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# **TECHNOLOGY ADOPTION OF ETHIOPIAN MANUFACTURING FIRMS: THE CASE OF TEXTILE AND LEATHER SECTOR**

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ADDIS ABABA  
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**ADDIS ABABA UNIVERSITY**  
**COLLEGE OF BUSINESS AND ECONOMICS**  
**DEPARTMENT OF PUBLIC ADMINISTRATION AND DEVELOPMENT**  
**MANAGEMENT**  
**GRADUATE STUDIES**

**TECHNOLOGY ADOPTION OF ETHIOPIAN MANUFACTURING FIRMS:**  
**THE CASE OF TEXTILE AND LEATHER SECTOR**

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**Submitted to the Department of Public Administration and Development Management in**  
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**in Public Management and Policy**

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## **DECLARATION**

I the undersigned, declare that this thesis is my original work and has never been presented for the award of a Degree in Addis Ababa University or any other University and that all the sources of materials used for the thesis have been duly acknowledged.

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## ACRONYMS

ADLI	Agriculture Development Led Industrialization
AMT	Advanced Manufacturing Technology
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAM	Computer-Aided Manufacturing
CAPP	Computer Aided Process Planning
CNC	Computerized Numerical Control Machines
EDI	Electronic Data Interchange
ERP	Enterprise Resource Planning
FMS	Flexible manufacturing systems
GT	Group Technology
GTP	Growth and Transformation Plan
JIT	Just In Time
MDGs	Millennium Development Goals
MRP	Material Requirement Planning
MRP II	Manufacturing Resource Planning
OLS	Ordinary Least Squares
R&D	Research and Development
SMEs	Small and Medium Enterprises
TQM	Total Quality Management

## **ABSTRACT**

Technology adoption has emerged as an important determinant of competitiveness in recent global trade. Gaining competitiveness in the quota free trade became a driving force for the manufacturing firms to adopt technologies. However, there has not been much research focused on technology adoption of manufacturing industries in Ethiopia. The purpose of this study is to investigate the status and the effects of organizational and environmental factors on the level of technology adoption.

A survey methodology was employed to collect data from 115 firms. A purposive sampling technique was used to select firms those engaged in the manufacturing leather and textile products. A combined quantitative and qualitative data analysis approach was used as an analytical lens to interpret responses gathered from manufacturing enterprises. The data was analyzed by both descriptive and inferential statistics.

The reasons, product and process quality improvement and productivity enhancement are firm's primary reason to adopt new manufacturing technology. Comparatively soft technologies are better adopted by the firms than hard technologies. The results revealed that the entire variable, except firm age, positively influences the technology adoption level of a firm. The effect of firm size, certification, competition, employee technical skill, financial resource and government support was significant. On the other hand, the results indicated that the top management commitment and firm age did not have significant effects on the technology adoption level. Recommendations are made for future research on technology adoption within the broader spectrum of manufacturing enterprises.

## **Keywords**

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Technology adoption, organizational and environmental factors, manufacturing enterprises.

# CHAPTER 1

## 1. INTRODUCTION

### 1.1 BACKGROUND OF THE STUDY

The Ethiopian government has set for itself a long term vision of becoming a middle income country by 2020-2023 and meeting the Millennium Development Goals (MDGs) in 2015. Several government policies and plans are in place to fulfill the larger goal of meeting the MDGs and the vision of becoming a middle income country. The latest is the Growth and Transformation Plan (GTP) that spans a period of 2010/11-2014/15 and emphasizes agriculture and industry as main drivers of growth (FDRE, 2010).

The industrial development strategy as a sectoral strategy issued in 2002 (FDRE, 2002) has preceded the GTP. It recognizes the private sector as an engine of development and emphasizes the need to follow export-led growth, the need to pursue Agriculture Development Led Industrialization (ADLI), the need to forge linkages between internal and external investors and the role of government in providing leadership. The purpose is to develop the industrial sector and enhance its contribution to the overall economic growth. Within the industrial sector, some specific industrial groups that are considered as strategic are selected as priority sub-sectors. These include textile, wearing apparel, leather tanning and footwear. These industries are labor-intensive, have the ability to forge strong linkages with agriculture and can bring export-led industrialization.

To keep the pace with ever-changing market situations, the issue of technology adoption is relevant for manufacturing industry. This is particularly vital for export-oriented manufacturers who face tough competition in international markets and must maintain a competitive edge by adopting latest product and process technologies to meet the requirements of upscale global markets. It is generally believed that Ethiopian firms have lagged behind their competitors in international markets in terms of technological advancement and consequently its exports continue to remain concentrated in low value-added and low quality product segments.

Accounting for differences in technology levels across countries thus can go a long way towards understanding global inequality. One mechanism by which poorer countries can catch up with richer countries is through technological diffusion, the adoption by low-income countries of the advanced technologies produced in high-income countries (Nelson and Phelps, 1966).

It is widely accepted that technology is a resource that is not only important to operations but also to corporate profitability and growth as well. Morone (1989) viewed technology as a source of competitive advantage for the business organization in a competitive environment. In addition to this Higgins (1995) identified technology as a contributing factor to successful operations and played a vital role in long term profitability. These phenomena indicate that technology has transcended beyond its traditional administrative support role toward playing a more central part of business strategy. Technology is now viewed as a strategic weapon to achieve sustainable competitive advantage and support the competitive strategy of the firm.

## **1.2 STATEMENT OF THE PROBLEM**

Technology is the most important force in increasing manufacturing competitiveness. The influence of technology on economic development is outstanding everywhere. Apparently, technology is the engine of the society and its economic development. However, to gain the competitive advantage, technology should have to be adopted in the production processes. Even with clarifying and identifying benefits and contribution of technologies for manufacturing firms, there are issues regarding the effective adoption of these technologies.

The contribution of new technology to economic growth can only be realized when and if the new technology is widely adopted and used. Adoption itself results from a series of individual decisions to begin using the new technology, decisions which are often the

result of a comparison of the uncertain benefits of the new technology with the uncertain costs of adopting it.

According to Woodside and Biemens (2005), the term technology adoption refers to the decision-making process of an individual firm to accept and use technology for firm's success. Technology adoption is a complex phenomenon and depends on firm characteristics and the economic environment under which the firms operate.

Technological adoption and diffusion is a major channel by which poor countries can develop. However technology adoption is incomplete or the inputs associated with the technologies are under-utilized in poor or slow-growing economies. Though, the introduction of modern technologies is crucial for the survival of manufacturing firms in developing countries like Ethiopia.

One of the important issues for economic growth is technology adoption among manufacturing Enterprises to enable them to be more competitive and survive in the global business environment. In other words one of the barriers to industrialization is the lack of technology adoption by the industry. To understand the competitive environment of technology adoption decisions by a business entity, it is necessary to look into the internal and external factors that may influence the technology adoption decision (Murad and Thomson, 2011).

Adopting a particular technology depends on many factors that contribute to the success or failure of technology adoption in firms. Therefore, an understanding of the factors affecting the decision towards technology adoption is essential. However, the factors that influence the introduction of these technologies have not been explored, and the published research literature on this topic, to date, is fragmented. The question of technology adoption by manufacturers has received little attention in the empirical literature.

Thus, obtaining a better understanding of the constraints and opportunities on adoption of manufacturing technologies are useful in understanding a major component of growth. The purpose of this research is to explore empirically technology adoption of Ethiopian manufacturing industry particularly on leather and leather product, and textile and apparel sectors.

### **1.3 RESEARCH QUESTIONS**

The research questions addressed by this study were:

Why firms adopt new technology?

What is the status of hard and soft technology adoption of the firms?

What are the factors affecting technology adoption?

How these determinant factors affect technology adoption?

What are the success factors and barriers influencing technology adoption process?

### **1.4 OBJECTIVES OF THE STUDY**

#### **1.4.1 GENERAL OBJECTIVES**

This study provides an in-depth understanding of both organizational and environmental factors that influence Ethiopian manufacturing firms to adopt new technology. This paper also provides a holistic picture of determinants that affect the effective and efficient adoption of new manufacturing technologies.

#### **1.4.2 SPECIFIC OBJECTIVES**

The specific objectives of this study are:

To find out the reasons to adopt new technology among the firms;

To identify the status of firms hard and soft technology adoption;

To identify and examine the critical factors affecting technology adoption; and

To investigate the key success factors and the barriers in technology adoption process

### **1.5 SIGNIFICANCE OF THE STUDY**

The study contributes to the broadening of our understanding of technology adoption in Ethiopian manufacturing industry perspective. It also avails knowledge that is of use to owner-managers, researchers and policy-makers by providing insights on the leather and textile sectors in particular and manufacturing companies in general. Additionally, it provides current and up to date assessment of the factors that affect Technology adoption of manufacturing enterprises in Ethiopia.

### **1.6 SCOPE OF THE STUDY**

This thesis is concerned with industrial manufacturing technology adoption by Ethiopian manufacturing companies. This research aims to provide an in-depth understanding of factors that may influence Ethiopian manufacturing companies' technology adoption process. For the purpose of this study, the researcher examined both organizational and external environment factors that influence technology adoption decisions.

This study is an attempt to explore the determinants of technology adoption by the manufacturing firms based on a short term survey of firms in two major categories including textiles and apparel, and leather and leather products.

### **1.7 CHALLENGES AND LIMITATION OF THE STUDY**

There were several challenges and limitations to undertake this research. First of all, the data collection process was very difficult for the researcher; some firms were not willing to fill the questionnaire, some of the firms were very late to return the questionnaire, due to this data collection process the study takes longer period of time than expected.

Both dependent and independent variables are better be defined as percentage of total annual expenditures spent on new technology adoption and percentage share of a given

firm from the explanatory variables respectively. However, in this study, due to lack of data in this way, most of the variables have been taken as binary variables.

The other limitation is that although the variables that the researcher has employed may explain the dependent variable, and even the error term on the econometric model capture variables that are not included in the study. There are explanatory variables that may also influence technology adoption like organizational structure.

## **1.8 ORGANIZATION**

The structure of the thesis is as follows. Chapter 2 lays out the literature review; Chapter 3 deals with the research design and methodology; Chapter 4 presents analysis, interpretation and discussion of the result about Ethiopian manufacturing industry technology adoption. The final section, Chapter 5, concludes the study and forward recommendations.

## **CHAPTER 2**

### **2. LITERATURE REVIEW**

#### **2.1 INTRODUCTION**

In this chapter, a review of literature that assists in addressing the research questions is presented. Before proceeding to the main study area, overview of important terms helps to have better understanding about the issue and presented in section, 2.2 and 2.3. Since the purpose of this study is to understand the adoption of technology on manufacturing enterprises, the type of manufacturing technology and its benefit is discussed in Section 2.4 and 2.5. Technology adoption is the primary research domain and discussed in Section 2.6. The main focus of this study is on factors that influence manufacturing technology adoption and is therefore discussed in Section 2.7. Section 2.8 unifies the literature findings and proposes the research framework.

#### **2.2 DEFINITION OF TECHNOLOGY**

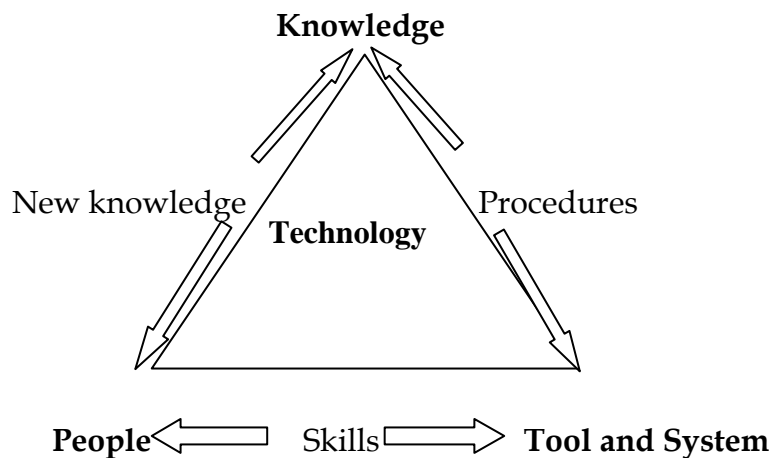
Defining technology is paramount because it helps to identify phenomena related to technology adoption. Since the 1960s many scholars have tried to understand the real meaning of technology using different underlying philosophies. Most contemporary discussion of technology transfer assumes that technology and its advance contribute to change and that this change fuels economic growth through increasing productivity.

Technology incorporates, among other things, research and development, design, process and production engineering, maintenance, management and entrepreneurship, marketing, investment and finance, human resources, information technology, and many others. Technology is always the means of creating new tools serving humans and their environment (Betz, 1998).

Technology can be described as the integration of people, knowledge, tools and systems with the objective to improve people's lives (Porter, 1985). Certain relationships exist between the elements in the definition, as shown in Figure 1.1. These relationships are the

skills that people need to operate the tools and systems, procedures that contain the knowledge needed to operate the tools and systems and new knowledge generation that includes training.

*Figure 2.2: Definition of technology*



(Porter, 1985)

### 2.3 DEFINITION OF MANUFACTURING TECHNOLOGY

Manufacturing technologies defined as the "master tools of industry that blow up the efforts of individual workers and enable production of all manufactured goods, with production tools including machine tools and other related equipment, their accessories, and tooling" (Sinha and Nobel 2008, pp. 944). This very broad definition includes every technical system that supports the production process, no matter whether the transformation of goods is directly affected, or some kind of data is stored or edited by any kind of information technology related to the manufacturing process. The definition also makes no distinction between the newness of the invented technology or the extent to which the production process is adapted. The new technology can be a small procedural change, a change of equipment or the total automation of manufacturing processes.

## 2.4 TYPES OF MANUFACTURING TECHNOLOGY

There are various classification schemes in the literature, that manufacturing technology encompasses a wide group of computer-controlled technologies, which have been introduced within the past two decades. Swink and Nair (2007) identify three types of AMT, namely design technologies, processing technologies, and planning (administrative) technologies.

Beside the above category, (Boyer et al. 1997, and Idris et al. 2008) categorize the manufacturing technologies under three variables: design technology, manufacturing technology and administrative technology as shown in the table.

**Design technology:** include computer aided design (CAD), computer aided engineering (CAE) and computer aided process planning (CAPP).

**Manufacturing technology:** includes computer-aided manufacturing (CAM), Robotics, Real-time process control systems, Group technology (GT), Flexible manufacturing systems (FMS), Computerized numerical control machines (CNC), automated material handling systems, environmental control systems and Bar coding/automatic identification

**Administrative technology:** includes electronic mail, electronic data interchange, office automation, knowledge-based systems, decision support systems, material requirement planning (MRP), manufacturing resource planning (MRP II), and activity based accounting systems.

The most extensive body of literature in the area of new manufacturing technologies has been developed with regard to advanced manufacturing technologies (AMT). AMT broadly suggests both soft and hard technologies which are being employed to enhance manufacturing competencies Chong et al. (2009). In more detail, AMT refers to a broad spectrum of computer-controlled process technology involving new manufacturing techniques and machines embedded in information technology and combined with microelectronics and new organization practices in the manufacturing process (Zammuto and O'Connor, 1992; Sun, 2000; Swink and Nair, 2007; Idris et al. 2008). Although there is a broader conceptualization of AMT including also soft technologies such as Just In Time

(JIT) and progressive human-resource development techniques, most authors understand AMT to be the application of the latest scientific or engineering discoveries to design production processes with the help of computer integrated technologies (Zammuto and O'Connor 1992, Swink and Nair 2007, Idris et al. 2008).

## **2.5 BENEFITS OF NEW MANUFACTURING TECHNOLOGIES**

Manufacturing firms faced a number of challenges since the nineties of the last century. According to Sun (2000), the most important issues that should be addressed by the manufacturing firm that can be met by the adoption of new manufacturing technology are; the reduction of lead time to satisfy consumers, getting new products to market more quickly, flexibility to adapt to changes in the market, improvement of product quality, cost reduction, and increased consumer services. Broadly the benefits of new manufacturing technology can be categorized as operational performance and organizational performance.

Literature has investigated the usage of new and advanced manufacturing technology as an adequate means to improve operational performance and its impact on firm performance (Swink and Nair 2007, Idris et al. 2008). According to these authors, the typical dimensions of manufacturing performance are flexibility, cost, quality and delivery.

Flexibility allows firms to produce a variety of products at low volumes with no additional costs or penalty. AMT also leads to increased productivity by reducing firms' direct labor costs, rework costs and work-in-process-inventories by embedding routine repetitive tasks into AMT hardware and software. In addition to these, firms using AMT achieve higher product quality, because process-related technologies allow for stable manufacturing processes according to product conformance. Especially, automation technologies provide greater consistency with specifications and therefore reduce scrap rates leading to a higher level of quality (Swink and Nair, 2007).

Beside the above benefit, the significance of new manufacturing technology on organizational performance was investigated by several authors. Empirical evidence

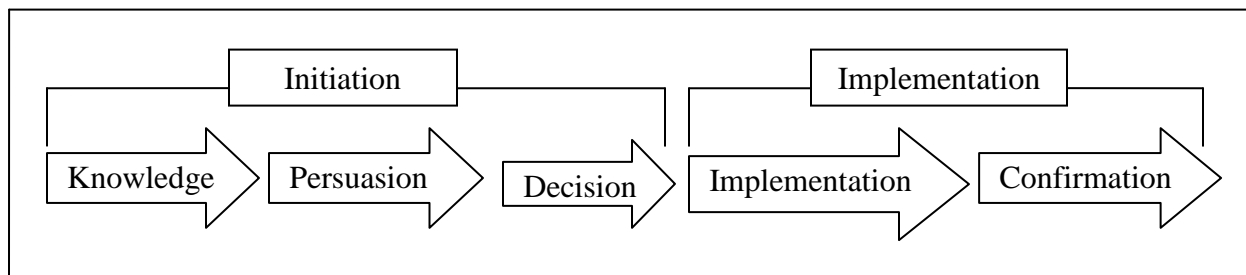
shows that new manufacturing technologies and the adoption of manufacturing programs are crucial for the success and survival of manufacturing firms (Sinha and Noble, 2008). For example, the adoption of AMT such as robots, lasers, or computer-controlled machinery explains the subsequent growth or failure of the firm. That is, the firms that use larger numbers of AMT demonstrate higher growth rates and lower failure rates.

## 2.6 TECHNOLOGY ADOPTION

A number of authors have defined adoption in a variety of ways and have distinguished between adoption, diffusion, initiation, development, implementation and use. While recognizing these legitimate distinctions, for this study the researcher has chosen to use “adoption” in the broadest sense so that it encompasses “the generation, development, and implementation” of the technologies (Damanpour, 1991, p. 556).

According to Premkumar and Roberts (1999) and Rogers (2003), adoption is considered as a decision to make full use of an innovation as the best course of action, and conversely, rejection is a decision not to adopt an available innovation. Furthermore, Rogers states that technology users go through five stages before they can adopt a new technology. The five stages are: (1) awareness, (2) interest, (3) evaluation, (4) trial, and (5) adoption. Thus technology adoption is the choice to acquire and use a new invention or innovation.

*Figure 2.6: Stage of technology adoption*



(Rogers, 2003; Damounpor, 1991)

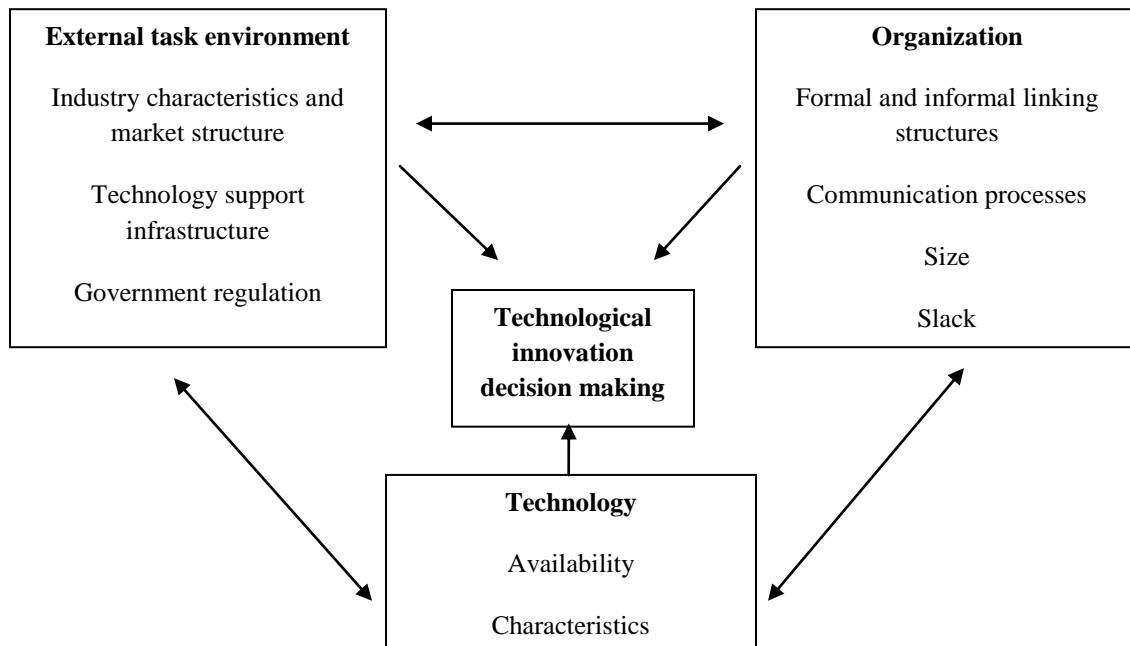
1. Knowledge occurs when an individual (or other decision-making unit) is exposed to the existence of innovation and gains some understanding of how it functions;
2. Persuasion (attitude formation) occurs when an individual (or other decision-making unit) forms a favorable or unfavorable attitude toward the innovation;
3. Decision occurs when an individual (or other decision-making unit) engages in activities that lead to a choice to adopt or reject the innovation;
4. Implementation occurs when an individual (or other decision-making unit) puts an innovation to use; and
5. Confirmation occurs when an individual (or other decision-making unit) seeks reinforcement of an innovation-decision already made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation.

## **2.7 FACTORS AFFECTING TECHNOLOGY ADOPTION**

The literature on adoption of innovations has mostly focused on the factors affecting adoption and diffusion of new technology. A variety of factors may affect an organizations decision to adopt and implement a particular technology. These factors can be categorized under technology, organization and environment aspects of an enterprise's context as shown in the Figure 2.7 below (Oliveira and Martins 2011).

- a. 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.
- b. Organizational context refers to descriptive measures about the organization such as scope, size, and managerial structure.
- c. Environmental context is the arena in which a firm conducts its business; like its industry, competitors, and dealings with the government.

*Figure 2.7: Technology, organization, and environment framework*



(Oliveira and Martins, 2011)

In most literature there are two dominant approaches that inform the decision of technology adoption and implementation: One suggests that technology adoption and innovation is driven by the external requirements of the market (Schmookler 1966), while the other views the activities and internal capabilities of firms as the primary drivers of adoption and innovation (Dosi 1982). Taken in isolation, each approach highlights key aspects of technological development but, as many have argued, the greatest insight derives from their joint consideration (Mowery and Rosenberg 1979). Thus literature indicates adoption of new innovation is determined not only by its internal characteristics, but also through forces present in the external environment. Accordingly, the aim of this study is to obtain a better understanding of the main constructs and factors that affect the adoption of new technology from both internal and external environment perspectives.

### 2.7.1 ORGANIZATIONAL FACTORS

A variety of organizational factors have been suggested to impact innovation and technology adoption. Among these factors most literature indicates organization's demographic characteristics (like age of the firm, size of the firm, sales volume, ownership and certification), organizational structure, organizational culture, manufacturing strategy, human resource practices, top management commitment, and financial resource are the most common internal factors that influence new manufacturing technology adoption.

**Age of the firm:** it can affect the probability of investment in new technology in two ways. On the one hand, older firms that are more experienced and are better cognizant of the market opportunities and requirements could be more inclined to invest in new technology to maintain their competitive strengths acquired over a longer period of time. Also, older firms may in fact need to invest in new technology to replace their older machinery and equipment Parhi (2008). One may, however, argue that newer firms having a modern outlook may be more likely to invest in new technology Fariaa, *et al.* (2002).

**Firm size:** It plays an important role in innovation adoption. Large firms enjoy economies of scale in production, have a relatively higher capacity for taking risks, and have better financial positions all of which contribute to higher probability of investment on new technology. It is theorized that larger organizations have the financial and technology resources to invest in new technologies and absorb the associated risk (Grover and Goslar, 1993). Previous research, regardless of the measures used to evaluate size and adoption, has consistently indicated that organizational size positively correlates with technology adoption (Germain et al., 1994). Studies examining individual technologies like Electronic Data Interchange (EDI), also found firm size to be an important factor to the adoption decision (Williams, 1994; Premkumar et al., 1997). In addition to this, Cragg and King (1993) showed that lack of technical knowledge and resources inhibit

technology adoption in small firms. Thus, larger organizations are expected to possess the financial resources and risk capacity necessary for new technology investments.

**Certification:** focuses on improvements in a firm's operating processes as the means to enhance quality and efficiency (Benner and Veloso, 2008). ISO-certification requires a detailed review and documentation of the routines underlying the internal delivery of the firm's products and/or services. The routines are subject to improvements to rationalize processes and streamline interfaces between the firm's sub-units. Once processes are reviewed and improved, standardized best practices are adopted throughout the firm. The adherence to routines ensures that the organizational processes are repeated allowing for continued efficiency improvements. ISO-certification indicates the adherence to consistent process standards; hence it represents the adoption of advanced organizational technology by firms, which is a key component of their technological knowledge (Lipsey and Carlaw, 2004). The adoption of international standards and technical regulations through ISO-certification is a major channel for firms to acquire technological information and introduce product and process technology upgrading (Blind et al. 2005; Corbett et al. 2005).

**Ownership:** there is a significant difference in investment volume and returns across ownership types. Foreign firms invest more and have higher returns than domestic private firms. Foreigners may have more experience using high technology and the organizational practices that best suit it. For firms engaging in foreign direct investment (FDI), it is found that multinational enterprises facilitate technology transfers and indigenous firms benefit from international technology spillovers Chen et al. (2008). Moreover foreign ownership exposes firms to global best practice technology and management techniques (Djankov and Hoekman 2000).

**Organizational structure:** it has been found to either facilitate or inhibit innovation adoption and considered as an important factor to adopt new technology (Williams,

1994). Organizational structure can be identified through indicators such as the degree of centralization within an organization.

Previous research has provided ambiguous results with some studies indicating positive effects of a centralized organizational structure (i.e., concentration of decision-making) on technology adoption while others have shown negative relationships. Pierce and Delbecq (1977) suggest centralization of decision-making may reduce conflict between organizational units and foster innovation adoption. In support of this proposition, Ettlie et al. (1984) found that organizations with a centralized structure were more likely to adopt new technologies.

However, an alternative approach reasons that organizations that have adopted a flatter, more decentralized structure would be expected to have adopted more innovative and cutting edge technology in order to enhance communication and coordination within the organization as well

as with supply chain members. Grover and Goslar (1993, p. 142) suggest that the “decreased autonomy and bounded perspective” of a centralized organizational structure explain the negative relationship often found between centralization and adoption. Germain et al. (1994) found decentralization (of technology decisions) does not significantly relate to overall technology adoption but may influence decisions regarding integrative technologies.

**Organizational culture:** it denotes a general concept that defines the comprehensive areas of knowledge framework which employees apply to accomplish their duties and engender social/collective behavior. The organizational culture provides guidance for organization members and interprets in different situations through establishing a set of shared mental assumptions (Ravasi and Schultz, 2006).

The effects of technology adoption process, such as competitive performance or overall satisfaction, which take longer to happen, are being influenced by cultural flexibility. The authors have attempted to clarify the connection between the success rate of AMT introduction and organizational culture. What most analysis illustrates is that the cultures

that are more control-oriented likely will succeed only partially in AMT adoption process. Recent studies reveal that successful manufacturing companies which were successful in AMT adoption had selected for a more flexibility-oriented organizational culture that might have comforted the AMT implementation through creating an atmosphere of encouragement and trust (Darbanhosseiniamirkhiz and Ismail, 2012).

Organizations with open and flexible corporate cultures adapt easily to new technology and the changes that come with it, as their employees at all levels tend to view changes positively and are more willing to adapt to the changes. This is especially true if a philosophy of empowering and motivating employees prevails in the organization (Ezzamel et al., 1996). Another study by Kitchell (1995) found that organizations with cultures seen as being flexible or open, and having a long-term orientation, had a greater propensity in adopting advanced manufacturing technology.

**Manufacturing strategy:** literature has suggested a direct link between firm performance and manufacturing strategy. Several authors have recognized the importance of this idea and they tried to analyze the connection between manufacturing strategy and firm performance. A manufacturing organization will be swift in addressing the demands of the market if it welcomes an approach that permits the organization to grasp mix and volume flexibility, while maintaining the high quality and low cost of products, and the result will be a manufacturing company with higher performance (Darbanhosseiniamirkhiz and Ismail, 2012).

Besides this, Khazanchi et al. (2007) analyzed successful AMT adopters (high performers) and compared them with failed cases (low performers) and concluded that among the two clusters in their sample of SMEs in employing AMTs, high performers were in general more likely to prefer the flexibility, delivery, and quality strategies rather than cost strategy.

**Human resource practices:** Successful adoption of AMTs requires employee support. In fact, lack of employee backing prior to the implementation of technologies would have detrimental effects. The behaviors, attitudes, and qualities of human resources can add edge to the competitiveness of the company and make its advantages more distinctive compared with its rivals (Cascio, 2010). Inadequate concentration on the human aspect of ATM implementation has been recognized as a major failure reason in terms of reliability, flexibility, quality and responsiveness. The involvement of managers in R&D operations and development of employees in socialization activities are examples of work-force development techniques. This approach can improve relational requirements and skills of human capital of the company, which is supposed to exploit the new technologies (Darbanhosseiniamirkhiz and Ismail, 2012).

AMT implementation, basically, requires highly skillful workers who should be provided with more autonomy facing issues such as AMT plans and problem solving. Moreover, they should become more adept with respect to skills, responsibility, knowledge, and attitudes. Consequently, catering to employees` job satisfaction and intrinsic motivations by creating opportunities of employee involvement can be considered as a viable method to affiliate the goals of human elements with the company which is adopting AMTs (Waldeck and Leffakis, 2007).

**Top management commitment:** the top management support has been one of the most widely discussed organizational factors in several manufacturing technology adoption. Researchers argue that top management interest, motivation, support and participation of the executive /top-level management/ toward adoption of new technology play a key role (AlQirim, 2007).

The strong commitment of top management, especially of a particular 'innovation champion', leads to early adoption, while a lack of top management commitment inhibits adoption (Mehrtens et al., 2001).

Understanding the importance of AMT by the top management would inspire it to play an important role in persuading employees to welcome new technology, moreover

managers would allocate willingly enough resources to the adoption. To obtain the potential benefits of an adopted AMT, top managers should focus on long term strategic plans emphasizing flexibility, responsiveness, and quality (Darbanhosseiniamirkhiz, and Ismail, 2012). However, top manager should prepare company even before the implementation of AMT by enhancing enterprise's performance and technological strategy. Top management support has also been recognized as essential for creating a supportive climate and providing adequate resources for the adoption and implementation of new technologies (Premkumar & Roberts, 1999).

**Financial resource:** It is found that availability of monetary assets is crucially significant to managers and owners, and such subjects often determine the destiny of AMT adoption and implementation, particularly in smaller manufacturing companies. The cash flow strength has also profound effect on the decision to upgrade technologies. For example, companies with a strong cash flow may find it easier to obtain financing to upgrade technologies (Pearson and Grandon, 2004).

Advocates of automation like Bromwich and Bhimani (1991) state that the benefits of AMT are often difficult to quantify in financial terms, are not immediately tangible, and require long-term consideration. Therefore, managers of organizations with little cash flow strength will tend to shy away from the expense of adopting AMT, especially when the cost savings appraisal compares the cost of AMT with the costs of using alternative technologies. Furthermore, when a company is short of cash, managers have a tendency to minimize risks.

Other companies did not plan to finance AMT through their internal cash flow given the high fluctuations they have experienced in the past. Instead, they felt that a credit line from a financial institution or some sort of government assistance would bring them more stability, which would assure them the implementation of the adoption of the AMT. Banks and other financial institutions are more reluctant to lend to small businesses because of high failure rates in the past, instability, and uncertainty. Securing additional

financing at favorable terms may prove to be a difficult challenge. Because the benefits of AMT are difficult to quantify in financial terms such as return on investment, payback period, etc., banks are less likely to lend money to high-risk projects (Bromwich & Bhimani, 1991)

### **2.7.2 ENVIRONMENTAL FACTORS**

In the literature there are factors beyond organizational limits, which arise from the external /environmental/ factors that play a great role for the success of technology adoption (Scupola, 2003; Idrissia et al., 2012). The external factors influence the adoption and diffusion of new technologies because of their unique features and characteristics, which can present opportunities and constraints for technological innovation adoption.

The environment context includes the external actors and factors that affect a company's decision to adopt a technology, either directly or indirectly. These include customers, supplier, competitors, market, government or economy.

**Customer's demand:** It is one of the external pressures influencing manufacturing technology adoption behavior of the firms (Chong et al., 2009). Demand from customers influenced firms to look into new product development and operations which influenced them to adopt a new technology into their operations. If customer demand is less, then there's no point in adopting new technology for firm's operations. Customer demand for quality gives effect for company to make a decision to develop a new product and eventually to adopt a new technology into their operations (Scupola, 2003).

**Competitive pressure:** In a technologically dynamic environment enterprise's have to constantly improve their technology to maintain their competitiveness. They ought to enhance their product features, production process technologies, and research and development (R&D) activities. In this case continuous upgrade of technology level and progressive adoption of complex AMTs are the probable outcome of such a highly competitive environment. To put it differently, in a hostile environment the same logic prevails; therefore, companies should continuously upgrade their manufacturing and

production equipment to remain competitive, since the competition is extreme, shifting among rival products is easy, and a constant pressure is on profit margins (Spanos and Voudouris, 2009).

**The suppliers of technology:** it is external element which has determining impact on the outcome of the technology adoption. In fact, the need to establish supportive relationships with technology vendor has been found to have a crucial effect on the success of the adoption of manufacturing technology (Darbanhosseiniamirkhiz, and Ismail, 2012).

**Government support and regulation:** generally can have a powerful effect on technology adoption, often via the ability of a government to support a technology with network effects. The effect of regulation is often to foreclose entry and grant fairly large market shares to serving, reducing incentives for cost-reducing innovation but also in many cases increasing the benefits from innovation due to the small number of firms in the market. The exact effects observed will depend partly on the particular price-setting mechanisms chosen by the regulator.

Simpson and Doherty (2004), showed that it is unlikely that the lack of monetary fund hinders AMT adoption especially in small and medium enterprises (SMEs). Many government programs are geared toward manufacturing firms that wish to upgrade their technologies. The availability and type of subsidy offered by the government plays a significant role in the decision for some small and medium-sized firms to upgrade technologies. A recent study shows that governments need to provide SMEs with more efficient funding instruments in order to encourage technology adoption (Darbanhosseiniamirkhiz, and Ismail, 2012).

On the other hand, Environmental regulations directly affect adoption because in many industries regulations will either prohibit or require the use of certain technology or production methods. This regulatory shift to estimate the effect of regulation on

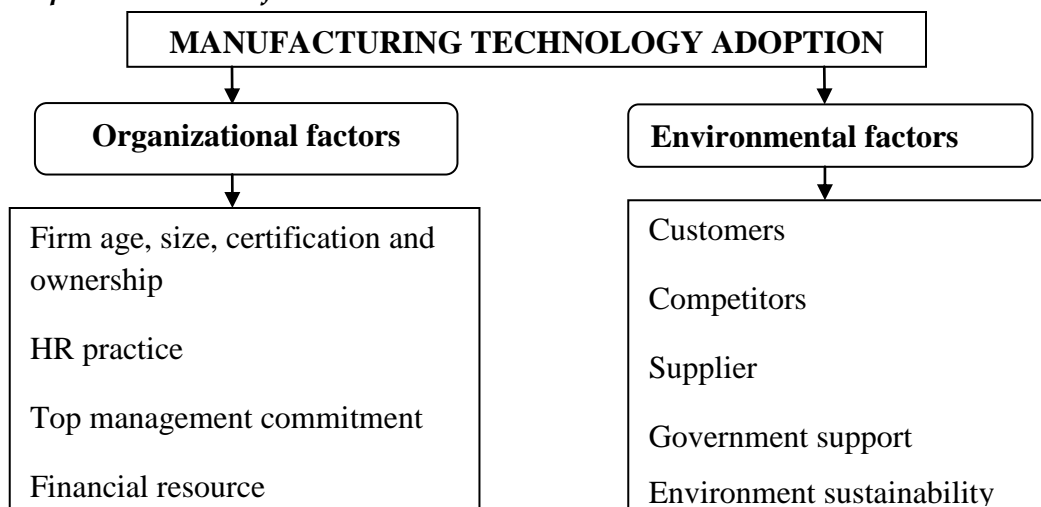
investment strategies of firms within the industry, where environmental regulations could have encouraged adoption of new production technology if they required replacement of older, more pollution-creating machines or methods.

However, the effect of regulation also reduced overall investment and therefore the diffusion of new innovations if it was costly for firms to purchase pollution abatement technologies or remodel older plants. The regulation-driven investment and productive investment crowd each other out, i.e., more investment in pollution-abating technologies has led to a decline in investment in production technology (Hall and Khan, 2002).

## 2.8 THE PROPOSED RESEARCH FRAMEWORK

The development of appropriate manufacturing technology assumes critical importance, the magnitude of which is reflected in the desire to adopt such innovations by the developing countries like Ethiopia. In this thesis, because the researcher is interested in the adoption of a considerable number of new manufacturing technologies, the focus is limited to key organizational and environmental factors. A comprehensive literature review has been undertaken to prepare an integrated framework based on previous findings. The resultant framework categorized the determining factors in manufacturing technology adoption under Organizational and Environmental main dimensions are as shown in the figure below.

*Figure 2.8: Proposed research frame work*



## **CHAPTER 3**

### **3. RESEARCH DESIGN AND METHODOLOGY**

#### **3.1 INTRODUCTION**

In this chapter, the research design and methodology of the study were discussed. The research approach is presented in section 3.2; source and method of data collection are described in section 3.3. In section 3.4, sampling that is sample frame; sampling technique and sample size are described. In section 3.5, methods of data analysis are presented. In section 3.6, the concept of Logit model was described. In the last section, summary of the methods with respective to objectives of the study is presented.

#### **3.2 RESEARCH APPROACH**

To fulfill the objectives of the study, the researcher used both quantitative and qualitative methods. The research questions that can be informed by both approaches develop rich insights into various phenomena of interest that cannot be fully understood using only a quantitative or a qualitative method (Venkatesh et al, 2013). Different authors believe that quantitative methods can be used to explore and generate new understanding, opening the door for qualitative methods to dig deeper into the research area, as well as complement existing research (Fatoki and Garwe, 2010).

The study did not wish to examine the longitudinal changes to the specific technology adoption. Rather a cross sectional time horizon was in use. According to Oates (2006), there are several periods associated with cross sectional research. Historical and short-term studies are examples of two types of studies based on the aspect of time. Historical studies focus on past events while short-term studies examine present events. Thus, the study used a short-term approach, however, because of the dynamic nature of this study, questions relating to previous and current issues regarding the technology adoption are asked as part of the survey.

### **3.3 SOURCE AND METHOD OF DATA COLLECTION**

The study used primary source of data to investigate the fact about technology adoption in Ethiopian manufacturing firm empirically. The data for this study was collected through the survey of manufacturing firms. However, at this juncture the researcher undertake extensive literature study connected with the benefit of technology adoption and factors affecting technology adoption in manufacturing firms as well as the models that help to understand the relationship between variable. For this purpose, the abstracting and indexing journals and published or unpublished bibliographies, academic journals, conference proceedings, government reports, and books are tapped that are related to the nature of the problem.

#### **Survey Questionnaire**

In order to assess the sample manufacturing firms closed ended structured questionnaire was distributed to the respondents. This type of questionnaires are simple to administer and relatively inexpensive to analyze. Structured questionnaires are those questionnaires in which there are definite, concrete and pre-determined questions. The questions are presented with exactly the same wording and in the same order to all respondents. Resort is taken to this sort of standardization to ensure that all respondents reply to the same set of questions. The form of the question may be either closed (i.e., of the type 'yes' or 'no') or open (i.e., inviting free response) (Kothari, 2005).

However, the respondents' suggestion, comment and additional idea were asked to full fill the missed gap. The questionnaires used as part of the survey were filled in on-site in the work environment of the manufacturing enterprises. Owners or managers were asked to complete the questionnaire on behalf of the enterprise.

### **3.4 SAMPLING**

Since the purpose of this study is to explore this relatively young research domain, the sample of manufacturing enterprises includes young enterprises (between 1 and 5 years of operation) and more mature enterprises (over 20 years of operation). In addition to

these age categories firms that operates between the specified ages was also included. The study populations include small, medium and large domestic and foreign owned enterprise that were involved in the manufacturing industry specifically leather and leather product, and textiles and apparel sectors.

In the literature, firms have been classified into small, medium, and large-scale enterprises, either based on sales turnover, capital outlay, or number of persons employed. In Africa, according to Oyelaran-Oyeyinka (1997), firms employing less than 10 persons are considered to be micro-enterprises. Firms employing 10 to 49 persons are usually considered to be small-scale, 50 to 199 medium-scale, and firms employing 200 or more persons are considered to be large-scale firms. On the other hand, SMEs can be classified as small firms that have 50 or less number of employees, and medium size firms that have 50 to 150 numbers of employees (Zealelem and Getachew, 2002).

The definition in this research is based on the number of employees (small-scale firms have 10 to 50 employees; medium-scale firms have 51 to 200 employees; while large-scale firms have more than 200 employees).

This survey used a non-probability purposive sampling technique, because it provide the researcher more freedom in terms of the number of issues that could be investigated, such as instances that may be different, extreme, unusual or somehow atypical. This sampling techniques are common when researchers prefer not to generalize, but to understand the topic in-depth (Oates, 2006).

Thus a total of 105 leather and textile firms were surveyed, which was 30 percent of the total population 384 firms that are operated in textile and leather manufacturing firms.

The questionnaires were distributed and delivered for the selected sample firms. But, a total of 83 completed responses were received, resulting in a response rate of 79.05 %.

After careful review of the returned responses, four responses were determined unusable because of a significant number of missing values. Therefore, a total of 79 responses were deemed usable and were included in the analysis. Although the sample size may not yield significant statistical results, it provided important qualitative insights into new technology adoption by the manufacturing enterprises.

### 3.5 METHODS OF DATA ANALYSIS

The study used both descriptive and exploratory approach utilizing surveys as the primary data collection methods. Descriptive method of analysis provides statistics that are used to describe the basic features of the data in a study. This facilitates to describe the demographic characteristics of the respondents and the firm; the benefit of manufacturing technology; as well as the critical success factors and barriers for technology adoption using frequency, percentage, mean, tabulation and graphs. The limitation with this analytical procedure is that descriptive statistics do not show the relationship among the variables and the influence that each variable may have on the response. Descriptive analysis does, however often provide guidance for more advanced quantitative analyses (Kothari, 2005).

Exploratory research studies are termed as formulative research studies and its main purpose is formulating a problem for more precise investigation or of developing the working hypotheses from an operational point of view. This helps the researcher to explore the factors that affect both soft and hard technologies adoption. Inbuilt flexibility in research design is needed because the research problem, broadly defined initially, is transformed into one with more precise meaning in exploratory studies, which fact may necessitate changes in the research procedure for gathering relevant data (Kothari, 2005).

The casual relationship between technology adoption and factors affecting the adoption was analyzed by Logistic regression. Logistic regression models are appropriate in this study due to the categorical nature of the dependent variable technology adoption. Categorical variables are defined as those for which the measurement scale consists of a set of categories. For such responses, the use of continuous data analytical methods is inappropriate; the ordinary least squares (OLS) method will not produce the best linear unbiased estimation. These models include Probit, Logit, and Tobit (Pindyck and Rubinfeld ,1991).

Both probit and logit approaches are probabilistic dichotomous choice qualitative models. These models are statistically similar, except that the probit model assumes a normal cumulative distribution function while the logit model assumes a logistic distribution of the dependent variable. Although parameter estimates may differ in the two models because the two distributions have different scales, it would require enormous sample sizes to have significant differences in the two models. Use of either model is thus discretionary. Probit models lack flexibility in that they do not easily incorporate more than one prediction variable unlike logit models. The choice of the Probit or Logit model convenience and availability of the computer package are considered (Wabbi, 2002).

Binary logistic models are the most popular type because binary data are a common type of categorical data - the response is either a 'success' or a 'failure'. The advantage with these models is that their assumptions are realistic for binary adoption study data. Thus in this thesis binary logit model is employed.

Logit model, and its binary outcomes, helps the researcher to explore how each explanatory variable affects the probability of the occurrence of events and it also to explore the level and direction of the relationship between dependent and independent variables in the adoption of new technology in manufacturing industry at firm level (See Long and Freese, 2006). Data analysis for the study was done using the Statistical data analysis software package (STATA version 12.1).

### **3.6 DESCRIPTION OF THE CONCEPTUAL LOGIT MODEL**

The logit regression model is an appropriate statistical tool to determine the influence of independent variables, and the explanatory variables are continuous, categorical and dummy (Long and Freese, 2006). In the logit model, the coefficients are compared with the probability of an event occurring or not occurring and bounded between 0 and 1 (Sheikh et al., 2003). The dependent variable becomes the natural logarithm of the odds when a positive choice is made. The odds ratio and predicted probability of the independent variables indicate the influence of these variables on the likelihood of

adoption of new technology if other variables remain the same. Hence, if the estimated values of these variables are positive and significant, it implies that the firms with high values for these variables are more likely to adopt new technology.

Logit fits a logit model for a binary response by maximum likelihood; it models the probability of a positive outcome given a set of regressors. Dependent variable equal to nonzero and non-missing (typically dependent variable equal to one) indicates a positive outcome, whereas dependent variable equal to zero indicates a negative outcome.

The value of the function is limited between 0 and 1, as necessary for a probability model.

The logistic function is given by:

$$P_i = e^z / (1 + e^z)$$

Where  $P_i$  is the probability of a binary outcome (adoption or non-adoption of new technology by the firm  $i$ , and  $Z = \beta X$ , where vector  $X$  represents firms' characteristics, and  $\beta$  is a vector of coefficients. The unknown parameters can be estimated by Maximum Likelihood Method. The natural log of odds ratios is given by:

$$Z_i = \ln[P_i / (1 - P_i)]$$

Since these probabilities are not directly observable, we proxy these by a binary variable  $Tec_i$  which takes a value of 1 if the  $i^{th}$  firm makes an investment in new technology and 0 otherwise.

Using  $Tec_i$  as a dependent variable we estimate the following model:

$$Tec_{hi} = \beta_0 + \beta_1 \ln Age_{hi} + \beta_2 DSize_{hi} + \beta_3 Own_{hi} + \beta_4 Cert_{hi} + \beta_5 Comp_{hi} + \beta_6 Custm_{hi} + \beta_7 Markt_{hi} + \beta_8 HR_{hi} + \beta_9 Mgt_{hi} + \beta_{10} Env_{hi} + \beta_{11} Fina_{hi} + \beta_{12} Govt_{hi} + v_{hi}$$

$$Tec_{si} = \beta_0 + \beta_1 \ln Age_{si} + \beta_2 DSize_{si} + \beta_3 Own_{si} + \beta_4 Cert_{si} + \beta_5 Comp_{si} + \beta_6 Custm_{si} + \beta_7 Markt_{si} + \beta_8 HR_{si} + \beta_9 Mgt_{si} + \beta_{10} Env_{si} + \beta_{11} Fina_{si} + \beta_{12} Govt_{si} + v_{si}$$

Where:

Tech= Hard technology

Tec<sub>s</sub>= Soft technology

Age = Age of firm in categorical years.

Dsize = Dummy variable with a value of 1 for large sized enterprises and 0 otherwise.

Own = Dummy variable taking a value of 1 if the firm is domestically owned and 0 otherwise.

Certi = Dummy variable taking a value of 1 if the firm is certified and 0 otherwise.

HR= variable taking value of 1 if the firm is influenced by Human resource technical skill and 0 if not influential.

Mgt = variable taking value of 1 if the firm is influenced by top level management commitment and 0 if not influential.

Fina= variable taking value of 1 if the firm is influenced by financial resource and 0 if not influential.

Comp= variable taking value of 1 if the firm is influenced by competitors and 0 if not influential.

Custm= variable taking value of 1 if the firm is influenced by customers demand and 0 if not influential.

Supp= variable taking value of 1 if the firm is influenced by market and 0 if not influential.

Evnt= variable taking value of 1 if the firm is influenced by environmental sustainability and 0 if not influential.

Gvt= variable taking value of 1 if the firm is influenced by government support and 0 if not influential.

### 3.7 SUMMARY OF OBJECTIVES AND METHODS

The summary that links specific objectives and methods to achieve them were presented in Table below.

*Table 3.7 Summary of specific objectives and methods*

<b>Specific Objective</b>	<b>Source of Data</b>	<b>Data Collection Method</b>	<b>Method of Data Analysis</b>
Identify the reason to adopt new technology	Primary source	Survey questionnaire	Descriptive statistics (frequency, percentages)
Identify technology adoption status of the firm	Primary source	Survey questionnaire	Descriptive statistics (frequency, percentages)
identify and examine factors affecting technology adoption	Primary source	Survey questionnaire	Logistic regression analysis
Investigate success factor and barriers of technology adoption	Primary source	Survey questionnaire	Descriptive statistics, using Mean

## **CHAPTER 4**

### **4. DATA PRESENTATION, ANALYSIS AND INTERPRETATION**

#### **4.1 INTRODUCTION**

In this part of the thesis, the data collected from primary and secondary sources are presented, analyzed and interpreted accordingly. The chapter is divided into four main parts. The first part deals with the analysis and interpretation of data collected from respondents related to the benefit that firms acquire by adopting manufacturing technology. The second part deals with the types of product and process technologies adopted by the firms; the third one is related to the analysis of responses on factors affecting manufacturing technology adoption. Finally, the critical success factors and barriers that influence the adoption process are analyzed and interpreted.

In order to analyze the firm's reason for technology adoption and the types of product and process technology adopted by the firm, the researcher conducted descriptive analysis using tabulation and percentage. The factors affecting technology adoption were analyzed using logit model. In doing so, twelve independent and two dependant variables were selected. The last section, the success factor and inhibitors of the adoption process were analyzed by descriptive statistics using mean as a central tendency taken from questionnaire that involves five response levels Likert scale.

#### **4.2 DEMOGRAPHIC CHARACTERISTICS OF THE RESPONDENTS AND FIRMS**

The focus of this part is to present a background profile of the manufacturing enterprises contacted during the data collection process. The manufacturing sectors included various textile and leather manufacturers. Information was provided on the number of years the enterprise had been in operation. The size of the enterprises was also presented, with the number of employees being used as a basis to determine the size of the enterprise. In addition to this information, the type of ownership and firms certification standards also

described. Moreover the respondent's gender, job title and educational background were analyzed by descriptive statistics using frequency, percentage, tables, and graphs.

**Table 4.2.1** Demographic characteristics *of the respondents*

<b>Characteristics of the respondents</b>	<b>Frequency</b>	<b>%</b>	<b>cumulative %</b>
<b>Gender</b>			
Female	3	4	4
Male	76	96	100
Total	79	100	
<b>Job Title</b>			
General manager	15	19	19
production manager	40	51	70
plant manager	24	30	100
Total	79	100	
<b>Educational Background</b>			
2nd degree	8	10	10
Degree	53	67	77
Diploma	18	23	100
Total	79	100	

*Source: Own survey data (December, 2014)*

The sample includes 96% of male respondents and only 4% female respondents. This is a clear indication of the dominance of male over female owners or managers. The questionnaire was designed to fill by owners or managers of the firm that are directly or indirectly participated in the decision of the technology adoption. The result, as Table 4.2.1 above, indicates, most of the respondents are production manger of the firm, which was 51% of the respondents. This was followed by plant manager by 30% and the general manager by 19% of the respondents. The researcher has tried to assess the educational background of respondents. The data show that 67 % of the respondents had first degree, 23% of the respondents were diploma holders and the rest 10% of the respondents were 2<sup>nd</sup> Degree holders. This shows that most of the firms are managed by educated personnel and they are able to decide what technology to be adopted or not to be adopted for their efficient operation.

#### 4.2.2 SECTORAL DISTRIBUTION OF FIRMS

Two manufacturing sectors, which are considered as the priority area of the industry, were taken for investigation in this study as a sample. The result of Table 4.2.1 indicates, 48% of the firms were from the textile and apparel sectors, and the rest 52% of the firms were from leather and leather product manufacturing sectors. This signifies almost equivalent number of firms was taken from both sectors to undertake this study.

*Table 4.2.2 Sectoral distribution of firms*

Sector	Frequency	%	Cumulative %
Textile and apparel	38	48	48
Leather and leather product	41	52	100
Total	79	100	

*Source: Own survey data (December, 2014)*

#### 4.2.3 LEGAL STATUS OF FIRM ESTABLISHMENT

As shown in the table below, 67% of the respondents were private limited company (PLC.), the rest 25% and 8% of the firms were sole proprietors and cooperatives forms of organization. This indicates that, the legal establishments of the majority of the firms in this study were private limited company.

*Table 4.2.3 Legal status of firm establishment*

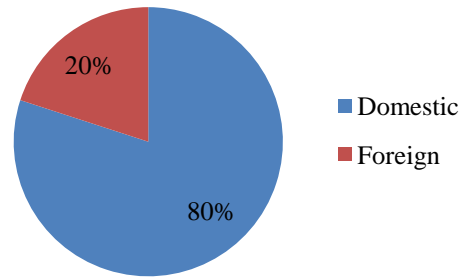
Legal status	Frequency	%	Cumulative%
Sole proprietorship	20	25	25
P.L.C	53	67	92
Cooperatives	6	8	100
Total	79	100	

*Source: Own survey data (December, 2014)*

#### 4.2.4 DISTRIBUTION OF FIRMS BY OWNERSHIP

The type of ownership plays an important role in influencing a firm's decision to adopt new technology. Due to this fact the researcher takes both foreign and domestic owners for this study. The result in the pie-chart below indicates most of the firms were domestic owned, which is 80% of the respondents. The remaining 20% of the respondents were firms owned by foreigners as shown in the pie-chart below.

**Figure 4.2.4: Types of Ownership**

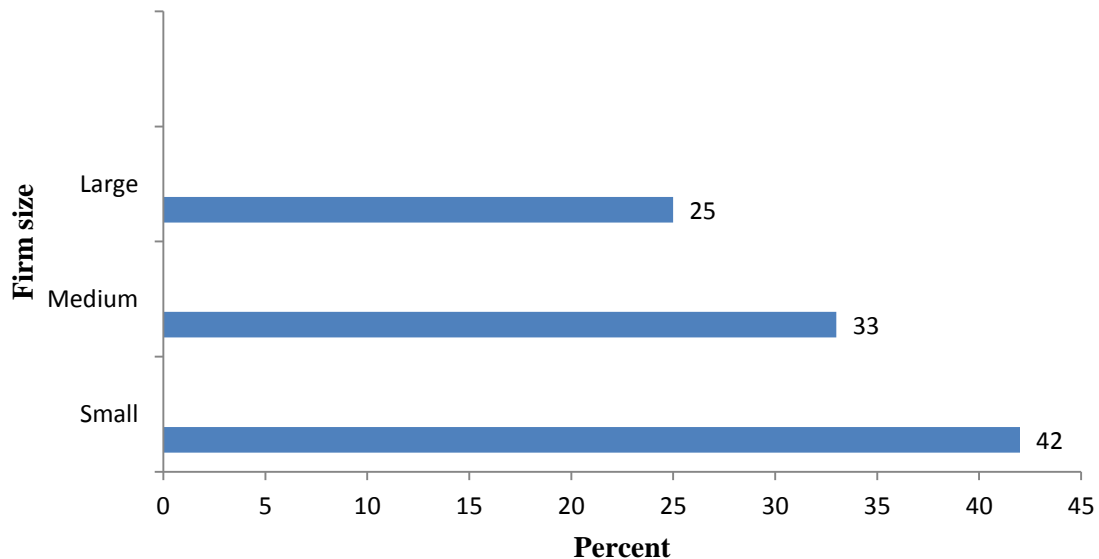


*Source: Own survey data (December, 2014)*

#### **4.2.5 FIRM SIZE DISTRIBUTION BY THE NUMBER OF EMPLOYEES**

The size of the firm was categorized as small, medium and large based on the number of employees working in the firm. As shown in bar graph below, the majority of the respondents were from small firms which are 42%. This was followed by medium firm by 33% and large firm by 25% of the respondents. This indicates the study was undertaken with close number of respondents from each category of the firm size.

**Figure 4.2.5: Firm size based on number of employees**



*Source: Own survey data (December, 2014)*

#### 4.2.6 FIRMS CERTIFICATION STATUS

ISO-certification standards are a set of internationally accepted standards and technical regulations serving as the basis for implementing quality management systems in manufacturing or services firms developed by the International Organization for Standardization. As depicted in the table below most of the respondents were from firms that have not ISO-certificate, which was 75% of the respondents. The rest 25% of the respondents were firms that have got ISO-certificate.

*Table 4 .2.6 Firms Certification status*

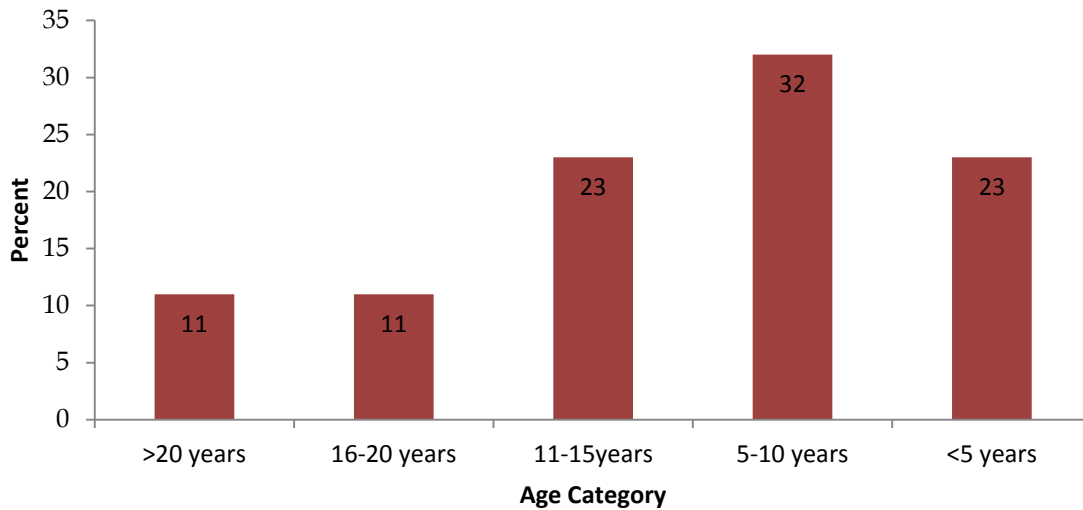
Certificate	Frequency	%	Cumulative %
Have certificate	20	25	25
Have not certificate	59	75	100
<b>Total</b>	<b>79</b>	<b>100</b>	

*Source: Own survey data (December, 2014)*

#### 4.2.7 DISTRIBUTION OF FIRMS BY AGE CATEGORY

Age category was made to be representative of the whole population. In doing so, the researcher segregated age of respondents into five categories. Accordingly, 23% of the respondents fall under the age category of less than 5 years. The next category (5-10) represents the maximum proportion of respondents having 32% of the sample firm. Age categories 11-15 had 18 respondents, which incorporate 23% of the respondents. On the other hand, Age bracket 16-20 years old and greater than twenty years old had 9 respondents from each age category, which is contributing 11% of the sample firm. The result is illustrated in the column graph below.

**Figure 4.2.7: Firms distribution by age**



*Source: Own survey data (December, 2014)*

### 4.3 BENEFITS OF MANUFACTURING TECHNOLOGY ADOPTION

There are a number of challenges manufacturing firms face and some of the problems should be addressed by the adoption of new manufacturing technology. In this part of the study descriptive analysis is used to discuss the firm's reasons to adopt new manufacturing technology.

*Table 4.3.1 Benefits of adoption of new manufacturing technology*

Benefits of Manufacturing technology adoption	No of Resp.	Freq.	%
To improve product & process quality	79	79	100
To meet customer demand	79	63	80
Increase productivity	79	79	100
Enhance competitive advantage	79	69	87
Increase profitability	79	65	82
To extend the market	79	65	82
Cost reduction	79	67	85
Survival	79	32	41
Competitive price	79	66	84
Reduction of lead time	79	61	77
Enhance delivery capability	79	59	75

*Source: Own survey data (December, 2014)*

As indicated in the table above all respondents need to adopt and implement manufacturing technology to improve product and process quality, as well as to increase productivity and considered them as the primary reason. This was followed by the reasons, 'competitive advantage' (87% of the respondents), 'cost reduction' (85% of the respondents), competitive price (84% of the respondents), and 'to extend the market' and 'to increase profitability' (82 % of the respondents for each reason). The reason; reduction of lead time was considered as a reason by 77% of the respondents and to enhance delivery capability was also taken as a reason by 75% of the respondents. But among all the reason in this study; 'survival' was the least reason for firms to resolve their problems by technology adoption, which is taken as a reason only by 41% of the respondents.

#### 4.4 TECHNOLOGY ADOPTION STATUS OF THE FIRM

To overcome various problems or to acquire the benefit indicated in the previous section, adoption and implementation of both product (hard) and process (soft) technologies are vital. Hard technologies are those relating to facilities, equipments, robotics and computer aided-manufacturing. Soft technologies are those related to management and information system such as total quality management (TQM), just in time (JIT), enterprise resource planning (ERP) and others. The next sections describe both soft and hard technologies that had been adopted by the companies using frequency and percentage.

*Table 4.4.1 Manufacturing technology adopted by the firm*

Types of technology	Freq.	%	Cumulative %
<b>Soft technology</b>			
Adopted	39	49	49
Not adopted	40	51	100
Total	79	100	
<b>Hard technology</b>			
Adopted	23	29	29
Not adopted	56	71	100
Total	79	100	

*Source: Own survey data (December, 2014)*

As indicated in the table above the adoption status of both process and product technologies by the Ethiopian firms are small. As shown in Table 4.4.1, 49% of the firms

adopt new soft technology and only 29% of the firms adopt new hard technology. This result demonstrates that, soft technology was relatively better adopted by the firms than hard technology.

#### **4.5 RESULT AND DISCUSSION OF THE LOGIT MODEL**

The choice of technology adoption is a discrete choice. Firms either invest or do not invest in new technologies. Due to this categorical nature of dependent variable, the ordinary least squares (OLS) method of estimation is biased and inefficient. This situation calls for the use of one of the binary dependent variable techniques.

In the literature the most commonly used techniques are Logit and Probit models. The basic difference between these two techniques lies in the assumption about the distribution of the error term. In the Logit model, errors are assumed to follow the logistic distribution, whereas in the Probit model errors are assumed to follow the standard normal distribution. In this thesis the researcher used the Logit estimation technique due to mathematical simplicity. But the result obtained using probit model is also presented in the Appendix<sup>1</sup>.

A logit regression model was developed to explore factors influencing the adoption of new technology in this study. The model explains in terms of the factors facing firms and the probability that firms would adopt the technology. This empirical model introduces an array of relevant factors in econometrically determining the parameters that provide information on the characteristics of technology adoption in Ethiopian manufacturing firms.

In this part of the study both internal and external factors that affect new soft as well as hard manufacturing technology are analyzed by the logit model using the Statistical data analysis software package (STATA version 12.1).

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<sup>1</sup> A Probit model for both technologies has also been estimated, but the results are very similar and are also presented (see Appendix).

**Table 4.5.1 Soft technology adoption logistic regression**

Variable	Coefficient estimate	P-Value	Marginal Prob.(dy/dx)	P-Value	X
_cons	-9.420	0.000			
<b>Internal factors</b>					
Age	-0.043	0.412	-0.011	0.414	11.443
Size	1.828***	0.055	0.418	0.021	0.253
Own	0.922	0.404	0.225	0.378	0.203
Cert	1.128	0.295	0.273	0.255	0.253
HRs	2.503****	0.004	0.521	0.000	0.696
Mgts	0.354	0.650	0.088	0.647	0.646
Finas	2.615****	0.006	0.538	0.000	0.696
<b>External factors</b>					
Comps	3.111****	0.003	0.599	0.000	0.709
Custms	0.977	0.271	0.234	0.241	0.709
Supps	0.971	0.292	0.233	0.258	0.709
Gvts	1.219*	0.139	0.291	0.110	0.633
Envts	1.081	0.201	0.259	0.177	0.658

Note: '\*', '\*\*', '\*\*\*' and '\*\*\*\*' are significant at 15%, 10%, 5% and 1% level respectively.

Source: Own survey data (December, 2014)

As shown in the logistic regression above, the variable 'age' has a negative relation with soft manufacturing technology adoption, but it has insignificant effect for firm's decision to invest in new soft manufacturing technology. However, the dummy variable for firm size turns out to be positive and significant at 5% level of significance showing that larger firms have a higher likelihood of investment in new soft technology to enhance economies of scale and achieve technological efficiency.

The coefficient of the dummy variable for certification is significant with a positive sign implying that being certified to international quality standards increases the probability of a firm's technology adoption. Firms that have obtained process standards have a better awareness about the benefits of new technology in terms of process efficiency. Hence, such firms have a better likelihood of investing in new technology to maintain their competitive strengths. The dummy variable for ownership has a positive and significant coefficient implying that foreign-owned firms are more likely to invest in new soft technology than domestically owned firms but relatively less significant.

The variable for human resource technical skill has also positive and significant correlation with new soft manufacturing technology adoption. The result indicates employee's technical skill influence firm's decision new soft manufacturing technology adoption at 1% level of significance. Similarly, availability of financial resource has also positive correlation with soft technology adoption and significant, at 1% level, to influence firms technology adoption decision.

The variable top level management commitment has positive but insignificant coefficient implying that the factor has less impact for firm's decision to invest on new soft manufacturing technology. However, researchers argue that top management interest, motivation, support and participation of the executive /top-level management/ toward adoption of new technology play a key role (see AlQirim, 2007).

The external variable competition has a positive and significant coefficient at 1% level of significance implying that firm's competitors either locally or globally influence the firm to invest in new soft technology in order to enhance their process quality to be competitive in the market. The variables for customer demand and supplier of the new technology have also positive and significant coefficient. But these variables were influential above 15% level of significance to adopt new soft manufacturing technology. Similarly the variable environmental sustainability has positive and significant influence implying that the government regulation to keep the environment healthy influence firms to adopt new soft technology.

Moreover, the variables government support also has positive and significant coefficient implying that the government support, in terms of tax relief, credit access, influence firms to adopt new soft manufacturing technology at 15% of level of significance.

In the Logit regression, the marginal effects provide a good approximation to the magnitude of change in the dependent variable due to a change in the independent variable. Holding other independent variables constant at the mean values, firms under competition are 60% more likely to invest in new soft technology than the other. Similarly, financial resource by 54% and HR technical skill by 51% are more likely

influence firm's decision on new soft technology adoption. Beside this large firm are also 42% more likely than that of small or medium firms to adopt new soft technology holding other variables at their mean values.

**Table 4.5.2 Hard technology adoption logistic regression**

Variable	Coefficient estimate	P-Value	Marginal Prob.(dy/dx)	P-Value	X
_cons	-8.915	0.004			
<b>Internal factors</b>					
Age	-0.023	0.718	-0.002	0.730	11.443
Size	3.263****	0.006	0.543	0.012	0.253
Own	1.253	0.274	0.169	0.417	0.203
Cert	2.104***	0.048	0.313	0.152	0.253
HRh	1.861*	0.166	0.163	0.087	0.646
Mgth	0.242	0.800	0.024	0.800	0.684
Finah	1.864**	0.111	0.169	0.124	0.620
<b>External factors</b>					
Comph	0.987	0.305	0.095	0.290	0.595
Cusmh	0.661	0.553	0.061	0.510	0.684
Supph	0.541	0.555	0.051	0.548	0.671
Gvth	1.827*	0.171	0.165	0.118	0.620
Envth	0.770	0.397	0.074	0.406	0.595

Note: '\*\*', '\*\*\*', '\*\*\*\*' and '\*\*\*\*\*' are significant at 15%, 10%, 5% and 1% level respectively.

Source: Own survey data (December, 2014)

Like that of the soft technology, the variable age has negative but insignificant coefficient implying that firms age has almost no impact on firms decision to invest on new hard technology relative to the other explanatory variables.

The dummy variable firm size has positive and significant coefficient (at 1% level) implying that larger firms are more likely to invest on new hard technology than that of medium or small firms. This finding is consistent with previous findings that indicate organizational size positively correlates with technology adoption (Germain et al., 1994).

The variable ownership firms has positive correlation with hard technology adoption and has significant coefficient implying foreign owned firm are more likely to invest on new hard technology than that of domestic owned firms.

The coefficient of the dummy variable for certification is significant at 5% level with a positive sign implying that being certified to international quality standards increases the probability of a firm's technology adoption. Firms that have obtained product standards have a better awareness about the benefits of new hard technology in terms of product quality efficiency. Hence such firms have a better likelihood of investing in new hard technology to maintain their competitive strengths.

The coefficient of the variable, financial resource has positive relation with new hard technology adoption, and it was significant at 10% level. This implies that, firm's availability of finance increases the probability of its decision of hard technology adoption. This was supported by Pearson and Grandon (2004); they found that availability of monetary assets is crucially significant to managers and owners to determine the manufacturing technology adoption. Thus such firms have a better likelihood of investing in new hard technology to maintain their competitive strengths.

Like that of soft technology adoption the variable top level management commitment has positive but insignificant coefficient for firms to decide on new hard technology adoption, which indicates that firm's top level management commitment has little impact on firm's decision to adopt new hard technology.

The coefficient of the variable for competitors was significant at 10% level with a positive sign. This shows that the competitive environment in the market is influential for firm's hard technology adoption to keep their pace with the other.

The variables government support and human resource technical skill have also positive and significant coefficient to influence firm's decision to adopt new hard manufacturing technology. This indicates that firms that have got support from government in terms of credit access and tax relief for technology transfer have a better likelihood of adoption of hard technology. This is also true for firms that have skilled workers, to manipulate and

use the technology effectively and efficiently, have a better likelihood of adoption of new hard technology.

The variables supplier, customer demand and environment sustainability turns out to be positive but insignificant influence on firm's technology adoption decision. This indicates that the customer demand for quality product and the government regulation do not significantly affect the firm's likelihood of investing in new hard manufacturing technology.

In the Logit regression, the marginal effects provide a good approximation to the magnitude of change in the dependent variable hard technology adoption due to a change in the independent variable. Holding other independent variables constant at the mean values, large firm are 54% more likely to invest on new hard technology than that of small or medium firms. In the same way, certified firms are 31% and foreign owned firms are 17% more likely than that of non-certified firm and domestically owned firms to invest on hard technology.

In addition to these, firms that have available financial resource influence firm's decision by 17% to invest on new hard technology holding other independent variables constant at the mean values. The marginal probability for firms having government support increases the likelihood of adoption by 16.5% above the mean as compare to the other firms.

#### **4.6 CRITICAL SUCCESS FACTORS AND BARRIERS FOR TECHNOLOGY ADOPTION**

To supplement the logit result and for further understanding the factors affecting adoption of new manufacturing technology, respondents were asked to indicate their critical success factors and barriers. Tables 4.6.1 and 4.6.2 report the factors that respondents felt were critical to the success of technology adoption and management, and the barriers that limit the success. Successful technology adoption requires key success factors such as the openness of innovation culture in all management levels and in the

whole organization, an open communication system both vertical and horizontal, top management support and involvement, the availability of resources that support technology adoption, employee training and education, and clear direction in planning. However, when adopting new manufacturing technology, firms encountered major difficulties. The factors that inhibit successful technology adoption in the form of skill shortages, the need for training and the lack of financial sources, the lack of government support, strategic perspectives and resistance to change were investigated in this study. In the next section, the data were generated and analyzed descriptively using means on a 5 point scale where means close to 5 represented extremely influential, while the means close to 1 represented not at all influential

**Table 4.6.1 Critical success factor to new manufacturing technology adoption**

Success factor	N	Range		Soft Tec.	Hard Tec.
		Min.	Max.	Mean	Mean
Openness innovation culture	79	1	5	3.75	3.58
Open communication system	79	1	5	3.82	3.27
Availability of resources	79	1	5	4.03	4.52
Top management support and involvement	79	1	5	2.53	2.70
Employee training and education	79	1	5	4.19	4.05
Clear and systematic direction in planning	79	1	5	3.38	3.62

*Source: Own survey data (December, 2014)*

As the table above indicates ‘availability of resource’ and ‘employee training and education’ were highly influential factors of mean 4.03 and 4.19, respectively, for successful adoption of new soft manufacturing technology. This was followed by open communication system of mean=3.82 and openness innovation culture of mean 3.75 considered by the firm as influential success factors for soft technology adoption. In addition to this, clear and systematic direction in planning was somewhat influential factor for successful soft technology adoption. While the top level management support and involvement was slightly influential for successful adoption of new soft manufacturing technology.

The result also indicates that the factor ‘availability of resource’ as extremely influential (Mean=4.52) factor for successful adoption of hard manufacturing technology. In addition to this, employee training and education was considered by the firm as very influential factor for successful hard technology adoption process. Moreover, ‘clear and systematic direction in planning’, ‘Openness innovation culture’ and ‘Open communication system’ was influential success factors of mean 3.62, 3.58 and 3.27 respectively. However, like that of soft technology adoption, the top management support and involvement were slightly influential to adopt new hard manufacturing technology.

**Table 4.6.2 Barriers to adopt new manufacturing technology**

Barriers to Technology Adoption	N	Range		Soft Tec.	Hard Tec.
		Min	Max	Mean	Mean
Resistance to change	79	1	5	4.63	4.57
Lack of government support	79	1	5	3.13	3.44
Availability of budget	79	1	5	4.22	4.51
Lack of technical supporting services	79	1	5	4.07	4.29
Lack of strategic perspective	79	1	5	3.71	3.56
Lack of skilled worker	79	1	5	4.47	4.39

*Source: own survey data (December, 2014)*

The result of table 4.6.2 indicates ‘resistance to change’ was considered as extremity influential barrier for firm’s new soft technology adoption. This was followed by very influential barriers ‘lack of skilled worker’ (Mean=4.39), ‘lack of budget’ (Mean=4.22), ‘lack of technical supporting services’ (Mean=4.07) and ‘lack of strategic perspectives’ (Mean=3.71). In addition to these ‘lack of government support’ was somewhat influential for firm’s new soft technology adoption.

Similarly, the table above indicates ‘resistance to change’ and ‘lack of budget’ was considered as extremity influential barriers for firm’s new hard technology adoption. This was followed by very influential barriers ‘lack of skilled worker’ (Mean=4.47), ‘lack of technical supporting services’ (Mean=4.29), ‘lack of strategic perspectives’ (Mean=3.56) and ‘lack of government support’ (Mean=3.44).

## CHAPTER 5

### 5. CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 CONCLUSIONS

Based on the findings of the study the researcher comes up with the subsequent conclusions. The empirical result shows that the firms have different reasons to adopt new manufacturing technology. Among the reasons, product and process quality improvement and productivity enhancement are taken by all respondents as primary reasons. This is followed by the reasons 'cost reduction', 'competitive price', 'market extension', 'profitability', 'competitive advantage', 'customer demand', 'reduction of lead time' and 'delivery capability' in order of priority. Most of the firms in this study were not considered technology adoption for the survival of the firm operation, which was taken as a reason only by 41% of the respondents. This indicates firms are aware of the benefit they can acquire by adopting new manufacturing technology. Even if firms express the benefit they can obtain from new technology adoption, the result indicates that, most of the firms did not adopt product and process technologies that are taken in this study. However, comparatively soft technologies are better adopted than hard technology.

The result indicates all of the variables taken in this study, except firms age, have positive relation with both soft and hard technology. As the finding shows almost all the independent variables have more or less similar influence on both types of new technologies. This study revealed the relative significance of the proposed factors in predicting the level of a firm's technology adoption and supported that some organizational and environmental factors significantly predict firm's technology adoption activities. The technology adoption level of a firm was found to be positively related to the firm size that is the findings indicate that larger firms are more likely to adopt new technologies than medium or smaller firms.

The significant influence of the firm size on both types of technologies indicates that a considerable difference exists in the level of technology adoption between large and small manufacturing firms. This is supported by a previous study that found larger firms in the industry, where a large number of small businesses are dominant, have a great tendency to adopt new technologies.

The financial resources required to implement adoption are probably the reason why large firms are more likely to adopt technologies than small firms, since financial resource are also influential factors for firm's technology adoption process. In contrast, small and medium firms may be constrained by available resources and technical knowledge that can be allocated to adoption of new technologies. The result warns that small sized firms may have limitation in responding to global and local competition through technology adoption and need supports from the government.

The competitive pressure has been found as one of the most significant environmental variables that influence technology adoption of a firm. The significance of the competitive advantage influence indicated that the competitive advantage gained through technology adoption has determinant in technology adoption. Competition and environmental changes and the competitive pressure from them may force the firms to seek new technologies. It may be that a firm chooses to adopt advanced technologies because of a fear of losing business in competition.

Firms that have obtained process and product standards certificate have a better awareness about the benefits of new technology in terms of process and product efficiency. Hence such firms have a better likelihood of investing in new technology to maintain their competitive strengths. Technology adoption of foreign owned firms are more likely to adopt new technology than domestic owned firms, which was more significant for hard technology adoption.

The relationship between human resource technical skills and technology adoption was also found to be significant. The typical production in the manufacturing process may need automatic operations of the machines and automated assembly. This indicates enterprise training is an essential complement to new investment in technology, plant

and equipment as well as new organizational methods. Many studies also suggest that the shortage of appropriate worker skills is a major constraint on the adoption of new technologies, while well-trained workers accelerate adoption.

Government support had been found significant for firm's technology adoption decision. This noted that firms were ready to adopt the best practices in technology as long as they had adequate resources. A recent study also shows that governments need to provide with more efficient funding instruments in order to encourage technology adoption especially for small and medium firms.

On the other hand, the results indicated that environment sustainability, supplier and customer demand have positive but little significant effects on the technology adoption level relative to the above variables. In addition to this firms age has negative but insignificant effect on the adoption decision of new manufacturing technology.

The study found that the factor top management commitment was not significant in influencing a firm's technology adoption decision; although most prior studies on technology adoption found it significant.

In many firms, the primary decision-maker in areas like technology adoption is the owner or top management of the business and his or her vision for the use of these technologies determines the level of support for the innovation adoption.

This study also found the critical success factor and barriers that limit the success of technology adoption. The finding from descriptive analysis shows that, the critical success factor, availability of resource was extremely influential for firm's technology adoption as it was also confirmed in logit model. This was also true for the success factor employee training and education, which is very high to influence firm's successful technology adoption. This shows that enhancing technological skills and capabilities of employees helps firms to adopt new technology successfully.

Beside this, finding from this study also conclude open innovation culture; open communication system; and clear and systematic direction in planning are also influential for successful technology adoption. Thus the applicability of manufacturing strategy and

the creation of open organizational culture encourage firm's technology advancement. However top level management support and involvement found slightly influential factor to influence firm's investment in new technology.

To adopt and implement new technology, resistant to change, lack of budget, lack of skilled worker and lack of technical supporting services are very influential barriers in order of priorities. Other inhibitors include lack of strategic perspective and government support that influence firms technology adoption and implementation. In managing adoption process of new manufacturing technology, key success factors are needed and barriers have to be overcome.

## **5.2 RECOMMENDATIONS**

Based on the findings and conclusions drawn from the study, the researcher forwards the following important recommendations.

**5.2.1** Small and medium size need to be nurtured through proper fiscal incentives for technology adoption including tax credits for research and development activities. Domestically-owned enterprises should be offered incentives to enable them investing in better product and process technologies. Beside this, Facilitation of certification to technical standards can also be instrumental in promoting adoption of new technology. There is, therefore, a need to facilitate certifications through fiscal incentives as well as through helping to upgrade and establish the necessary physical infrastructure for technical testing.

**5.2.2** As the study found, the human resource technical skill are factors that determine firm's decision to adopt new technology. The first step for policy makers is to establish the nature of skill provision and the needs, and the gaps between the two that need to be remedied. This requires conducting a 'skills audit' at the enterprise and industry level, accompanied by an assessment of the capabilities, staffing, curricula and facilities in teaching institutions.

- 5.2.3** The government regulation should be reviewed and strengthened for environmental protection, which may owe a favor for firm's new manufacturing technology adoption and implementation.
- 5.2.4** In an effort to help domestic firms to improve technological adoption and innovative capabilities, the researcher recommended promoting partnerships and joint ventures between foreign and domestic firms using incentives and direct Government support.
- 5.2.5** Finally, the researcher recommends future researches that focus on specific technology adoption and longitudinal approach would be also valuable to study technology adoption over time and determine influential factors.

## BIBLIOGRAPHY

- AL-Qirim, N. (2007). *The adoption of e-Commerce communications and applications technologies in small businesses in New Zealand*. Electron. Commer. Rec. Appl., 6(4), pp. 462-473.
- Benner, M., and Veloso, F. (2008). *ISO 9000 Practices and Financial Performance: A Technology Coherence Perspective*, *Journal of Operations Management* 26(3): 611-629.
- Betz, F. (1998). *Managing technological innovation: Competitive advantage from change*. New York: John Wiley & Sons, Inc.
- Blind, K. , Andre, J. , Paul, T. , Chris, S. , Peter, S., and Witt, R. ( 2005). *The Empirical Economics of Standards*, DTI Economics Paper 12, UK Department of Trade and Industry, London. UK.
- Boyer, K.K.; Leong, G.K.; Ward, P.T., and Krajewski, L.J. (1997). *Unlocking the potential of advanced manufacturing technologies*. *Journal of Operations Management*, Vol. 15, No. 4, 331-347.
- Bromwich, M., and Bhimani, A. (1991). *Strategic investment appraisal management accounting*, 72(9), 45-48.
- Cascio, W. F. (2010). *Managing human resources: Productivity, quality of work life, profits*. McGraw-Hill/Irwin, New York.
- Chen, C. P., Liu, P. L., Tsai, C. H. (2008). *A study of the influence of organizational knowledge ability and knowledge absorptive capacity on organizational performance in Taiwan's hi-tech enterprises*. *Journal of Applied Sciences*, 8(1) 1138-48.
- Chong, A.Y.L., Ooi, K.B., Lin, B.S. and Raman, M. (2009). *Factors affecting the adoption level of c-commerce: An empirical study*, "Journal of Computer Information Systems", Vol. 50, No. 2, pp 13-22.

- Corbett, C., Maria, M.S., and Kirsch, D. (2005). *The Financial Impact of ISO 9000 Certification in the United States: An Empirical Analysis*, *Management Science* 51(7): 1046-1059.
- Cragg, P., and King, M. (1993). *Small firm computing: motivators and inhibitors*. *MIS Quarterly* 17 (1), 47-60.
- Damanpour, F. (1991). *Organizational innovation: a meta-analysis of effects of determinants and moderators*. *Academy of Management Journal* 34 (3), 555-590.
- Djankov, S., and Hoekman, B. (2000). *Foreign Investment and Productivity Growth in Czech Enterprises*, *World Bank Economic Review* 14(1): 49-64.
- Darbanhosseiniamirkhiz, M. and Ismail, W.K.(2012). *Advanced Manufacturing Technology Adoption in SMEs: an Integrative Model*, *Journal of Technology Management and Innovation* vol.7 no.4 Santiago dic. Available: <http://dx.doi.org/10.4067/S0718272420120004009> [Accessed 26 September 2014]
- Dosi, G. 1982. *Technological paradigms and technological trajectories*. *Res. Policy* 11 147-162.
- Ettlie, J.E., Bridges, W.P., and O'Keefe, R.D., (1984). *Organizational strategy and structural differences for radical versus incremental innovation*. *Management Science* 30 (6), 682-695.
- Ezzamel, M., Gwilliam, D. R., and Holland, K. (1996). *Some empirical evidence from publicly quoted UK companies on the relationship between the pricing of audit and non-audit services*. *Accounting and Business Research*, 27(1), 3-16.
- Faria, A., et al. (2002) *Determinants of Adoption of Flexible Production Technologies: Evidence from Portuguese Manufacturing Industry*. *Economics of Innovation and New Technology* 11:6, 569-580.
- Fatoki, O., and Garwe, D. (2010). *Obstacles to the Growth of New SMEs in South Africa: A Principal Component Analysis Approach*. *African Journal of Business Management*, Vol. 4(5), pp. 729-730 -738.

- FDRE, (2002). *“Industrial development strategy” (Amharic version)*. Ministry of information, Addis Ababa
- FDRE, (2010). *Growth and Transformation Plan, 2010/11-2014/15*, Ministry of Finance and Economic Development, Addis Ababa
- Germain, R., Droge, C., and Daugherty, P.J. (1994). *A cost and impact of typology of logistics technology and the effect of its adoption on organizational practice*. Journal of Business Logistics 15 (2), 227–248.
- Grover, V., and Goslar, M.D. (1993). *“The initiation, adoption, and implementation of telecommunications technologies in US organizations.”* Journal of Management Information Systems 10 (1), 141–160.
- Hall, B.H, and Khan, B. (2002). *Adoption of New Technology, New Economy Handbook: University of California*. Available: <http://eml.berkeley.edu/~bhhall/papers/HallKhan03%2520diffusion.pdf> [Accessed 16 October 2014]
- Higgins, J.M. (1995). *“How Effective Innovative Companies Operate: Lessons from Japanese Strategy”*. Creativity and Innovation Management. Vol. 4. pp. 110-119.
- Idris, F., Rejab, R., and Ahmad, A. (2008). *Relationships between Investments in Advanced Manufacturing Technology (AMT) and Performances: Some Empirical Evidences*. European Journal of Economics, Finance and Administrative Sciences, Issue 13, 67-78.
- Idrissia, M. O., Amaraa, N., and Landrya, R. (2012). *SMEs’ Degree of Openness: The Case of Manufacturing Industries*. Journal of Technology Management & Innovation, 7(1), 186-210.
- Khazanchi, S., Lewis, M. W. ,and Boyer, K. K. (2007). *Innovation-supportive culture: the impact of organizational values on process innovation*. Journal of Operations Management, 25 (4), 871.

- Kitchell, S. (1995). *Corporate culture, environmental adaptation, and innovation adoption: A qualitative/ quantitative approach*. Journal of the Academy of Marketing Science, 23(3), 195-205.
- Kothari, C. R. (2005). *Research Methodology Methods and Techniques (2nd ed.)*. India: New Age Publications.
- Lipsey, R., and Carlaw, K. (2004). *Total Factor Productivity and the Measurement of Technological Change*, Canadian Journal of Economics 37(4): 1118-1150.
- Long, S.T., and Freese, J. (2006). *Regression model for categorical dependent variables using stata*. A stata press publication, college station, Texas.
- Mehrtens, J., Cragg, P. B., and Mills, A. M. (2001). *A model of internet adoption by SMEs*. Information & Management, 39(3), 165-176.
- Morone, J. (1989). *"Strategic Use of Technology"*. California Management Review. Vol. 39. pp. 91-110.
- Mowery, D. C., and Rosenberg, N. (1989). *Technology and the Pursuit of Economic Growth*, Cambridge: Cambridge University Press.
- Murad, M.A., and Thomson, J.D. (2011). *Progress in Business Innovation & Technology Management*, External environment factors influencing the technology adoption-diffusion decision in Malaysian manufacturing SMEs: Graduate School of Business and Law RMIT University, Melbourne. Available <http://apbitm.org> [Accessed 29 September 2014].
- Nelson, R., and Phelps, E. (1966). *Investment in humans, technological diffusion, and economic growth*. American Economic Review, 56: 69-75.
- Oates, B. J. (2006). *Researching Information Systems and Computing*: Sage Publications.
- Oliveira, T., and Martins, M. F. (2011). *Literature Review of Information Technology Adoption Models at Firm Level*. Available: <http://www.ejise.com/issue/download.html%3FidArticle%3D705>. pdf [Accessed 11 October 2014]

- Oyelaran-Oyeyinka, B. (1997). *Comparative Advantage in Engineering*. In *Nigeria in 2010*, ed. by Adedotun O. Phillips and S. 'Tunji Titilola. Ibadan: Nigerian Institute of Social and Economic Research.
- Parhi, M. (2008). *Technological Dynamism of Indian Automotive Firms: A Close Look at the Factors Inducing Learning and Capability Building*. Paper presented in the VI Globelics Conference at Mexico City, September 22-24.
- Pearson, M., and Grandon, E. (2004). *E-commerce adoption: perceptions of managers/owners of small and medium-sized firms in Chile*. *Communications of the Association for Information Systems*, 13(8). 81-102.
- Pierce, J.L., and Delbecq, A.L. (1977). *Organization, structure, individual attitudes and innovation*. *The Academy of Management Review* 2 (1), 27-37.
- Pindyck, R.S., and Rubinfeld, D.L. (1991). *Econometric Models and Economic Forecasts*. 3rd Edition Mc-Graw Hill Inc.
- Porter, M. E. (1985). *Competitive Advantage - creating and sustaining superior performance*. Chapter 5. The Free Press, New York.
- Premkumar, G., Ramamurthy, K., and Crum, M.R., (1997). *Determinants of EDI adoption in the transportation industry*. *European Journal of Information Systems* 6 (2), 107-121.
- Premkumar, G., and Roberts, M. (1999). *Adoption of new information technologies in Rural Small Business*. *The International Journal of Management Science* 27, 467-84.
- Ravasi, D., and Schultz, M. (2006). *Responding to organizational identity threats: Exploring the role of organizational culture*. *Academy of Management Journal*, 49 (3), 433-458.
- Rogers, E. M. (2003). *Diffusion of Innovation*, 5th ed. New York: The Free Press.

- Scupola, A. (2003). *The adoption of Internet Commerce by SMEs in the South of Italy: an environment, technological and organizational perspective*. Journal of Global Information Technology Management 6(1), 52-71.
- Sheikh, A.D., Rehman, T., and Yates, C.M. (2003). *Logit Models for Identifying the Factors that Influence the uptake of New Technologies by Farmers in the Rice-Wheat and Cotton-Wheat Farming Systems*. Agricultural Systems 75, 79-95.
- Simpson, M., and Doherty, A. J. (2004). *E-commerce adoption support and advice for UK SMEs*, Journal of Small Business and Enterprise Development, 11(3), 315-28.
- Sinha, R.K., and Noble, C.H. (2008). *The adoption of radical manufacturing technologies and firm survival*. Strategic Management Journal, Vol. 29, Issue 9, 943-962.
- Schmookler, J. (1966). *Invention and Economic Growth*. Harvard University Press, Cambridge, MA.
- Spanos, Y. E., and Voudouris, I. (2009). *Antecedents and trajectories of AMT adoption: The case of Greek manufacturing SMEs*. Research Policy, 38 (9) 144-155.
- Sun, H. (2000). *Current and future patterns of using advanced manufacturing technologies*. Technovation, Vol. 20, No. 11, 631-641.
- Swink, M., and Nair, A. (2007). *"Capturing the competitive advantage of AMT: Design-manufacturing integration as a complementary asset."* Journal of Operations Management, Vol. 25, No. 3, 736-754.
- Venkatesh, V., Brown, S.A., and Bala, H. (2013). *Bridging the qualitative-quantitative divide: Guidelines for conducting mixed methods research in information systems*. MIS Quarterly, 37(1), pp. 21-54.
- Wabbi , J.K. (2002). *Assessing Factors Affecting Adoption of Agricultural Technologies: The Case of Integrated Pest Management in Kumi District, Eastern Uganda*  
Available: [http://lumiere.lib.vt.edu/sample\\_theses/submitted/trash/etd-12182002-225624/restricted/etd](http://lumiere.lib.vt.edu/sample_theses/submitted/trash/etd-12182002-225624/restricted/etd) [Accessed 17 October 2014]

- Waldeck, N. E., and Leffakis, Z. M. (2007). *“HR perceptions and the provision of workforce training in an AMT environment: an empirical study.”* OMEGA: An International Journal in Management Science, 35(2), 161-72.
- Williams, L.R., (1994). *“Understanding distribution channels: an inter organizational study of EDI adoption”*. Journal of Business Logistics 15 (2), 173–203.
- Woodside, A. G. and W. G. Biemans (2005). *“Modeling Innovation, Manufacturing, Diffusion and Adoption/Rejection Processes.”* Journal of Business and Industrial Marketing 20:7, 380– 393.
- Zammuto, R., and O’Connor, E. (1992). *Gaining advanced manufacturing technologies’ benefits: the roles of organization design and culture.* Academy of Management Review, Vol.17, No.4, 701-728.  
Available: <http://links.jstor.org/sici?sici=03637425%28199210%2917%3A4%3C701%3AGAMTBT%3E2.0.CO%3B2-K> [Accessed 10 October 2014]
- Zealelem T., and Getachew H. (2002), *“TQM and the planning behaviour of SMEs in developing economies”*, the TQM magazine, Vol. 14 No.3, pp.181.

## Appendix I- Result using probit model

*Table 1 Probit regression for soft technology adoption*

Variable	Coefficient estimate	P-Value	Marginal Prob. ( dy/dx)	P-Value	X
_cons	-5.434	0.000			
<b>Internal factors</b>					
Age	-0.027	0.384	-0.011	0.385	11.443
Size	1.067***	0.059	0.399	0.029	0.253
Own	0.536	0.420	0.210	0.401	0.203
Cert	0.668	0.289	0.260	0.260	0.253
HRs	1.507****	0.003	0.521	0.000	0.696
Mgts	0.154	0.734	0.061	0.733	0.646
Finas	1.487****	0.005	0.516	0.000	0.696
<b>External factors</b>					
Comps	1.827****	0.002	0.594	0.000	0.709
Custms	0.556	0.281	0.216	0.261	0.709
supps	0.568	0.280	0.220	0.256	0.709
Gvts	0.710*	0.142	0.274	0.120	0.633
Envts	0.619	0.208	0.240	0.190	0.658

Note: '\*', '\*\*', '\*\*\*' and '\*\*\*\*' are significant at 15%, 10%, 5% and 1% level respectively.

*Table 2: Probit regression for hard technology adoption*

Variable	Coefficient estimate	P-Value	Marginal Prob. (dy/dx)	P-Value	X
_cons	-5.115	0.003			
<b>Internal factors</b>					
Age	-0.011	0.763	-0.002	0.771	11.443
Size	1.804****	0.003	0.512	0.008	0.253
Own	0.714	0.293	0.176	0.401	0.203
Cert	1.254***	0.038	0.333	0.103	0.253
HRh	1.097*	0.152	0.182	0.068	0.646
Mgth	0.097	0.854	0.019	0.853	0.684
Finah	1.071**	0.124	0.184	0.100	0.620
<b>External factors</b>					
Comph	0.536	0.318	0.099	0.293	0.595
Cusmh	0.328	0.596	0.060	0.561	0.684
Supph	0.288	0.579	0.053	0.569	0.671
Gvth	1.101*	0.145	0.189	0.082	0.620
Envth	0.448	0.378	0.084	0.382	0.595

Note: '\*', '\*\*', '\*\*\*' and '\*\*\*\*' are significant at 15%, 10%, 5% and 1% level respectively.

## Appendix II -Survey questionnaire

### ADDIS ABABA UNIVERSITY SCHOOL OF GRADUATE STUDIES

#### Department of Public Administration and Development Management

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

This research questionnaire is in support of fulfilling the Masters Research study; new technology adoption by Ethiopian manufacturing firms.

The researcher will use the information provided in this questionnaire for analysis and discussion of findings. The outcome of this study should help fellow academics and vendors to understand critical factors for the adoption of new manufacturing technology in micro, small, medium and large manufacturing firms.

The researcher will respect the information with strict confidentiality and used only for academic purpose.

#### General Description for completing the questionnaire

The following guidelines will assist you in answering the questions to follow:

- Technology is, defined on this study as, the knowledge, products, processes, tools, methods, and systems employed in the creation of goods or in delivering service.
- It is important that you complete the questionnaire by answering **ALL (Section A, B and C)** questions with sincere honesty.
- Kindly, do not hesitate to explain your true feeling
- Note the instructions for specific type of questions carefully. Instructions will be provided below the main heading of the section and also after a specific type of question. This will guide you to answer the questions more efficiently and effectively.

The questionnaire should not take more than **30** minutes of your time to complete.

*Thank You In Advance for Sparing Your Precious Time to Fill This Questionnaire*

*Yours sincerely*

*Kumlachew*

**SECTION A: General information about you and your firm**

Place a “√” next to the answer that best describes your response.

1. Gender: Female  Male
2. Your title/position in the firm \_\_\_\_\_
3. Your educational background:  
 2<sup>nd</sup> Degree  Degree  Diploma  specify if other \_\_\_\_\_
4. What would best describe the manufacturing sector in which your manufacturing enterprise operates?  
 Textile and apparel  leather and leather product
5. Ownership of your company:  
 Domestic owned  Foreign owned
6. Which would best describe your organization ownership structure?  
 Sole proprietorship  Cooperatives  PLC  Other \_\_\_\_\_
7. How many years has your enterprise been operating? \_\_\_\_\_
8. How many employees do you have?

Number of employees	“√”
More than 200	
51-200	
10-50	

9. Have you got certificate from international organization like ISO1400, ISO 9000

Yes  No

**SECTION B: Benefit of manufacturing technology and its adoption status of the firm**

10. which of the following best describes features that manufacturing technology should deliver to your firm? You can “√” more than one choice, if applicable.

Features of manufacturing technology	“√”
To improve product and process quality	
To meet customer demand	
Increase productivity	
Enhance competitive advantage	
Increase profitability	
To extend the market	
Cost reduction	
Survival	
Competitive price	
reduction of lead time	
Enhance delivery capability	

If you have other features other than listed above, Specify on the space provided

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11. Did your firm currently installed new soft manufacturing technology like enterprise resource planning (ERP), total quality management (TQM), or computer aided design (CAD)

Yes

No

12. Did your firm currently installed new hard manufacturing technology like computer aided manufacturing (CAM), Group technology (GT), or Flexible manufacturing systems (FMS)

Yes

No

**SECTION C: Factors affecting technology adoption in your firm**

13. Which factors influence your firm to adopt new manufacturing technology?

Factors	To adopt soft technology		To adopt hard technology	
	Yes	No	Yes	No
Competition				
Customer demand				
Human resource technical skill				
Supplier of the technology				
Top management commitment				
Environment sustainability				
Availability of finance				
Government support				

For question 14 and 15; Place “√” on the table that the best describes your answer using the likert scale on 1to 5. The Scale represent as the following: 1= not at all influential, 2 =slightly influential, 3 = somewhat influential, 4 = very influential and 5 = extremely influential

14. Which factors considered as the critical success factors that influence technology adoption process in your organization?

Success factors	To adopt soft technology					To adopt hard technology				
	1	2	3	4	5	1	2	3	4	5
Openness innovation culture										
Open communication system										
Availability of resources										

Top management support and involvement										
Employee training and education										
Clear and systematic direction in planning										

List other success factors that enable your technology adoption process on the space provided

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15. Which of the following factors inhibits technology adoption process in your organization?

Barriers to Technology Adoption	To adopt soft technology					To adopt hard technology				
	1	2	3	4	5	1	2	3	4	5
Resistance to change										
Lack of government support										
Availability of budget										
Lack of technical supporting services										
Lack of strategic perspective										
Lack of skilled worker										

List other barrier that made your technology adoption process difficult on the space provided

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