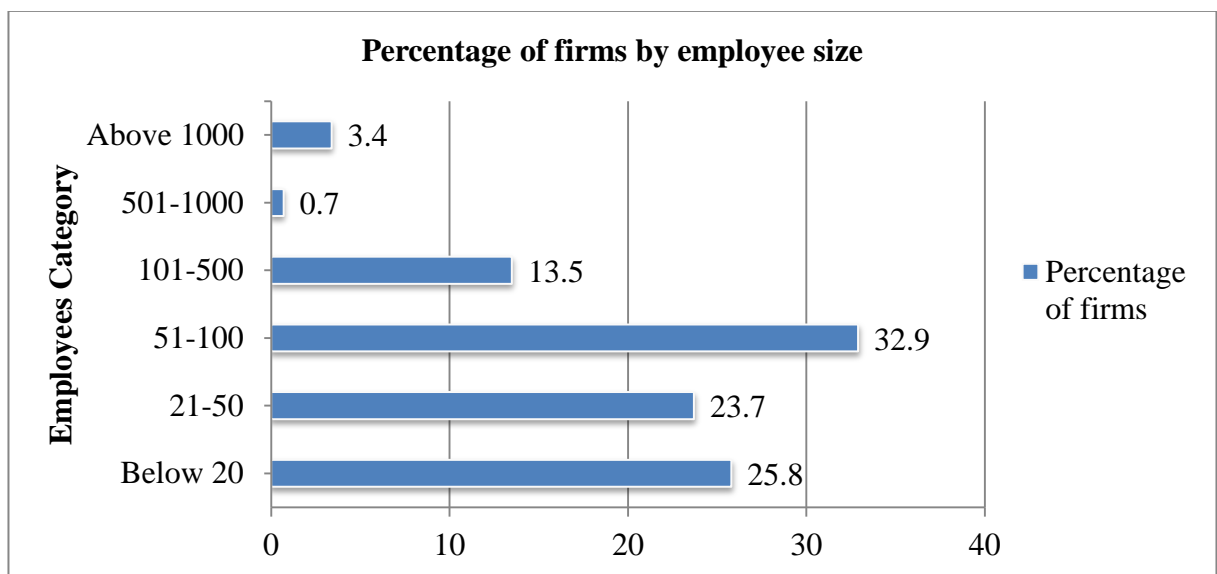


Figure 15: Percentage of firms by employee size (Survey Data, 2018)

Figure 15 also illustrates the distribution of firms by employee size. The maximum number of firms (nearly 33%) under study have relatively larger amount of employees (lie in the range 51-100), 25.8% of firms have employees below 20, 23.7% of firms have employees in the range 21-50 and 13.5% of firms have employees in the range 101-500. Only 3.4% of survey firms have employees above 1000 and 0.7% of firms have employees in the range 501-1000.

3.5.6. Firms distribution by age

According to Figure 16, the ages of maximum number of the firms (54%) were found in the range of 5-10 year, 28% were above 10 year and only 18% were laid in 10-15 years of range.

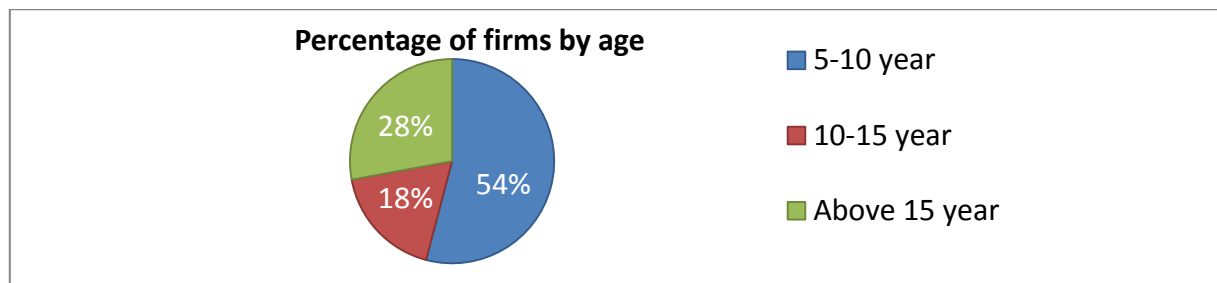


Figure 16: Distribution of firms by their age

3.6. Method of data collection

The data was gathered through different methods particularly using survey questionnaire, interview and document investigation.

Questionnaire survey

The questionnaires were prepared after extensive literature review and researcher's discussion with advisors and academicians. Its purpose was to collect information on the intended topic from different level managers/owners of surveyed firms in order to address all study objectives. Researcher used the questionnaire involving major close-ended and lesser open-ended questions based on research objectives. This is because the close-ended questionnaire can be administered to groups of people simultaneously, since they are less costly and less time consuming than other measuring instruments. Open-ended questionnaire gives freedom of describing personal opinion without external bias. Consequently, some questions were provided with blanks for personal

opinion other than condensed by the researcher. The questionnaire developed was adopted from the Likert-type scale method. The Likert-type scale method used a range of responses: ‘Strongly Disagree’, ‘Disagree’, ‘Neutral’, ‘Agree’, and ‘Strongly Agree’, with a numeric value of 1-5, respectively. The usage of this particular scaling method ensures that the research study illustrates the ability to assess the responses and measure the responses quantifiably so that a pattern or trend may be produced in order to assess research questions (see Appendix I).

Hence, the standard questionnaires compiled by researcher with due attention were distributed and collected the completed questionnaires from survey firms by using three approaches—by researcher, by using enumerators and e-mail. About five (5) enumerators each having Bachelor Degree and above were assigned to undertake the distribution and collection activity from different region after making sure their due consent and awareness about the subject matter of the questionnaires. All survey firms have also returned the completed questionnaires with 100% of response rate.

Interviews

Direct interview was carried out with focus groups from selected survey firms. The number of these personnel was 15, which were deliberately selected from different level of managers and the interview was conducted through a face-to-face (f2f) approach by the researcher. The aim of this interview was to get detailed information regarding an IT adoption status, opportunities and challenges to adopt IT among manufacturing firms and also to determine what type of IT adoption model/framework should be proposed for these companies. The detail of interview questions is attached in Appendix II.

Documents investigation

Additional secondary data were gathered directly and using online database from various governmental organizations such as Ministry of Trade and Industry, regional bureaus of trade & industry, Central Statistics Agency and from international databases such as World Bank (Development Indicators and Enterprise Survey), World Economic Forum (the Global Competitiveness Report and the Global Information Technology Report) and IMF reports.

3.7. Data analysis

After data was collected, both descriptive and inferential statistical techniques were employed to analyze the information. Descriptive statistics was used to describe a set of data in terms of its frequency, central tendency (means), and dispersion (standard deviation). The regression and correlation analysis were examined through inferential statistics and the data were analyzed by using Statistical Packages for Social Science (SPSS) version 21, and Microsoft excel. The study used multiple linear regression to analyze the relationships between the three functional roles of IT adoption in SCM and SC performance of MLSM firms. The following analytical model showed how the dependent variable (SC performance) is affected by any changes in the three independent variables (IT role in transaction execution, collaboration and coordination and decision support). The regression equation to be used was as follows;

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

Where:

Y: – SC Performance of MLSM firms

β_0 : – constant (coefficient of intercept)

β_1, β_2 & β_3 : – regression coefficients of three variables

X_1 : – IT role in transaction execution

X_2 : – IT role in collaboration and coordination

X_3 : – IT role in decision support

ε : – error term

3.8. Validity and reliability test

To avoid errors in the variable measurement, validity and reliability tests were performed by using formulas in Appendix IV. The validity test was performed to find whether the instruments appropriately measure the variable. It was performed using Pearson Correlation with significance level of 5% ($\alpha = 5\%$). After the validity test, reliability test was performed to ensure the consistency of the responses (Hair *et al.*, 2010).

Table 4: Validity test result (Survey Data, 2018)

No.	Instrument	Pearson Correlations ^c
Barriers of IT adoption		
1.	Individual challenges	0.817**
2.	Organizational challenges	0.785**
3.	Technological challenges	0.870**
4.	Governmental challenges	0.502**
5.	Environmental challenges	0.692**
CSFs of IT adoption		
1.	Individual CSFs	0.867**
2.	Organizational CSFs	0.940**
3.	Technological CSFs	0.815**
4.	Governmental CSFs	0.901**
5.	Environmental CSFs	0.929**
Roles of IT		
1.	Transaction Execution	0.726**
2.	Collaboration and Coordination	0.806**
3.	Decision Support	0.778**
SC Performance		
1.	SC Reliability	0.840**
2.	SC Responsiveness	0.844**
3.	SC Flexibility	0.882**
4.	SC Cost	0.801**
5.	SC Asset Management	0.631**

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

c. Listwise N=438

The result of validity test, as depicted in Table 4, shows that all the instruments for functional IT role variable such as Transaction Execution, Collaboration and Coordination, and Decision Support are linearly related with p value $< 1\%$ on two-tailed test of significance. The result also shows that the instrument testing for SC performance also shows that the validity tests for SC

Reliability, SC Responsiveness, SC Flexibility, SC Cost, and SC Asset Management are valid with p value $< 1\%$. Similarly, the validity test for Barriers of IT adoption and CSFs to IT adoption shows good relation though some results indicate low values (0.502 & 0.692). Hence, all the instruments of variables can be used in the next analysis.

Table 5: Reliability test result (Survey Data, 2018)

No.	Variables	Cronbach's Alpha	No. of Items
1.	Barriers of IT adoption	0.894	10
2.	CSFs of IT adoption	0.945	11
3.	Functional role of IT	0.910	15
4.	SC performance	0.944	19

For reliability test Cronbach's alpha test statistics was applied, which is a measure of internal consistency used to assess how reliably multiple items in a survey or test assess the same skill or characteristic. If Cronbach's alpha is low, then the items may not reliably measure a single construct. Typically, a value of 0.7 or higher is considered good. However, the benchmark value varies by subject area and number of items. The reliability test result in Table 5 shows that all the instruments used are reliable with Cronbach's alpha coefficient > 0.8 .

3.9. Ethical consideration

A formal letter was written from Hawassa University-IOT, Department of Industrial Engineering to all interested manufacturing firms and concerned government bureaus. The data collection was started only after getting consent from the parties mentioned above. The research followed society norms, laws, codes, policies, standards and human subjects such as honesty, objectivity, respect for intellectual property, privacy, security, copyright, confidentiality, non-discrimination and many others that outline ethical behavior and guide researchers.

CHAPTER FOUR

RESULTS AND DISCUSSIONS

As discussed in previous chapters, this study attempted to examine the demography of respondents, relationship between IT adoption and SC performance and to develop a conceptual model for IT adoption in Ethiopian manufacturing firms. Hence, the survey results of this study were presented and discussed in this chapter.

4.1. Title of respondents

The following Figure 17 illustrates the title of respondents' participated during data collection.

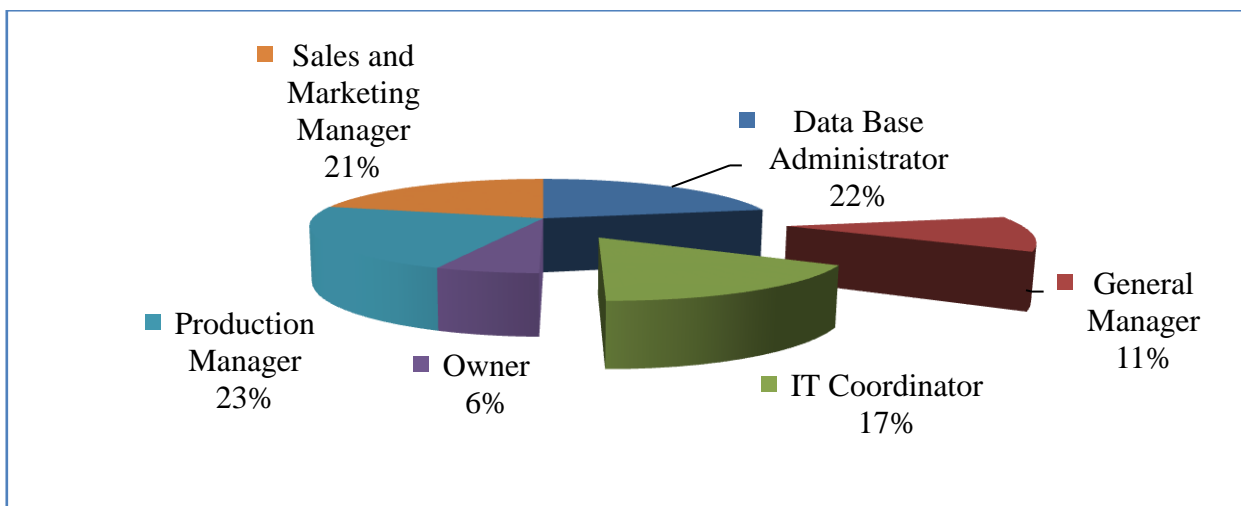


Figure 17: Respondents distribution by their title (Survey Data, 2018)

According to Figure 17, 23% of respondents were production managers, 22% were database administrators, 21% were sales and marketing managers, 17% were IT coordinators, 11% were general managers and 6% were owners of firms. Almost all respondents were on higher and middle managerial level of position, which was very important to ensure that each of the respondents has a good understanding as well as experience on subject matter of survey questions and their response was credibly acceptable for the study analysis.

4.2. Educational level and work experience of respondents

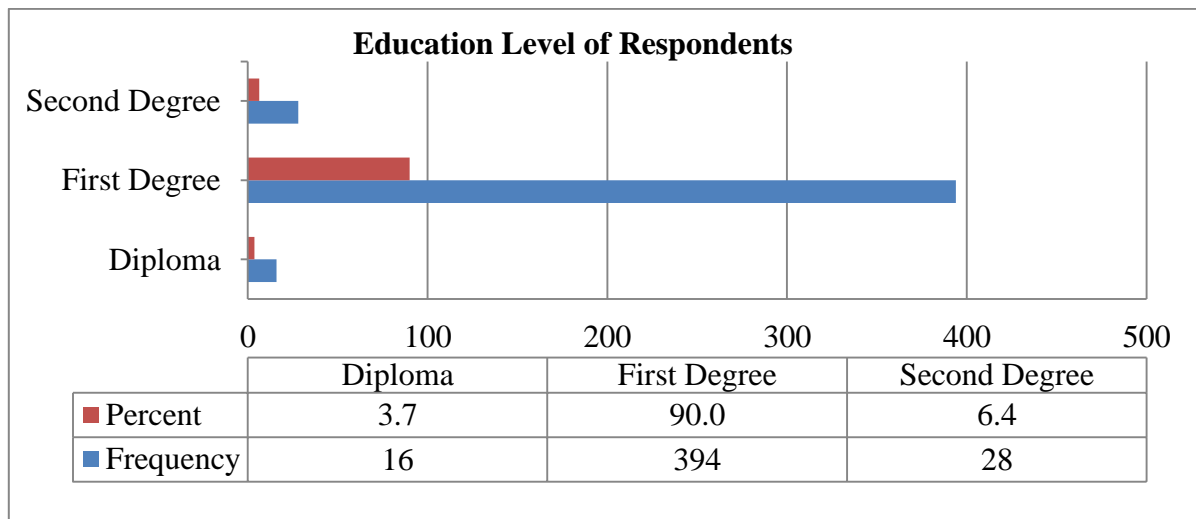


Figure 18: Educational level of respondents (Survey Data, 2018)

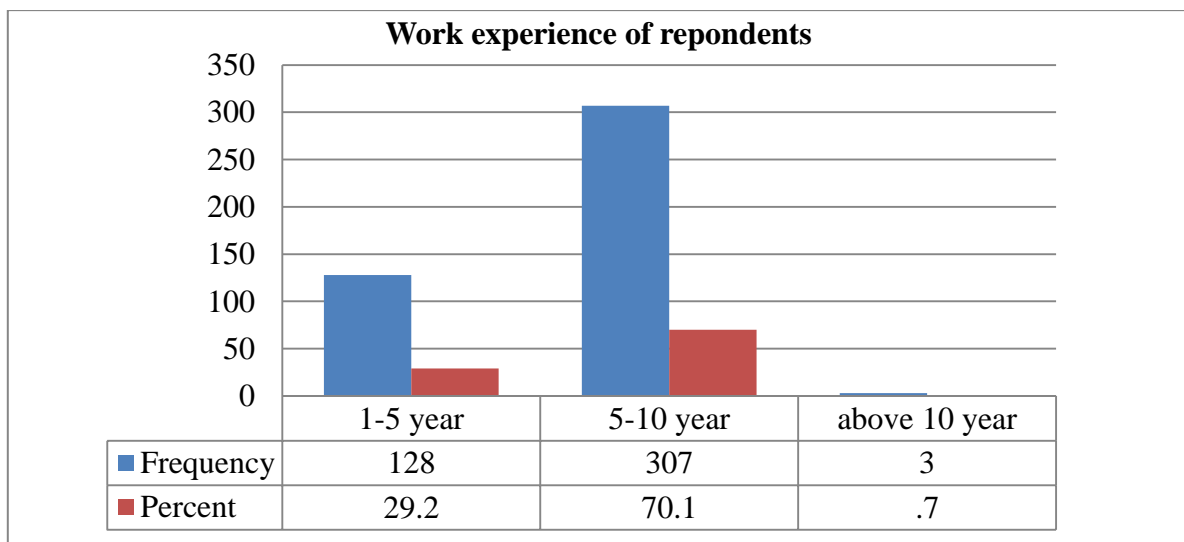


Figure 19: Work experience of respondents (Survey Data, 2018)

Figure 18 illustrates education level of respondents. According to the result, about 90% (394 respondents) were first-degree holders, 6.4% (28 respondents) were second degree and the rest 3.7% (16 respondents) were the holders of diploma. This indicates that most manufacturing companies involve first-degree employees on the head of their functional departments. Therefore, since the majority of survey respondents were the holders of first degree and above, the result

would confirm the higher degree of data reliability and a relevant results because a trust on respondents' competence and literacy level.

Figure 19 shows work experience of respondents. The experience year has been divided in to three categories (1-5 year, 5-10 year and above 10 year). Around 70% (307 respondents) have the work experience in the category of 5-10 year of work experience, 29% (128 respondents) were found in 1-5 year and 0.7% (3 respondents) was found in 10-15 year. Since majority amount (70%) of respondents was stayed in the sample companies more than 5 year, they could be highly conscious about the operation performance of the respective companies. Therefore, the researcher presumed the returned information with a high level of dependability.

4.3. IT adoption status in surveyed firms

4.3.1. Different IT tools adoption status in MLSM firms

This part would answer the first study objective; and, thus the generated bar chart in Figure 20 illustrates the number of MLSM firms adopting different IT tools that are perceived as enablers of effective and efficient SCM performance. According to the figure IT tools that have been mostly adopted and being implemented in survey companies are the Internet, Intranet, Bar Code and Scanner, Computer Aided Design (CAD), Product Data Management (PDM), Automated Quality Control (AQC) and Warehouse Management System (WMS) and Data Warehouse and Data Mining (DW & DM).

Particularly, the users of the Internet in their business practice were very large (288 firms), which shows that the manufacturing industries especially MLSM firms in Ethiopia have been shifting the paradigm towards e-business. As Figure 20 illustrates, out of surveyed manufacturing companies the maximum number of firms were using the Internet, which implies that there is a greater preference toward the Internet among product delivering firms as it enables them to surf several websites, communicate with suppliers and customers, put and receive an order and to advertise electronically. This is an improvement being shown by manufacturing firms to change from traditional way of communications such as telephone, fax, and letters to electronic communication (Georgise *et al.*, 2014).

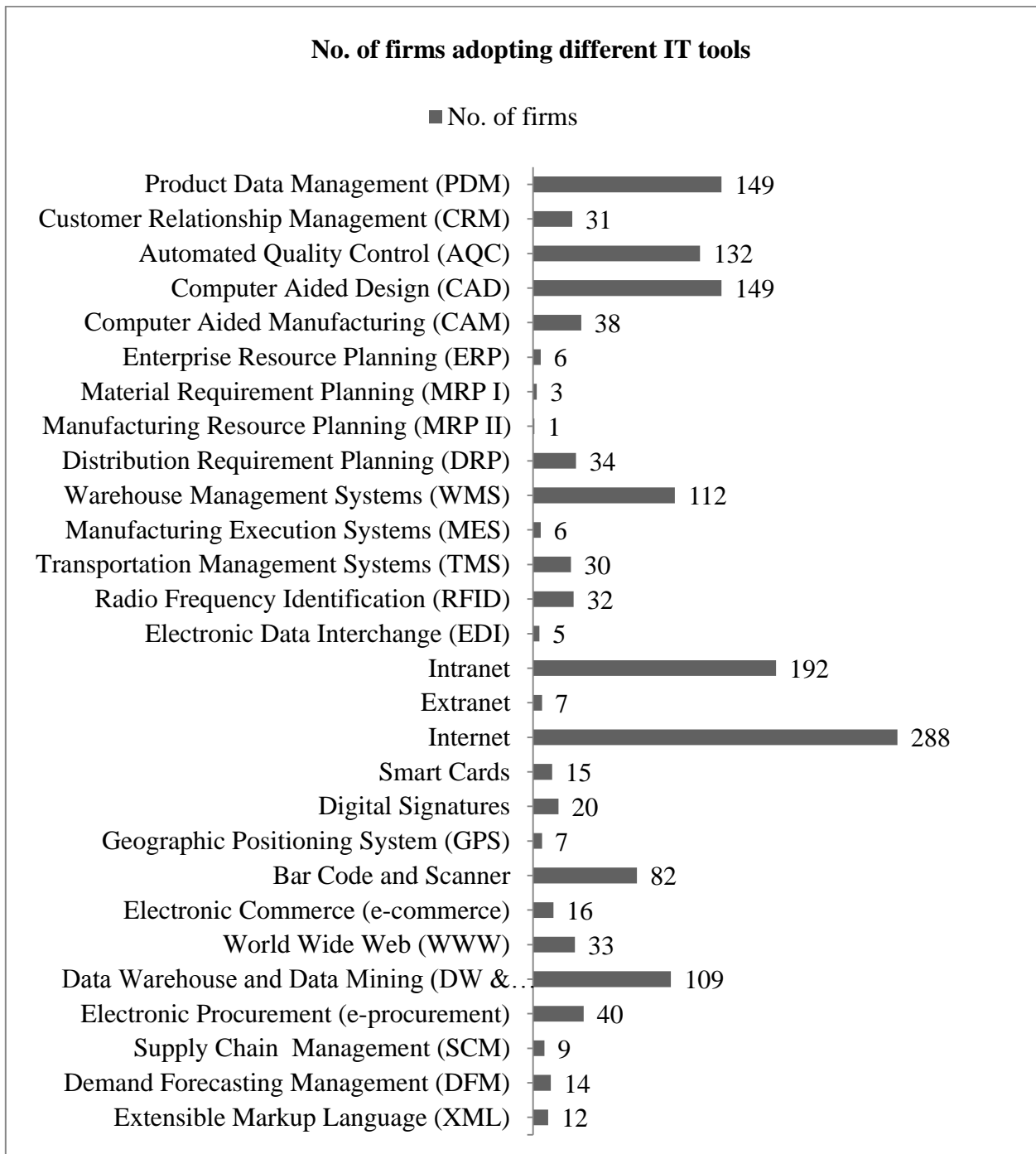


Figure 20: Different IT tools adoption status among survey firms (Survey Data, 2018)

The Internet, now a day, is becoming the prominent enabler of SC integration both internally and along SC. Manufacturers could easily communicate with their potential suppliers as well as customers with updated information exchange through the help of the Internet.

Intranet was also shown in the Figure 20 as the second largest enabler of SCM for MLSM firms, being implemented by 192 firms. Intranet is a network of computers, similar to the Internet, only accessed by staffs within a particular company or organization. This helps many departments in a particular company for exchange of information internally. Bar code scanner was one of the transaction execution tools being used by 80 firms among surveyed MLSM firms. Its function extends from identify product specification to improving customer service time.

Among the surveyed firms, only 33 firms have developed their own World Wide Web (WWW) page, 40 firms use electronic procurement (e-procurement), 30 firms adopted Transportation Management Systems (TMS), 38 firms have Computer Aided Manufacturing (CAM), and 20 firms have Digital Signatures. Only a few companies implemented some sophisticated SC technologies such as ERP, SCM, EDI, RFID, MES, and even most firms surveyed did not develop website for their company.

All these SC enabling IT tools involve hardware as well as software applications. For example, Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM) are hardware applications utilized to make a robust design of parts, tools, fixtures, products, processes and layouts in many companies. Others such as Transportation Management Systems (TMS), Data Warehouse and Data Mining, Product Data Management (PDM), the World Wide Web (WWW), ERP, SCM, EDI, etc., provide information visibility like data storage, data exchange, reports and decisive analysis to different stakeholders and partners in business venture.

4.3.2. IT adoption status in functional departments of MLSM firms

Table 6 shows the statistic mean results from surveyed firms about the level of IT implementation in their organizational departments. Firms responded to questionnaire prepared in five Likert-scale (5 = Very Highly, 4 = Highly, 3 = Moderately, 2 = Lowly, & 1 = Very Lowly). The means scored by firms were almost moderate (3) and above use of IT in their five-departments—Human Resource (HR), Production, Sales and Marketing, Finance and Accounting, and Quality control departments. Only procurement and SC and R&D departments were responded between lowly (2) and moderately (3) application of IT, scoring the mean values of 2.96 and 2.64 respectively. These two departments are even new concepts to many firms so that they need a due

consideration since their effectiveness would have high impact on organizational performance. Generally, it shows that IT system is not adequately implemented in all departments, even though companies were selected in adoption basis.

Table 6: Descriptive statistics of IT adoption in different departments (Survey Data, 2018)

Departments	N	Mean	Std. Deviation
1. Human resource department (HR)	438	3.05	0.787
2. Procurement and SC Department	438	2.96	1.037
3. Production department	438	3.34	0.786
4. Sales and marketing department	438	3.03	1.083
5. Finance and accounting department	438	3.29	0.835
6. Research & Development (R&D)	438	2.64	1.047
7. Quality control	438	3.00	1.068

4.4. CSFs & Barriers of IT adoption in MLSM firms

This section presents the results sought to answer the second study objective. In the literature, CSFs bring a concept that helps an organization identify the critical issues that affect the process of IT implementation. Table 7 describes the statistical results of different CSFs for IT adoption in MLSM firms.

All the mean values in the table of CSFs responded by MLSM firms were scored between 3.50 & 4.00. Specifically, among all factors the automation in production and control systems, open communication culture and labor and IT expert availability in the firms critically led them to apply IT system with the higher mean scores of 4.00, 3.97 & 3.94 respectively. Other three factors such as availability of budget, top management support and involvement, and industry expansion (prospect) were responded as the next critical factors with all scoring similar mean 3.90.

The rest such as good employees' literacy level, training, attitude and participation, strategic planning of IT system, good innovation culture, government support by incentives, policies and IT infrastructure and the features of IT (availability, speed, quality, capability, affordability, etc.)

were also responded as higher critical factors but with slightly lesser values than others, scoring 3.88, 3.86, 3.77, 3.74, & 3.69 respectively. The result implies that all described CSFs in the table highly affect the IT adoption process in MLSM firms. The result supports the previous study about different kinds of CSFs affecting the acceptance of IT in organizations mentioned by Raut *et al.* (2017) and Ngai *et al.* (2008). The standard deviation score also shows almost nearly similar value implying consistency of answers from respondents.

Table 7: Descriptive statistics of CSFs to adopt IT (Survey Data, 2018)

Critical success factors	N	Mean	Std. Deviation
1. Good innovation culture	438	3.77	0.934
2. Open communication system	438	3.97	0.703
3. Availability of budget	438	3.90	0.745
4. Top management support and involvement	438	3.90	0.819
5. Good employees literacy level, training, attitude and participation	438	3.88	0.74
6. Strategic planning of IT system	438	3.86	0.864
7. Automation in production and control system	438	4.00	0.771
8. Labor and IT experts availability	438	3.94	0.709
9. Industry expansion	438	3.90	0.768
10. Government support by incentives, policies and IT infrastructure	438	3.74	0.755
11. The features of IT (availability, speed, quality, capability, affordability, etc.)	438	3.69	0.814

According to Table 8, all mean responses for barriers of IT adoption lie between 4.50 & 3.50 score, which showing the “high” level of agreement for selected factors. Specifically, the lack of budget, resistance to change and lack of government support in policy, tariffs, regulation and IT infrastructure were responded as higher critical barriers among MLSM firms to adopt IT with mean score 4.09, 4.04 and 4.02 respectively. Others barriers such as lack of strategic IT planning perspective, lack of skilled labor, high cost of IT systems, IT security threat, increase of business competition, lack of IT supplier partnership and trust and globalization and customer preference

affected IT adoption process with a high degree mean scores 3.76, 3.78, 3.75, 3.86, 3.67 3.91 & 3.88 respectively. Indeed, some sophisticated SC technologies such as ERP, MRP I & II, RFID, etc., require a millions of dollar for adoption and implementation cost.

Table 8: Descriptive statistics of barriers to adopt IT (Survey Data, 2018)

Barriers of IT adoption	N	Mean	Std. Deviation
1. Resistance to change	438	4.04	0.731
2. Lack of government support in policy, tariffs, regulation and IT infrastructure	438	4.02	0.756
3. Lack of budget	438	4.09	0.672
4. Lack of strategic IT planning perspective	438	3.76	0.648
5. Lack of skilled labor	438	3.78	0.765
6. High cost of IT systems	438	3.75	0.764
7. IT security threat	438	3.86	0.741
8. Increase of business competition	438	3.67	0.754
9. lack of IT supplier partnership and trust	438	3.91	0.903
10. Globalization and customer preference	438	3.88	0.835

4.5. Results of IT roles on SCM among MLSM firms

Under this chapter, sub-sections such as 4.4, 4.5, 4.6 and 4.7 present the results obtained to answer the third study objective. Table 9 describes statistical results for questions in five Likert scale (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree) to gather information from MLSM firms about the functional roles of IT in SCM.

Three IT functional role areas, which have been mentioned frequently in previous studies (Simchi-Levi *et al.*, 2003; Shah, 2009), were analyzed in which most importantly IT tools could be applied in order to improve SC performance of manufacturing firms. These areas were transaction execution, collaboration and coordination and decision support. The result from survey responses was depicted in Table 9 showing all the mean response were “Agree” score ranging between 3.50 & 4.50 categories, and the detail analysis on the results were elaborated below.

Table 9: Descriptive statistics of functional IT roles on SCM (Survey Data, 2018)

Functional Roles of IT in SCM	N	Mean	Std. Deviation
1. Transaction Execution			
1. IT enables procurement transaction	438	3.91	0.707
2. IT assists sales transaction	438	3.83	0.749
3. IT enhances order management system	438	3.84	0.84
4. IT improves customer service	438	4.05	0.808
2. Collaboration and Coordination			
i. Intra-organizational collaboration and coordination			
1. IT increases interdepartmental collaborative planning	438	4.04	0.731
2. IT improves internal collaborative production system	438	4.02	0.756
3. IT improves interdepartmental integration	438	4.09	0.672
ii. Collaboration and coordination along the SC			
1. IT increases collaborative planning with suppliers and customers	438	3.76	0.648
2. IT increases collaborative forecasting along SC	438	3.78	0.765
3. IT increases collaborative replenishment	438	3.75	0.764
4. IT improves SC integration and coordination	438	3.86	0.741
3. Decision Support			
1. IT enhances Sourcing decision	438	3.67	0.754
2. IT improves supplier selection	438	3.91	0.903
3. IT improves transportation decision	438	3.88	0.835
4. IT assists network design support	438	3.77	0.934

Transaction Execution

It is obvious about IT deployment in ones' business transaction execution could result in a remarkable operational performance, especially in procurement, sales, and meeting customer satisfaction. All of these processes can be laid under order management category since it involves

the purchase order processes from a company to suppliers, sales order from wholesalers or retailers to a company and an associated money and information flow along this SC network.

Hugos (2003) in his book claims that the traditional transaction process has longer lead and lag times built into it due to the slow movement of data back and forth in the SC. This slow movement of data might work well enough in some simple SCs, but in complex SCs, faster and more accurate movement of data is necessary to achieve the responsiveness and efficiency that is needed. Hence, modern transaction execution focuses on IT techniques to enable faster and more accurate movement of order related data.

According to Table 9 all survey companies agreed with approximately “Agree” score on the IT roles on SC transaction execution with the mean score of 3.91, 3.83, 3.84 and 4.05 for enabling procurement, assisting sales, improving order management and customer services respectively. For example, bar code scanner, e-procurement, EDI, the Internet, and RFIDs are prominent IT applications for fast and accurate transaction execution in electronically operated SC.

Collaboration and coordination:

An efficient SCM performance can be achieved by effective collaboration and coordination both in inter-organizational and along SC integration. In case of inter-organizational collaboration and coordination every inhabitant from top management through company keepers should integrate to bring about company excellence. Some of important organizational systems are interdepartmental collaborative planning, internal collaborative production system and interdepartmental integration. Similarly, for effective, efficient and responsive SC of a company, committed collaboration is needed from all partners along SC and from stakeholders as well. Inter-organizational systems include collaborative planning with suppliers and customers, collaborative forecasting along SC, collaborative replenishment, SC integration and coordination.

In order to achieve this objective accordingly firms need to deploy prominent enabler of IT system for intra- organization and inter-organizational integration. Survey result in Table 9 also indicates responses from sample firms about IT roles in both intra-organization and inter-organizational collaboration and coordination. Above 3.75 and many were responded nearly four (4) mean scores implying “Agree” degree of agreement scale on survey questionnaire. Indeed,

ERP software, SCM, EDI, MES, WMS, etc. enable information visibility, reduce bullwhip effect, accurate data interchange, timely reports and notifications along organizational departments and SC partners. For example, vendor managed inventory (VMI) system enables both suppliers and manufacturers to get correct and updated inventory information for timely replenishment with an economic order quantity (EOQ) thereby minimizing inventory cost and total SC cost as well.

Decision Support:

Decision support is the third functional areas of IT in SCM. IT system should be utilized for only the support of decision making rather than doing a decision by itself. As Table 9 illustrates the mean scores for each questions under decision support category were relatively less than the means for the questions under other functional areas. They were responded as sourcing decision (3.67), supplier selection (3.91), transportation decision (3.88) and network design support (3.77).

Even though mean scores showed responses between “Neutral” and “Agree” level, there was comparatively lesser perception among respondents on IT role in some decision support functions than other functions. For example, for sourcing and network design decisions the mean scores were 3.67 and 3.77 respectively, implying the lesser necessity of IT in these areas than other operation areas. Nevertheless, for supplier selection and transportation decision, they responded with the means of 3.91, and 3.88 respectively, implying the greater importance of IT adoption in these areas.

Decision Support systems covers various levels of decision making in SCM. These levels include strategic, tactical and operational levels of SCM. According to Langley, *et al.* (2008), the different levels have different information needs; operational decisions where decisions on how to fulfill a customer’s order, tactical decisions entailing how to stock a particular product and strategic decisions where on warehouse locations and products to develop. For example, an Enterprise Resource Planning (ERP) system, as Demeke (2014) pointed out, is a corporate wide information system used to integrate the business processes and resources of a company. When the business environment of a company increases and becomes complex, it is difficult to continue with the traditional decentralized information systems for timely decision making and other activities. In today’s competitive business environment, ERP systems are found to be essential for

companies by decisive support during strategic, tactical and operational planning as well as to get competitive and strategic advantages.

4.6. Results of SC performance among MLSM firms

Evaluating SC performance is one of the criteria to the overall organizational performance measurement system.

Table 10 depicts mean responses about SC performance condition in surveyed companies. According to the responses of the respondents the 5 point Likert scale indicate the extent they agree with the statements that is: 5-Strongly Agree, 4-Agree, 3-Neutral, 2-Disagree and 1-Strongly Disagree. A mean score of 0 -1.5 means that the respondents strongly disagreed, 1.50 - 2.50 means they disagreed, 2.50 - 3.50 means they were neutral, 3.50 - 4.50 means they agreed, and a mean above 4.50 means the respondents strongly agreed.

Based on the findings on Table 10, all five building blocks of SC performance such as SC reliability, SC responsiveness, SC flexibility, SC cost and SC asset management were scored with values between 3.50 and 4.50. This implies that majority of respondents agreed to the fact that the firms' SC performance was good.

Table 10: Descriptive statistics of the SC performance (Survey Data, 2018)

S.N	SC Performance	N	Mean	Std. Deviation
1. SC Reliability				
1.	We are consistent in solving customer complaints	438	3.97	0.703
2.	We offer products that are highly reliable	438	3.90	0.745
3.	We offer products that are very durable	438	3.90	0.819
4.	We offer high quality products to our customers	438	3.88	0.74
2. SC Responsiveness				
1.	We deliver the kind of products needed	438	3.86	0.864
2.	We deliver customer order on time	438	4.00	0.771
3.	We provide dependable delivery	438	3.94	0.709

4. Time to solve customer complaints is short	438	3.90	0.768
3. SC Agility/Flexibility			
1. We are able to deal with different non-standard orders	438	3.74	0.755
2. We act quickly up on market changes	438	3.69	0.814
3. We are able to produce a new feature products	438	3.75	0.694
4. We are able to meet our customers' requirements	438	3.76	0.668
4. SC Cost			
1. We are able to offer prices lower than our competitors	438	3.92	0.851
2. Our capacity utilization is very good	438	3.90	0.774
3. Our Inventory turnover is high	438	3.75	0.854
4. We run operation with less Production cost	438	3.88	0.573
5. SC Asset management			
1. Knowledge sharing between our business units is high	438	4.06	0.904
2. Our organization is centrally managed	438	4.19	0.919
3. Intellectual Property (IP) rights are well managed	438	3.85	1.003

4.7. Correlation analysis between IT roles and SC performance

The result of the correlations between the variables of this study as shown in Table 11 indicated that the roles of IT in three different functional areas are positively correlated to all SCM performance dimensions except for SC asset management, which is weakly associated with transaction execution, with correlation coefficient $r = 0.036$. This reveals that IT use in transaction execution doesn't highly affect SC asset management. However, others such as SC reliability, SC responsiveness, SC flexibility and SC cost were strongly and positively correlated with all functional roles of information technology (IT). Consequently, it is suffice to say that the more the effort being put into implementing IT practices in function of transaction execution, collaboration and coordination and decision support, the direct impact it will have on SCM performance. Furthermore, the following finding in Table 12 indicates strong and significant positive relationship between SC performance and the roles of IT in three functional areas with correlation coefficient $r = 0.824$ with a significance level 0.01.

Table 11: Correlation between IT functional roles and SC performances (Survey Data, 2018)

Correlations		Transaction Execution	Collaboration & Coordination	Decision Support
SC Reliability	Pearson Correlation	.601**	.679**	.565**
	Sig. (2-tailed)	.000	.000	.000
SC Responsiveness	Pearson Correlation	.476**	.568**	.638**
	Sig. (2-tailed)	.000	.000	.000
SC Flexibility	Pearson Correlation	.637**	.604**	.640**
	Sig. (2-tailed)	.000	.000	.000
SC Cost	Pearson Correlation	.547**	.666**	.728**
	Sig. (2-tailed)	.000	.000	.000
SC Asset Management	Pearson Correlation	.036	.172**	.220**
	Sig. (2-tailed)	.447	.000	.000

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

Table 12: Correlation between the role of IT and SC performances (Survey Data, 2018)

Correlations		Roles of IT in SCM	SC Performance
Roles of IT in SCM	Pearson Correlation	1	.824**
	Sig. (2-tailed)		.000
SC Performance	Pearson Correlation	.824**	1
	Sig. (2-tailed)	.000	

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

4.8. Regression analysis between IT roles and SC performance

IT as a tool does not only improve the effectiveness and efficiency of the operations but also act as a competitive weapon to the organizations. Hence, IT adoption is critical to reduction of costs and enhancement of SC performance and competitiveness, especially in the wake of globalization and liberalization of economies that spurred competition. In this study, a multiple regression analysis equation (1) on page 62 was conducted to test relationship between extent of the IT roles

and SC performance of surveyed manufacturing organizations. The results of the multiple regression analysis were presented as follows.

Table 13: Model Summary for IT adoption and SC performance (Survey Data, 2018)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.828 ^a	.685	.683	.31305

a. Predictors: (Constant), Decision Support, Transaction Execution, Collaboration and Coordination

The adjusted R^2 , also called the coefficient of multiple determinations, is the percent of the variance in the dependent explained uniquely or jointly by the independent variables. In Table 13 adjusted R^2 was 0.683, which implies that functional IT roles can account for 68.3% of the variation in SC Performance of MLSM firms. Although there might be many factors that can explain the variable on SC performance in these firms, nearly 68.3% of it is explained by adoption of IT in three SCM functions. This amount changes in SC performance could be attributed to the combined effect of the predictor variables (functional IT roles in transaction execution, collaboration and coordination, and decision support). This means that the remaining 31.7% of the variation in SC performance cannot be explained by those dimensions of IT function. The R^2 value of 0.685 (68.5%) implies relative contribution of functional IT roles in supporting the SC Performance of the firm, the remaining 31.5% of the changes can be attributed to other factors.

Table 14 also shows the analysis of variance (ANOVA) result of the regression analysis between IT adoption and SC performance. The significance value of 0.000 indicates that the regression relationship is significant in predicting the effects of the three IT functional roles as independent variables (Transaction Execution, Collaboration and Coordination, Decision Support) on SC performance of the firms. The F-ratio in the ANOVA table tests whether the overall regression model is a good fit for the at 5% significance level.

Table 14: ANOVA^a between IT adoption and SC performance (Survey Data, 2018)

Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	92.410	3	30.803	314.315	.000 ^b
Residual	42.533	434	.098		
Total	134.943	437			

a. Dependent Variable: SC Performance

b. Predictors: (Constant), Decision Support, Transaction Execution, Collaboration and Coordination

Table 15: Result of Multiple Regression Coefficients^a (Survey Data, 2018)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	.453	.122		3.714	.000
Roles of IT Transaction Execution	.253	.026	.307	9.839	.000
Collaboration and Coordination	.293	.037	.270	7.824	.000
Decision Support	.343	.021	.493	16.143	.000

a. Dependent Variable: SC Performance

Table 15 shows the result of regression coefficients between the three functional roles of IT adoption in SCM and SC performance in surveyed firms. According to the SPSS generated table, the regression equation between these variables was:

$$Y = 0.453 + 0.253X_1 + 0.293X_2 + 0.343X_3 \dots \dots \dots (1)$$

From above regression equation the study found out that when all independent variables (transaction execution, in collaboration and coordination and in decision support system) are kept constant at zero the SC performance in Ethiopian MLSM firms will be at 0.453. The findings presented also show that a unit increase in the IT adoption in three SCM functions such as in transaction execution, in collaboration and coordination and in decision support system, would lead to a 0.253, 0.293 and 0.343 increase in SC performance respectively. At 5% level of significance and 95% level of confidence, all three functional IT roles in SCM had a 0.000 level of significance showing that the variables were significant with a corresponding P value of ($p < 0.05$).

The result is in line with Perez (2003) who suggests that SC technology is a technology or a system that is used in coordinating and integrating information flows electronically throughout the SC network of trading partners and customers in both directions so as to generate effective and efficient business transactions, quick access to information, allow better customer service, reduce paperwork, allow better communication, increase productivity and save time. Thus, to keep on competition, manufacturing firms within SC should routinely communicate with each other. The development of SCM requires that members of the chain coordinate their production and logistics activities accordingly. This type of coordination can be facilitated by adoption of IT, particularly when these technologies are used to span the traditional boundaries of SC in manufacturing firms.

4.9. Interview result

The survey interview was conducted to obtain relevant information from focus groups. Some managers responded that SCM concept was a new to them though it is being practiced in the firms. According to their responses, the IT adoption for SCM among MLSM firms was fragmented and based on resource availability rather than focusing on other IT roles such as customer satisfaction, firms' collaboration and coordination purpose, decision support and maintaining competitive advantage. Hence many managers suggested further studies to consider both internal and external barriers and CSFs as well as emphasis on e-SCM risk management process during IT adoption.

CHAPTER FIVE

PROPOSAL OF IT ADOPTION MODEL

5.1. Introduction

A number of studies were reviewed in the literature that importantly asserts different models of IT adoption in SCM. As it was reviewed in Chapter two, the study done by Oliveira and Martins (2011) reveals that, there are three levels of IT adoption, personal level, firm level and society level. For each level, there are specific adoption theories recommended by scholars as explained in Chapter two. However, the combined type of adoption model theories are more preferred so as to obtain the best and required level of IT adoption framework which then could lead to dependable and sustainable SCM as well as to earn good profit.

This chapter presents an effort rendered to attain the fourth objective of the study. Hence, the researcher was motivated to develop thoroughly a firm level, combined IT adoption model in Ethiopian manufacturing companies, specifically for MLSM firms. The model was developed based on both the knowledge gained through the literature review, focus group interview results and the empirical survey results obtained in the previous chapters. As the survey shows, there was a significant relationship between the functional role of IT and SCM performance. Therefore, it was sensible for researcher to propose confidently the conceptual IT adoption model (framework) among Ethiopian MLSM firms.

5.2. Components of proposed model

Generally, the model consists four fundamental conceptual parts; namely (1) Adopt IT systems gradually, (2) Exploit opportunity & CSFs, (3) Minimize challenges & barriers and (4) Minimize IT based risks (e-risks). The rationale of their combination and explanation was that manufacturing firms should increase the organizational change and sophistication by adopting IT tools step-by-step along adoption ladder and should exploit opportunities & CSFs. Concurrently, they have to minimize challenges & barriers during exploitation process and reduce IT based

risks (e-risks) while adopting different IT tools. Furthermore, each of these components of the cup type IT adoption model was depicted in Figure 21 and was explained separately below.

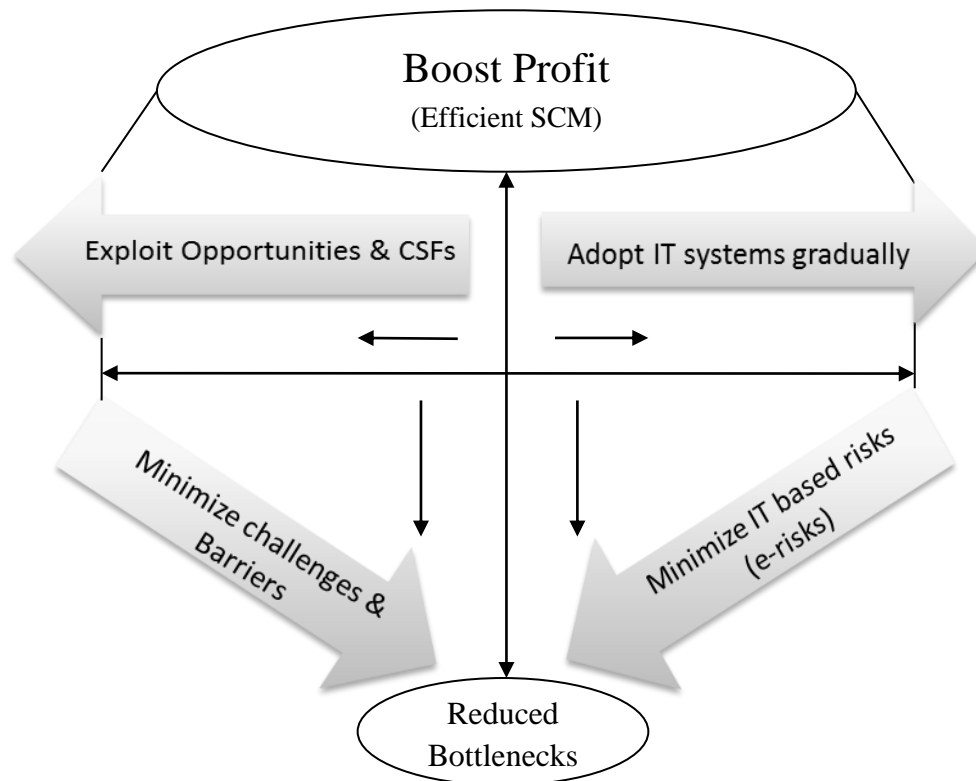


Figure 21: Proposed cup type IT adoption model for SCM

5.2.1. Adopt IT systems gradually

It is the first quadrant component on Cartesian plane of Figure 21 and the advantage of this adoption ladder approach was that it highlights the transformation aspects of technology and the key social needs from which it emerges. Even though the original adoption ladder approach was primarily designed for developed country UK small firms (Parida *et al.*, 2010), some part was edited (the first stage e-mail to the internet) and all others (stages one, two, three, four and five) were adapted as they are aspiring the relative significance on MLSM firms of developing countries like Ethiopia.

In order firms to begin an adoption process they need to have profoundly deterministic view of change and build on the understanding that they have a need and opportunity to follow a one prescribed course. First, there should be IT investment strategy, goal and objectives set by firms'

top management during strategic planning process. Second, after making sure that a firm is equipped in terms of internal organizational capability, employee fitness, IT necessity, ease of use and risk management, one can gradually begin, as depicted in Figure 22, from stage one adopting the Internet, then developing own website, e-commerce, e-business and some sophisticated IT applications such as ERP, SCM, CRM, EDI, RFID, etc.

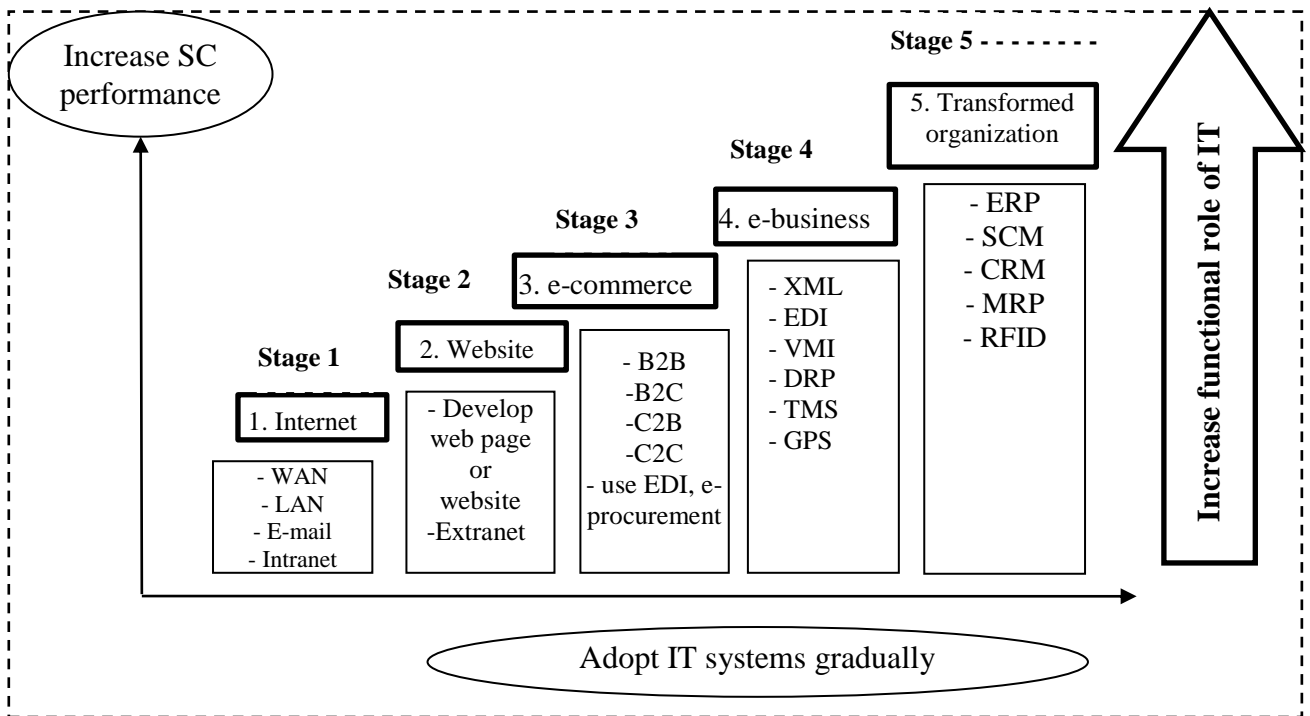


Figure 22: Gradual IT adoption Ladder

The gradual IT adoption in MLSM firms should be designed in such a way to increase its functional roles in the areas of transaction execution, collaboration & coordination and decision support in order to bring about improved SC performance and firms' competitive advantages.

For example, the Internet helps firms for efficient internal and external communication (e.g. E-mail and intranet). Developing website places oneself in global market environment and open window to worldwide suppliers. Firms can also use their websites to place details referring to corporate information on the site and provide real time information about their products. E-commerce also enable firms increase SC performance, especially to make order and pay online, to reduce transaction costs thereby maximizing accessibility and to speed up responsiveness (e.g.

EDI and e-procurement). Whereas e-businesses integrate SC partners, manufacture and delivery become seamless along SC and it enables to minimize waste at every stage of the SC network.

Since technology innovation is dynamic in nature, further sophisticated IT adoption would open systems information to customers, suppliers and business partners. It also could handle multiple complex operations automatically thereby reducing manual handling and could provide SC multi-functional roles such as good coordination and collaboration along SC, reliable transaction execution and decision support for different level managers (e.g. ERP). Hence, adopting IT systems accordingly with an adequate adoption procedure would enable firms boost profit and gain competitive position thereby achieving the overall SC performances such as SC reliability, SC flexibility, SC responsiveness, SC cost and SC asset management.

5.2.2. Exploit opportunities & CSFs

This is second quadrant and basic component to be considered during an IT adoption process. For every business venture there might be different opportunities and CSFs. For this particular model, firms can exploit opportunities and CSFs from the following five dimensions as indicated in Figure 23.

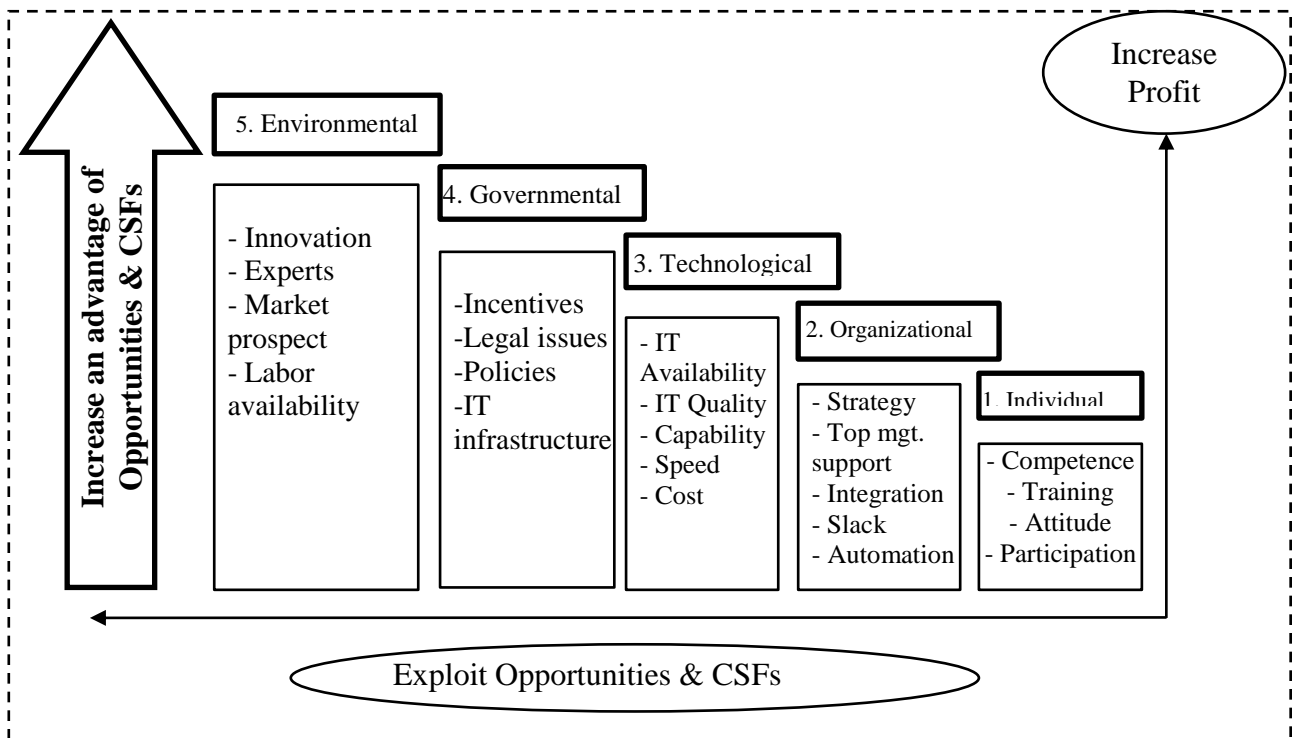


Figure 23: Opportunities and CSFs during IT adoption

1. **Individual factors:** one company would find opportunities and draw some CSFs from its employees, such as IT competence (knowledge and skill), willingness to innovation and training, good attitude and participation among employees.
2. **Organizational factors:** some organizational factors such as strategic level plan, top management support, open communication and perception, inter organizational integration, slack resource and system automation in the firms have significant influence on the adoption of IT.
3. **Technological factors:** if the IT system to be adopted becomes easily available, has dependable quality, capable of organizational fit, highly reliable in accuracy, and of a reasonable cost, then firms have to grasp these opportunities accordingly.
4. **Governmental factors:** government incentives like free tariff, subsidizes, national IT infrastructures and strategic IT development policies are the CSFs to adopt IT in firms.
5. **Environmental factors:** process and operation innovation, availability of IT experts and consultants, industry expansion and labor availability are determined as CSFs and opportunities associated with organizational factors to IT adoption.

5.2.3. Minimize challenges & barriers

This is the third quadrant component emphasizing the risk management part during the exploitation of opportunity and CSFs for IT adoption process. Many barriers as well as challenges might arise from aforementioned five dimensions of CSFs. Some of them include:

- Resistance to change
 - Low literacy level
 - Lack of resource
 - Lack of strategic IT plan
 - IT Security threat
 - High costs of IT adoption & implementation
 - Tariffs and regulations
 - Lack of IT infrastructure
 - Competition, Supplier partnership & trust
 - Globalization, Customer preference
- } Individual challenge
- } Organizational challenges/barriers
- } Technological challenge
- } Governmental challenge
- } Environmental challenge

Counterpart remedy should be applied gradually to deploy or maintain a favorable environment that may enable to persuade or trigger all inhabitants of a firm. For example, making a substantial effort on regular training for employees as well as for all level management staff about technology innovation, competitive strategy, customer service, dynamic global market change and most importantly upgrading staff in innovational technology disciplines will help firms minimize those challenges and barriers of IT adoption. Firms should also collaborate with government in developing IT infrastructures.

5.2.4. Minimize IT based risks (e-risks)

The fourth quadrant component of the model states about minimizing e-risks associated with SC technology adoption. It is a vital concern to every technology-based firm for SC security assurance in the network. Bolhari (2009) clarified information theft and tried to demonstrate details of this phrase connected to information security in e-SC. He emphasized that from an IT face of security (information security) the information theft contains different items such as viruses, worms, Trojan horses, hackers, Trap doors, Logic bombs, port scanning, spoofs, Domain Name Service (DNS) attacks, social engineering, etc.

On the other hand, there are some counter methods or tools, which enable us to make our networks secure from facing what mentioned above. These are using Password, Firewall, Virtual Private Network (VPN), Digital Signature, Secure Sockets Layer (SSL), Virus Applications, Available Disk Space, Formal Security Policy, Time/Day Restrictions, Restrictions to Location or Workstation, Removing Inactive Accounts, Segmenting LAN Traffic, Encryption, Certification Authorities, etc. These methods or tools are called factors of increasing security level (Bolhari, 2009). Hence, most importantly, organizations that have already adopted IT system and those in triumph to adopt should apply the following basic network security triangle, called “Security Trinity” (Canavan, 2001 as cited by Bolhari, 2009).

- **Prevention:** In order to provide some level of security, implementing measures to prevent the use of vulnerabilities is necessary. In developing network security schemes, one should emphasize preventative measures over two other legs: It is easier, more resourceful, and much more economical to prevent a security breach than to detect or respond to one.

- **Detection:** Once preventative measures are applied, procedures need to be established to detect potential vulnerabilities or security breaches in the event preventative measures not succeed. The sooner a problem is detected the easier it is to correct and cleanup.
- **Response:** Organizations should develop a map that identifies the suitable response to a security breach. The map should be in writing and should identify who is responsible for what actions and the different responses.



Figure 24: The security trinity (Canavan, 2001 as cited by Bolhari, 2009)

5.3. Model implication

As mentioned earlier in the introduction part the significant roles of IT function, the positive relationship between IT adoption and SC performance, and the current need of Ethiopian manufacturing firms toward IT adoption as obtained from survey result, were the leading rationales to motivate researcher developing the model.

The proposed cup type IT adoption model embraced some concepts from different previous model theories such as TAM, DOI, TOE and DTI adoption ladder approach. It is so called cup type model because the drawn conceptual framework has a cup shape thereby asserting two major concepts, Boosting Profit and Minimizing Risks. The former indicates grand total collection of profit from efficient SC attained by applying the first two components effectively—Adopt IT gradually and Exploit Opportunities & CSFs. The later, however, emphasizes a reduction of bottlenecks (challenges, barriers and e-risks) by employing the second

two components—minimizing barriers, challenges and e-risks that could exist when applying the first two components.

Regarding to time saving, the model provides simplified guideline to avoid calculated risks associated with IT adoption by trial and error. IT, generally, enhances customer service by minimizing bullwhip effect, enabling the right exchange of information along SC, enabling efficient logistics service and inventory management. Therefore, this particular proposed model was expected to reduce time taken during IT adoption process because it sets out better ground (opportunities and CSFs) that enable firms to consider before adopting any IT tool.

With respect to economic aspect, the model gives due emphasizes on mechanisms how to minimize risks associated with different IT adoption, which could lead to many losses and large maintenance cost unless it has been managed in time. The basic difference between this model and the models discussed so far in the literature part (such as TAM, DOI and TOE) is that the proposed model considers risk management process simultaneously while adopting IT system and exploiting opportunities. If companies decide to follow the intended guideline during investment and adoption processes of IT system they can reduce an associated risks (barriers and e-risks) thereby improving performance and boosting overall profit.

Generally, it was believed certainly that the model would provide a good approach to Ethiopian MLSM firms to adopt IT in SCM system. It lays a clear and gradual guideline and procedures in order to handle associated challenges and risks, which makes the model a unique from others. Figure 25 illustrates the detail of proposed model containing all components together for better understanding as shown below.

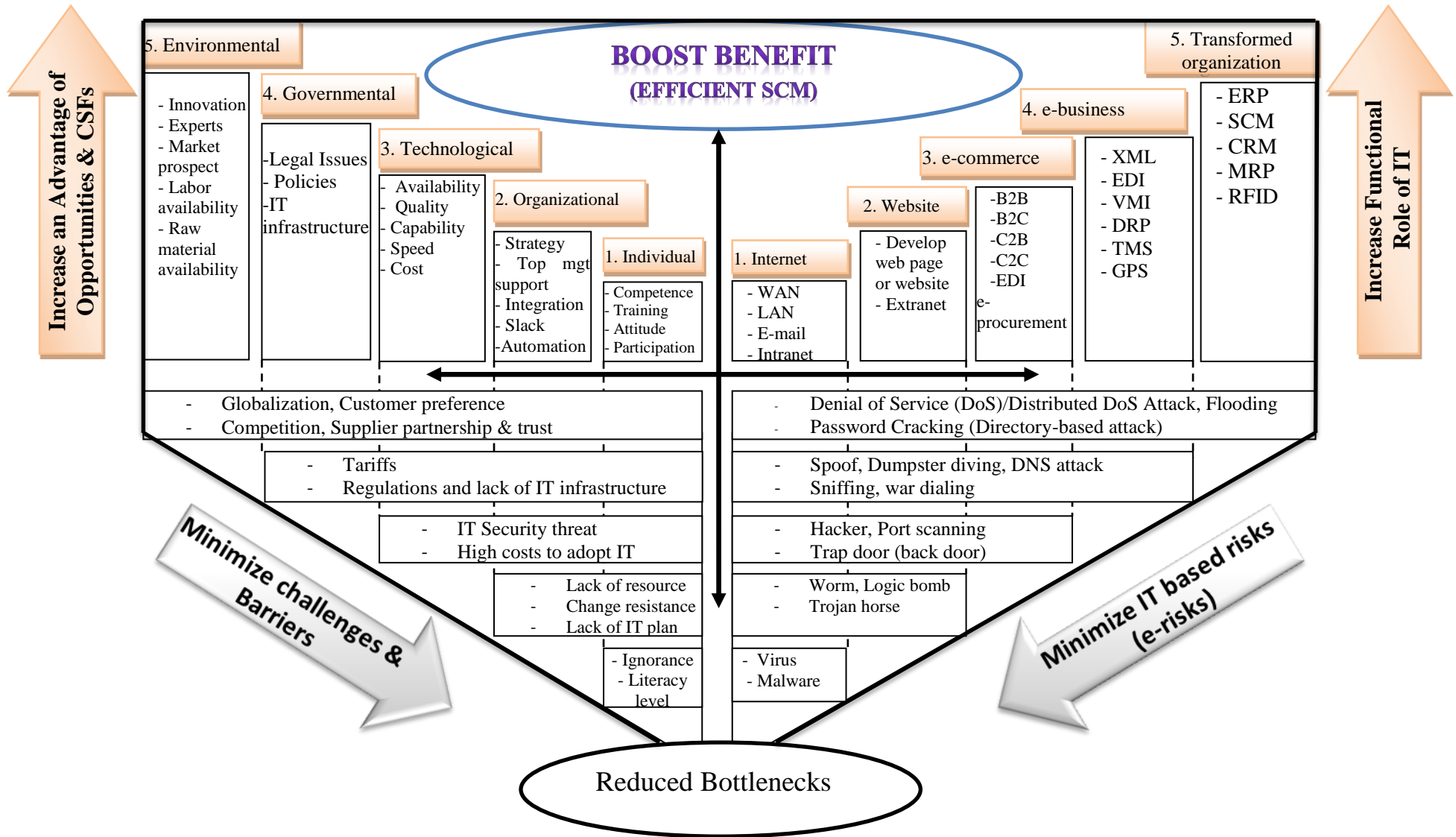


Figure 25: Proposed cup type IT adoption model for Ethiopian MLSM firms

CHAPTER SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

Chapter six presents summary of study carried out to attain the prescribed study objectives, conclusion and recommendations.

6.1. Summary

According to the results obtained from survey analysis in previous chapters, the major findings have been discussed thoroughly as follows.

- The current IT adoption status was conducted in 438 MLSM firms and the result indicated majority of them were applying the Internet, intranet, Product Data Management and Computer Aided Design with response size of 288, 192, 145 & 145 firms respectively. Nevertheless, a few firms were applying sophisticated IT applications (e.g. 6 firms adopted ERP, 5 firms adopted EDI, 3 firms adopted MRP I and only one firm adopted MRP II).
- The IT implementation status of different IT systems was investigated in organizational departments such as Human resource department (HR), Procurement and SC Department, Production department, Sales and marketing department, Finance and accounting department, Research & Development (R&D) and Quality control. Mostly the mean responses were nearly three (3) implying the “moderate” level of IT use in these departments.
- Concerning the CSFs to IT adoption all the mean values responded by MLSM firms were scored between 3.50 & 4.00. Specifically, among all factors the automation in production and control systems, open communication culture and labor and IT expert availability in the firms critically led them to apply IT system with the higher mean scores of 4.00, 3.97 & 3.94 respectively. Other three factors such as availability of budget, top management support and involvement, and industry expansion (prospect) were responded as the next critical factors with all scoring similar mean 3.90.

- For results of IT adoption barriers all mean responses lie between 4.50 & 3.50 score, which showing the “high” level of agreement for selected factors. Specifically, the lack of budget, resistance to change and lack of government support in policy, tariffs, regulation and IT infrastructure were responded as higher critical barriers among MLSM firms to adopt IT with mean score 4.09, 4.04 and 4.02 respectively.
- For investigation among MLMS firms concerning three functional IT roles to SCM, all survey companies scored with approximately “Agree” score on the IT roles to SC transaction execution, collaboration & coordination and decision support with all mean scores lying between 3.50 and 5.00.
- All five building blocks of SC performance such as SC reliability, SC responsiveness, SC flexibility, SC cost and SC asset management were scored with values between 3.50 and 4.50. This implies that majority of respondents agreed to the fact that the company SC performance was good.
- A Correlation coefficient matrix between three functional roles of IT adoption and five building blocks of firms’ SC performance was significantly strong and positive with four firms’ SC performance except weakly with SC asset management. And generally, the result also shows positive and strong correlation between the role of IT adoption and SC performance with a Pearson correlation coefficient of $r = 0.824$.
- Finally, the regression equation obtained by regression analysis indicates that without IT adoption the constant value of SC performance was 0.453 in MLSM firms. The findings presented also show that a unit increase in the IT adoption in three SCM functions such as in transaction execution, in collaboration and coordination and in decision support system, would lead to a 0.253, 0.293 and 0.343 increase in SC performance in MLSM firms, respectively.

6.2. Conclusion

Based on survey results and sets of summary stated above the following conclusion has been drawn. The IT adoption or implementation status among Ethiopian MLSM firms was shown as inadequate at all, though there are improvements in adopting some IT tools such as the Internet, intranet and barcode scanner services. Even a few firms have adopted some sophisticated IT

systems like ERP. Those manufacturing firms that have not yet adopted IT system would not have an equal access of competition with their competitors in the market. Moreover, study result shows that those firms already adopted one of IT systems did not still utilize adequately in the departments.

The CSFs that have helped survey firms to apply IT were the automation in production and control systems, open communication culture, good innovation culture, availability of finance, top management support and involvement, good employees literacy level, training, attitude and participation, strategic planning of IT system, labor and IT experts availability, industry expansion, government support by incentives, policies and IT infrastructure and the features of IT (availability, speed, quality, capability, affordability, etc.). But the barriers influencing MLSM firms during IT adoption process were resistance to change, lack of government support in policy, tariffs, regulation and IT infrastructure, lack of budget, lack of strategic IT planning perspective, lack of skilled labor, high cost of IT systems, IT security threat, increase of business competition, lack of IT supplier partnership and trust and globalization and customer preference. The practices of SCM among the firms also indicate unsatisfactory as revealed by survey results this is because the concept of SCM in the firms was still new. Thus, MLSM firms show a weak SCM performance, which needs another effort (enabler) to improve, technology innovation.

Generally, even though the IT adoption status of Ethiopian MLSM firms was at a low level, the mean responses to queries regarding IT roles to SCM generally showed good agreement. This implies that there was a need and enthusiasm to accept and adopt sophistication to their business activities. SC performances after adopting at least one of the IT tools became improved as the results illustrate. Besides, correlation and regression analysis results provide similar insight in relationship established between these two variables. Finally, as the finding indicates, the surveyed firms agreed that there is positive and strong correlation between the role of IT adoption and SC management performance, even though there is no such a systematic approach for them to accept these sophistication (IT tools). Hence, in order to tackle this problem the researcher has developed précised conceptual IT adoption model for Ethiopian MLSM firms.

6.3. Recommendation

Information Technology has such great potential to improve business operations, education, technology and economic growth. This technology could help contribute to poverty alleviation in developing economies if used to meet local and national needs. Based on the findings from study and drawn conclusion, researcher forwards the following recommendations to all stakeholders of this thesis.

- As far as the need of future development of country economy is concerned to be led by industry sector most importantly by manufacturing industry sector, a continuous improvement in competitive strategy among MLSM firms is substantial concept to achieve this goal. One of their business change area is an effective and efficient SCM practice. Therefore, MLSM firms should sophisticate their business operations by applying IT, which is one of the enablers of SCM.
- Since SCM concept is very crucial for effective organizational performance, all five building blocks of SCM performance such as SC reliability, SC responsiveness, SC flexibility, SC cost and SC asset management among MLSM firms should be well managed to achieve the firms' strategic goal.
- As many studies describe, IT roles for SCM in manufacturing firms consists of supporting transaction execution, enhancing intra and inter organizational collaboration and coordination, and enabling decision support for different level managers. Hence, these areas of SC should be supported by IT systems to bring all centered profit among SC network.
- The MLSM firms should focus on different CSFs (environmental, governmental, organizational, technological and individual) that affect IT adoption process such as good innovation culture, open communication system, availability of finance, top management support and involvement, clear and systematic direction in planning and they should minimize barriers that hamper IT adoption process.
- Furthermore, Ethiopian MLSM firms should revolutionize business processes by adopting new technology innovation not only for effective and efficient SCM practices but also as a competitive weapon in the wake of the globalization.

- Moreover, firms should focus on R&D, recruiting IT professionals from university graduates, creating linkage with universities as well as foreign and domestic industries, providing regular training to employees on the issue of technology innovations.
- The Ethiopian government should also encourage MLSM firms by developing supportive ICT development policies, IT security policies, incentives, subsidies and facilitating IT based training to foster manufacturing sector completion strategy in global standard.
- Since the value of IT in any organization depends on its infrastructure the Ethiopian government should also facilitate IT infrastructures collaborating with firms in order to create favorable environment to compete globally.
- As proposed cup type IT adoption model elaborates, the researcher suggests Ethiopian MLSM firms to follow correctly the guideline described in the model when they arrive at right decision of implementation. The model, as described so far, consist four components, such as exploiting opportunities and CSFs, minimizing challenges/barriers, minimizing e-risks, and adopting IT gradually—the stepping-stone to adopt IT systematically.

6.4. Suggestion for further study

The study was limited by some constraints not to address all necessary parts to conduct research that is more comprehensive. Among these: time constraint, wideness of the selected title, large number of SC partners, etc. Therefore, the researcher primarily suggests future researches to test the proposed model and conduct longitudinal study in specific manufacturing organizations regarding different sophisticated IT tools adoption status, such as ERP, RFID, EDI, etc. Different SC partners such as suppliers, manufacturers, wholesalers, distributors, retailers and end consumers should be involved during longitudinal survey study. In addition to these, study of IT adoption for SCM performance is also suggested to be conducted in Ethiopian small-scale enterprises.

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APPENDICES

Appendix I: Research questionnaire

Survey questionnaire to be filled by owners or managers of the firms

The questionnaire is in support to fulfill the Masters Research study on the title of “*IT Adoption Model Development for Supply Chain Management: Case of Ethiopian Medium and Large-Scale Manufacturing Firms*”.

The aim is to investigate the role and effect of IT in supply chain management and to develop a model/framework of IT adoption in medium and large-scale Ethiopian manufacturing firms. It’s believed that the outcome of research is very useful to supply chain managers and executives of manufacturing companies. The data collected will be used for academic purposes only and your information will remain confidential between the researcher and you. You are requested to fill them freely and the answers you offer will be treated confidentially.

Dear Respondents! Thank you in advance for allocating your precious time to answer this questionnaire.

General Instructions

- There is no need of writing your name
- Where answer options are available, please tick (√) in the appropriate box provided.

Contact Address

If you have any query, please do not hesitate to contact me as per your convenience at:

E-mail: tammebtj@gmail.com

Thank you for sacrificing your precious time!

Part I: General information about you and your firm

1. Your title/position in the firm
2. Your educational background: Diploma 1st degree 2nd degree PhD
3. Your work experience: 1-5 year 5-10 year 10-15 year 15-above
4. Company name
5. Manufacturing Sector of company.....
6. Number of suppliers: Below 10 10-100 100-500 500-1000 Above 1000
7. Number of customers: Below 50 50-100 100-500 500-1000 Above 1000
8. Company level: Medium-scale enterprise Large-scale enterprise
9. Number of employees
Below 20 21-50 51-100 101-500 501-1000 Above 1000
10. Type of Ownership: Private Governmental Share Company
11. Age of the company: Below 5 year 5-10 year 10-15 year above 15
12. Geographic scope of company's operation: Regional National Global

Part II: Supply Chain Technology adoption status

1. Have the following supply chain technologies been adopted and implemented in your company? Please tick (√) in the appropriate box if your answer is "Yes" and mention unspecified IT tools in the space provided.

"√"	Different IT tools	"√"	Different IT tools
	Product Data Management (PDM)		Intranet
	Customer Relationship Management (CRM)		Extranet
	Automated Quality Control (AQC)		Internet
	Computer Aided Design (CAD)		Smart Cards
	Computer Aided Manufacturing (CAM)		Digital Signatures
	Enterprise Resource Planning (ERP)		Geographic Positioning System (GPS)
	Material Requirement Planning (MRP I)		Bar Code and Scanner
	Manufacturing Resource Planning (MRP II)		Electronic Commerce (e-Commerce)
	Distribution Requirement Planning (DRP)		World Wide Web (WWW)
	Warehouse Management Systems (WMS)		Data Warehouse (DW) and Data Mining
	Manufacturing Execution Systems (MES)		Electronic Procurement (e-Procurement)
	Transportation Management Systems (TMS)		Supply Chain Management (SCM)

	Radio Frequency Identification (RFID)		Demand Forecasting Management
	Electronic Data Interchange (EDI)		XML (extensible markup language)

2. To what extent the following your organizational functions have adopted and implemented the appropriate information technology systems? Please encircle points provided. (Score of 5 =Very Highly, 4 = Highly, 3 = Moderately, 2 = Lowly, & 1=Very Lowly).

S.N	Departments	Very lowly..... to Very highly					
1	Human resource department	1	2	3	4	5	NA
2	Procurement and supply chain dept.	1	2	3	4	5	NA
3	Production department	1	2	3	4	5	NA
4	Sales and marketing department	1	2	3	4	5	NA
5	Finance and accounting department	1	2	3	4	5	NA
6	Research & Development	1	2	3	4	5	NA
7	Quality control	1	2	3	4	5	NA

1. What types of IT tools are you considering to adopt or implement in your company within two years?

S.N	Name of IT systems
1	
2	
3	

2. What would you expect the significance of implementing these IT tools to your organization?

_____.

Part II. Barriers and Critical success factors (CSFs) to adopt IT

1. To what extent would the following barriers have affected you not to adopt these technologies? (Score of 5 = Very Highly, 4 = Highly, 3 = Moderately, 2 = Lowly, & 1=Very Lowly).

S.N	Barriers to adopt IT						
1.	Resistance to change	1	2	3	4	5	NA
2.	Lack of government support in policy, tariffs, regulation and IT infrastructure	1	2	3	4	5	NA
3.	Lack of budget	1	2	3	4	5	NA
4.	Lack of strategic IT planning perspective	1	2	3	4	5	NA
5.	Lack of skilled labor	1	2	3	4	5	NA
6.	High cost of IT systems	1	2	3	4	5	NA
7.	IT security threat	1	2	3	4	5	NA
8.	Increase of business competition						
9.	lack of IT supplier partnership and trust						
10.	Globalization and customer preference						

Note: NA= Not Applied/Applicable

2. If you are recently practicing one of the IT tools mentioned above, to what extent the following CSFs are deriving you to adopt and implement these technologies? (Score of 5 =Very Highly, 4 =Highly, 3 =Moderately, 2 =Lowly, & 1=Very Lowly).

S.N	Critical success factors						
1.	Good innovation culture	1	2	3	4	5	NA
2.	Good employees literacy level, training, attitude and participation	1	2	3	4	5	NA
3.	Open communication system	1	2	3	4	5	NA
4.	Availability of budget	1	2	3	4	5	NA
5.	Top management support and involvement	1	2	3	4	5	NA
6.	Strategic planning of IT system	1	2	3	4	5	NA
7.	Automation in production and control system	1	2	3	4	5	NA
8.	Labor and IT experts availability	1	2	3	4	5	NA
9.	Industry expansion	1	2	3	4	5	NA
10.	Government support by incentives, policies and IT infrastructure	1	2	3	4	5	NA
11.	The features of IT (availability, speed, quality, capability, affordability, etc.)	1	2	3	4	5	NA

Part IV: Roles of information technology in supply chain management systems

To what extent does your company utilize IT tools in the following functions? Please encircle points provided. (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree).

1. Transaction Execution							
1	IT enables procurement transaction	1	2	3	4	5	NA
2	IT assists sales transaction	1	2	3	4	5	NA
3	IT enhances order management system	1	2	3	4	5	NA
4	IT improves customer service	1	2	3	4	5	NA
2. Collaboration and Coordination							
i. Intra-organizational collaboration and coordination							
1	IT increases interdepartmental collaborative planning	1	2	3	4	5	NA
2	IT improves internal collaborative production system	1	2	3	4	5	NA
3	IT improves interdepartmental integration	1	2	3	4	5	NA
ii. Collaboration and coordination along the supply chain (SC)							
1	IT increases collaborative planning with suppliers and customers	1	2	3	4	5	NA
2	IT increases collaborative forecasting along SC	1	2	3	4	5	NA
3	IT increases collaborative replenishment	1	2	3	4	5	NA
4	IT improves SC integration and coordination	1	2	3	4	5	NA
3. Decision Support							
1	IT enhances Sourcing decision	1	2	3	4	5	NA
2	IT improves supplier selection	1	2	3	4	5	NA
3	IT improves transportation decision	1	2	3	4	5	NA
4	IT assists network design support	1	2	3	4	5	NA

Part V: Supply chain performance

A) With regard to the effect of at least one IT tool adoption on supply chain performance of your company, please encircle the appropriate scale to indicate the extent to which you agree or disagree with each statement. (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree)

1. SC Reliability							
1	We are consistent in solving customer complaints	1	2	3	4	5	NA
2	We offer products that are highly reliable	1	2	3	4	5	NA

3	We offer products that are very durable	1	2	3	4	5	NA
4	We offer high quality products to our customers	1	2	3	4	5	NA
2. SC Responsiveness							
1	We deliver the kind of products needed	1	2	3	4	5	NA
2	We deliver customer order on time	1	2	3	4	5	NA
3	We provide dependable delivery	1	2	3	4	5	NA
4	Time to solve customer complaints is short	1	2	3	4	5	NA
3. SC Flexibility							
1	We are able to deal with different non-standard orders	1	2	3	4	5	NA
2	We act quickly up on market changes	1	2	3	4	5	NA
3	We are able to produce a new feature products	1	2	3	4	5	NA
4	We are able to meet our customers' requirements	1	2	3	4	5	NA
4. SC Cost							
1	We are able to offer prices lower than our competitors	1	2	3	4	5	NA
2	Our capacity utilization is very good	1	2	3	4	5	NA
3	Our Inventory turnover is high	1	2	3	4	5	NA
4	We run operation with less Production cost	1	2	3	4	5	NA
5. SC Asset management							
1	Knowledge sharing between our business units is high	1	2	3	4	5	NA
2	Our organization is centrally managed	1	2	3	4	5	NA
3	Intellectual Property (IP) rights are well managed	1	2	3	4	5	NA

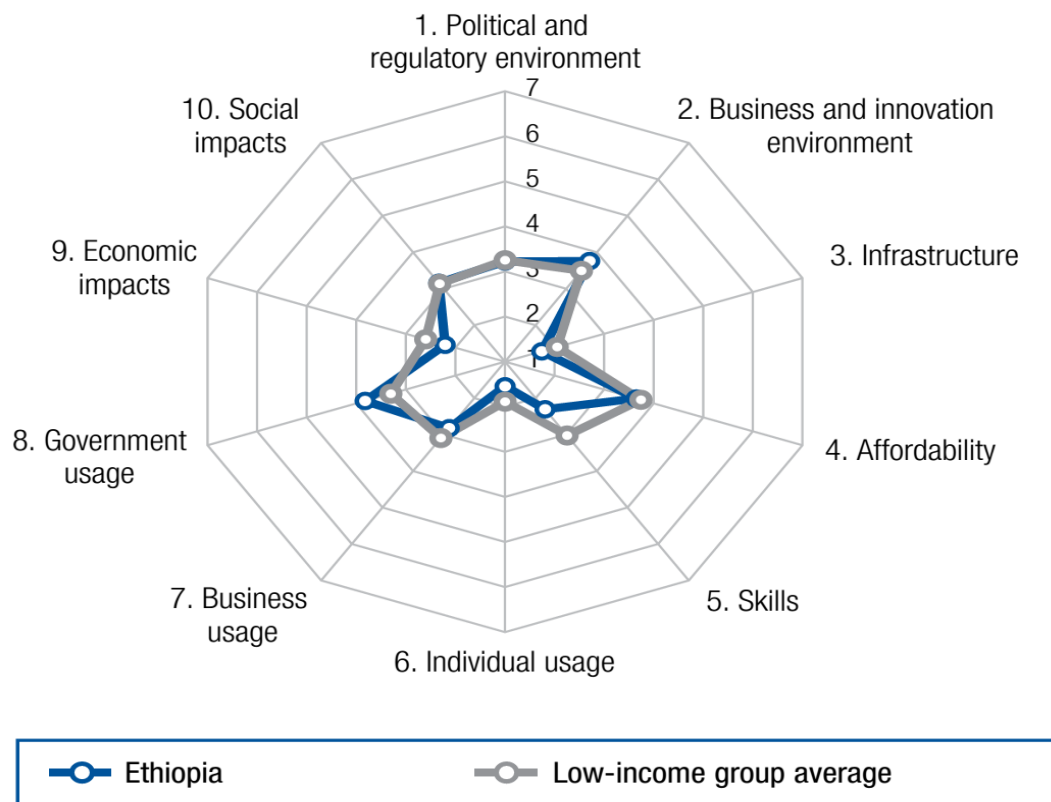
Note: SC=Supply Chain

6. Please comment on your experiences with effects of adoption, implementation, and integration of information technologies on organizations and the level of success in comparison with expectations.

Appendix II: Interview questions

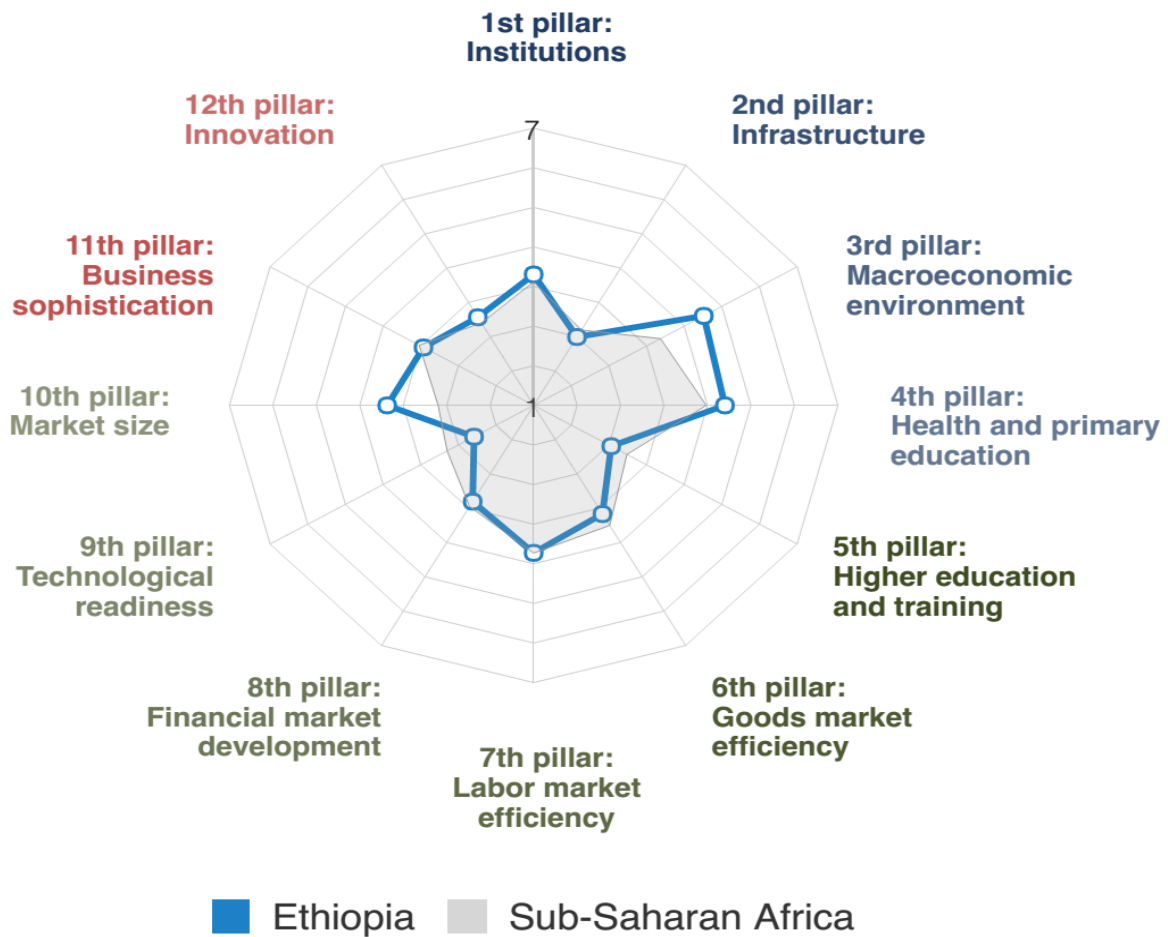
1. Does your company apply SCM principle? And what looks like, generally, the status of IT adoption with respect to enhancing SCM in your company?
2. What do you say about the benefits of IT adoption to your organization?
3. What are critical success factors (CSFs) and barriers you experienced during IT adoption and implementation process?
4. Is there any model/framework that helped you as a guideline during the IT adoption process?
5. What kinds of determinants you suggest to be considered during the development of IT adoption model/framework?

Appendix III: Figures from World Economic Forum Reports



Appendix Figure 1: Networked Readiness Index for Ethiopia (Global Information Technology Report by Dutta *et al.*, 2015)

2012-13	2013-14	2014-15	2015-16	2016-17	2017-18
121 / 144	127 / 148	118 / 144	109 / 140	109 / 138	108 / 137
3.6	3.5	3.6	3.7	3.8	3.8



Appendix Figure 2: The GCI scores for Ethiopia (Global Competitiveness Report by Schwab, K. World Economic Forum, 2017)

Appendix IV: Formulas for validity and reliability test

Cronbach's alpha (α)

Cronbach's alpha (Cronbach, 1951) is a measure of reliability. More specifically, alpha is a lower bound for the true reliability of the survey. Mathematically, reliability is defined as the proportion of the variability in the responses to the survey that is the result of differences in the respondents. That is, answers to a reliable survey will differ because respondents have different opinions, not because the survey is confusing nor has multiple interpretations. The computation of Cronbach's alpha is based on the following formula.

$$\alpha = \frac{Nc}{v + (N - 1)v}$$

Where(α) is Cronbach's alpha, (N) is the number of items on the survey, (c) is the average inter-item covariance and (v) is the average item variance.

Pearson's correlation coefficient (r)

Pearson's correlation assesses whether two continuous variables are linearly related. The coefficient will fall between -1 and +1. The closer the absolute correlation is to 1 the more tightly the data points fall on a line. A correlation close to 0 indicates no linear relationship. The computation of Pearson's correlation coefficient is based on the following formula.

$$r = \frac{N \sum xy - (\sum x)(\sum y)}{\sqrt{[N \sum x^2 - (\sum x)^2][N \sum y^2 - (\sum y)^2]}}$$

Where (r) is the pearson correlation coefficient, (N) is the number of pairs of scores and (x & y) are the scores of two variables.