Addis Ababa University

Addis Ababa Institute of Technology

School of Mechanical and Industrial Engineering

Post Graduate Program in Mechanical Engineering

MSc in Industrial Engineering

A Research on:

Enhancing Competitiveness through Technological Capability development of Metal and Engineering Enterprises

(Case: Small and Medium Enterprises in Addis Ababa, Arada Sub-City Administration)

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Presented for partial Fulfillment of the Requirements for the Degree of Master of Science in Mechanical Engineering (Industrial Engineering)

June 2024,

Addis Ababa, Ethiopia

Declaration

This is to witness that this thesis entitled Enhancing Competitiveness through Technological Capability development of Metal and Engineering Enterprises (Case: Small and Medium Enterprises in Addis Ababa, Arada Sub-City Administration) submitted in partial fulfillment of the requirements for the award of the degree of M.Sc. School of Mechanical and Industrial Engineering, Addis Ababa University done by Mrs. Tamrnesh Tadesse under my guidance. The work contained in this thesis has not been previously submitted for a degree or diploma at any other higher education institutions to the best of my knowledge and belief.

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AKNOWLEDGEMENT

Before and above all, I would like to thank the Almighty God and his Mother for giving me the strength and courage to accomplish this work.

My deepest gratitude goes to my advisor, Dr. Ermias Tesfaye, for his constructive feedback, valuable comments, and continuous encouragement during this research project.

Special thanks to the owners' and employees of SME's in Arada Sub-city Metal and Engineering Sector and all experts who support me by providing the necessary information and documents.

Endless thanks go to my mother, Menbre Abonhe, my sister, Hiwot Tadesse, and my husband, Abraham Zerihun, who were always with me throughout my studies.

Abstract

Technological capability plays an enormous role in firm improvement and getting competitive in the marketplace. The actual technological capacity of Ethiopia's metal industry is incredibly low. Because of this shortcoming, the sector cannot import substitutes as intended, even though it cannot adopt, improve, reengineer, and disseminate them to other similar industries at the desired level for the nation. Therefore, the study's main objective is to enhance the competitiveness of small and medium metal and engineering enterprises (SMMEEs) in Arada sub-city by developing technological capabilities. We employ qualitative and quantitative study approach to achieve this. Both primary and secondary data collection methods are used to gather information through observation, focus group discussions, and different literature and reports. We next apply system dynamics to analyze the data obtained so that we can understand the causal elements affecting competitiveness through technological capability. Vensim software is used to carry out the simulation. The simulation period is 10 years, and we also use the descriptive analysis method.

The analysis indicates that the competitiveness of small and medium metal and engineering enterprises in the Arada sub-city is determined by technology transfer which affected by level of technology, their network and organizational learning capability, research and development which is influenced by their level of education, international market linkage which is affected by the market innovation ,demand condition and competitors', organizational condition which is influenced by their existing knowledge financial capability ,investment and their commitment , innovation which affected by product and technology innovation, obsolescence rate and r and d characteristics , and financial capability which affected by inflation , investment and investment knowledge possibility. This study also revealed a lack of technology transfer practices, poor international market linkage, no use of research and development, and a lack of organizational vision for the development of technology. The competitiveness of the metal and engineering sectors in Arada Sub City is found to be unsatisfactory.

Finally the system dynamic model shows the causal elements affecting competitiveness through technological development. And working on these elements can indeed foster the competitiveness.

Key words: Competitiveness, Technological Capability, Small and Medium enterprises (SMEs), Metal and Engineering sector, System Dynamics

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Acronyms

AACA	Addis Ababa City Administration
AAAJEIDB	Addis Ababa Administration Job , Enterprise and industry Development Bureau
ASCA	Arada sub-city Administration
ASCJEIDO	Arada sub-city Industrial development office
BMEI	Basic Metal and Engineering Industry
CIP	Competitiveness Index Performance
EDRI	Ethiopia Development Research Institute
FC	Financial capability
FDRE	Federal Democracy republic of Ethiopia
GCI	Global Competitiveness Index
GDP	Gross domestic product
GTP	Growth and Transformation Plan
OC	Organizational Conditions
OECD	Organization for Economic Co-operation and Development
R&D	Research and Development
SD	System Dynamics
SME	Small and Medium enterprises
SSA	Sub-Saharan Africa
SPSS	Software Package for Social Sciences
TC	Technological capability
TCD	Technological capability development
TJ	Technological Trajectory
TT	Technology transfer
UNDP	United Nation Development Program
UNIDO	United Nations Industrial Development Organization
WEF	World Economic Forum
WHO	World Health Office

1. Introduction

1.1 Background and problem justification

In the majority of industrialized and developing nations, small and medium-sized businesses (SMEs) have emerged as one of the most important tools for addressing social and economic issues as well as achieving development goals. its significance for the expansion of production and its crucial relationship with the many productive sectors of society have therefore grown. (Elasrag, 2017).

Our world has undergone tremendous transformation in the previous few years due to a significant socioeconomic issue. This process, which includes the markets becoming more global and the economy becoming more international, is putting sectors all over the world in a position where fierce global competition is the rule. The imperative to consistently innovate, develop, and adapt in response to intensifying competitive constraints has emerged as a fundamental component of organizational excellence. The majority of industry observers concur that successful competition depends on innovation. (Tidd et al.; 2001, Brown; 1997, Davenport and Bibby; 1999). Simultaneously, scholars studying sustainable competitive advantage have concluded that developing Core Capabilities and, when it comes to innovation, Technological Capabilities, is one of the key factors that gives a company a sustained edge. In order to comprehend the relationships between technological capabilities and the long-term dynamism of a particular industrial sector, studies have rarely included the idea of Technological Capabilities (TCs). The majority of the latest ones have defended various technical capacities (TCs) and talked about how they affect a company's ability to compete. Nonetheless, every study either uses organizations from developed nations or samples of businesses from a variety of industrial sectors, the majority of which are focused on technology. For a particular industry, particularly in small and medium industries, no research has yet been conducted. In the new globalized marketplaces, mature, labor-intensive industries like the metal and engineering industry struggle to thrive, particularly in the wake of China's explosive entry.

The competitiveness notion encompasses various disciplines, as noted by Waheeduzzaman and Ryans (1996). These disciplines include the comparative advantage and/or price competitiveness perspective, the strategy and management perspective, and the historical and sociocultural views. Depending on how we approach the problem, competitiveness can alternatively be viewed as an in-

dependent, dependent, or intermediary variable. The range of techniques and levels truly illustrates how versatile this idea is.

Ethiopia's overall competitiveness level is low. For the year 2019 alone, it ranked 126th out of 140 countries and its score below the African average on export diversification, productivity and technological upgrading (WEF, 2019). UNIDO's CIP index put Ethiopia 134 on the rank from 152 countries (UNIDO, 2020) Similarly Global Competitiveness Index defined by World Economic Forum put Ethiopia in 108th place from 137 countries (GCI 2017/18). This shows Ethiopia is at the bottom rank in competing with the world.

Increasing competition forces companies to devise strategies to become more competitive in the dynamic global market. Those businesses and organizations can become more competitive by increasing the efficacy of their systems (Mureithi, 2013).

The aim of this research is to enhance the competitiveness of small and medium enterprises in the metal and engineering sector in the case of Arada sub city by developing their technological capability. Through developing technology capability, it is possible to develop an improved model using system dynamics.

1.2 Problem statement

Ethiopia is in the process to be a member of the World Trade Organization plus we sign the agreement of Africa Countries Free Trade Area (AfCFTA) for this and other globalization reasons our enterprises competitiveness is a matter of survival. According to Habtamu and Gashaw (2015), competitiveness is determined by the productivity with which a nation uses its human, capital, and natural resources. The idea that the metal and metal products sector may boost foreign exchange profits by promoting exports of standard quality, create jobs and income, and facilitate technological transfer underpins the industry's significance.

The majority of developing nations undervalue the role that businesses play in generating money, productivity gains, employment opportunities, and the advancement of technological capabilities. According to Tigabu et al. (2018), the engineering and metals sector is plagued by excessive workforce turnover, low productivity, and an inability to implement the desired structural transformation.
Major bottleneck of the so-called enhancing competitiveness in most SME is connected with the existence of slow growth both in output and employment. Mishra, M. K. (2018), explained that the characteristic of manufacturing sector. Currently the metal industry cannot substitute imported products and also cannot export metal products as it intended. Even we cannot adopt, improve, reengineer, and disseminate to other similar industries at the desired level, especially in the metal industry (Gulelat Gatew, 2011). Based on its reports and discussion with the experts of Arada sub-city also shares these challenges. The problems and challenges are running on the ground that enterprises are complaining frequently citing their failure to stay competitive on in the industry.
According to the ASCJEIDO 2015E.C report, there are more than 101 businesses in the Arada sub city that deal with metal and metal products. The goods produced remain meager. Despite the abundance of stories, there aren't many systematic researches to identify the variables linked to enterprise performance in the industry. The underwhelming performance of the fundamental metals engineering sectors highlights the need for more research into the variables influencing their competitiveness. Prior research has demonstrated that SME's in developing nations, particularly those in the metal engineering industry, can increase their competitiveness by utilizing quick and affordable production methods.

Therefore, this study is purposed to identify factors of technological capability which influence competitiveness of small and medium metal and engineering in Arada Sub-city to show the role of

technological capability in enhancing competitiveness of metal and engineering enterprises and develop comprehensive model of SMEs competitiveness, especially for metal and engineering sectors in Arada Sub-city. Even if the problem is so serious, the scientific and systematic investigations on the issue are too few, if any they lack comprehensiveness or have a methodological limitation.

1.3 Research questions

The general research question of this paper emphases on enhancing competitiveness of Small and Medium Enterprises in Metal and Engineering sector in Arada sub-city through developing technological capability.

The specific questions are:

- What are the factors that determine competitiveness through technological capability of small and medium enterprises in Metal and Engineering sector?
- What is the causal relationship to develop technological capability that can foster competitiveness of small and medium enterprises in the Metal and Engineering sector in Arada sub-city?

1. 4. The Objectives of the Study

1.4.1 General objective

The overall objective of this study is to enhance competitiveness of Small and Medium Metal and Engineering Enterprises (SMMEE's) in Arada sub-city by improving technological capability.

1.4.2 Specific objective

- To identify the factors of competitiveness of small and medium metal and engineering enterprises through technological capability
- To examine the causal relationship to develop technological capability that can foster competitiveness of small and medium enterprises in the Metal and Engineering sector in Arada sub-city?

1.5 Significance of the study

From this study, Arada Sub-city will be benefited from the improvement opportunities for its metal and engineering sector in the maximization of its productivity and competitiveness. Hence this will enable the sub-city to build structural frame work for its SME's competitive advantage. Likewise, the Enterprises will also be benefited from this study in a way that enhancing their capacity to generate profits over time that allow the business to prosper while simultaneously meeting demand needs in terms of price, quality, and quantity

In addition to these, this study will be helpful to primarily gain an empirical and extensive knowledge about competitiveness of SME's in metal and engineering sectors of Arada sub-city. The output of the study can also be used by other researchers and students as an input for further studies in similar or different business sectors related to competitiveness.

1.6 Scope and limitation of the study

Thematically, this study focused on small and medium metal and engineering enterprises with respect to enhancing competitiveness through technology capability. Geographically, the study covered Arada Sub City only.

Regarding the study's limitations, it was challenging to locate respondents who were willing to participate in the focus group discussion in order to gather data more broadly by contacting all relevant potential stakeholders and SME's in every sector of the Arada sub city within the allotted time frame. Although the scope of this research is restricted to Arada sub city SME's in the metal and engineering sectors, the findings may not accurately reflect the performance of SME's throughout the city of Addis Ababa. Nevertheless, the study made an effort to create representative samples for the research population within Arada, the target sub city.

2. Literature review

2.1 Introduction

Small and medium-sized businesses, or SMEs, are important to most economies, especially those in developing nations. The majority of enterprises globally are SMEs, and they play a significant role in both the creation of jobs and the expansion of the world economy. Approximately 90% of businesses and over 50% of jobs globally are held by them. In emerging economies, formal SMEs account for up to 40% of GDP. When informal SMEs are taken into account, these figures rise dramatically. (World Bank).

However, the International Trade Center (2018) claims that a variety of issues seriously impair the market and financial performance of SMEs in the majority of developing nations. Small and Medium-Sized Enterprises (SMEs) are a vital component of the global economy and one of the main forces behind innovation, employment growth, and economic progress. Like many SMEs in underdeveloped nations, African SMEs are less productive and frequently face obstacles to survival and expansion. But higher productivity among SMEs is a prerequisite for future growth.

Small local markets, the entry of numerous companies into their markets with occasionally superior products, the lack of developed regional integration, and extremely challenging business conditions—such as onerous official procedures, inadequate infrastructure, questionable legal systems, and unappealing tax regimes—are the main reasons why SMEs are weak in Africa. In other words, a lot of businesses continue to be small, unofficial, and rely on basic technology that doesn't use a lot of the country's infrastructure. They are unable to compete in the market because of this issue. (Chosniel et al 2014).

The Micro and Small Enterprises Development Agency (FeMSEDA) was founded in Ethiopia the next year after the country's Micro and Small Enterprises Development Strategy was prepared in 1997. Through the development of suitable laws and regulations, the creation of incentives like tax exemptions, the encouragement of partnerships like joint ventures, the provision of entrepreneurship training, and the enhancement of access to sufficient technology, markets, information, financing, and other resources, the strategy seeks to improve the business environment for micro and small enterprises.

2.2 Theoretical review

2.2.1 SME's definition in Ethiopia

The definitions of micro and small enterprises vary throughout nations. According to the Ethiopian government, small and medium-sized businesses are "small manufacturing industry" refers to a business that employs between six and thirty people, including the owner, his family, and other workers, and has a total capital, excluding buildings, of between Birr 100,001 and Birr 1,500,000 (one hundred thousand one Birr to one million five hundred thousand Birr); (Federal Negarit Gazette, 2016)

"Medium manufacturing industry" refers to an industry that employs between 31 and I00 workers, including the owner, his family, and other employees, and has a total capital, excluding buildings, from Birr 1,500,001 to Birr 20,000,000 (One Million Five Hundred Thousand One Birr to Twenty Million Birr) in the manufacturing sector; (Federal Negarit Gazette, 2016)

2.2.2 Definition of Competitiveness

The ability to successfully compete with other businesses, nations, organizations, etc. is the definition of competitiveness according to the Cambridge Dictionary.

Competitiveness is described as a multifaceted, multidimensional, and multilayer notion by Krugman (1994). In an increasingly open and linked global economy, competitiveness has emerged as a key challenge (Chosniel et al 2014). According to Porter (1990), the idea is the company's capacity to draw in and keep employees who enhance its chances of gaining a competitive edge.

According to Greenwald and Kahn (2005), a firm's competitiveness can be defined as its capacity to fight for resources, markets, and income. According to Jorge Morales Pedraza, competitiveness can also be defined as the capacity to succeed in the face of competition. The ability to provide goods that satisfy customer demands in terms of price, quality, and quantity while also generating steady profits over time that support the company's growth would thus be considered competitiveness.

The ability of a nation to expand its market share both domestically and internationally while creating industrial sectors and activities with higher value added and technological content is known as industrial competitiveness, according to UNIDO (2012–13).

2.2.3 Definition of Technological capability

The definition of technological capability is Capacity to adjust or absorb technology imported from abroad and to join the extra and distinct resources required to oversee and put to beneficial utilize the newly obtained technology" (Aw & Batra, 1998 as cited in Mulugeta, A). According to Saadi, I. A., & Che Razak, R. (2019) In the twenty-first century, technological ability has become an increasingly important component in achieving an organization's many triumphs. A company's technological capabilities are the cornerstone of its long-term competitive advantage, as personnel possess both valuable and difficult-to-replicate production skills and technology awareness. In order to give businesses, industries, and even nations a competitive edge, technological competency, or technological capability, is strategically important (Lall, 1990).

Jin J. & Von Zedtwitz M. (2008), To effectively employ technical knowledge and skills, not only to develop and enhance goods and processes but also to advance current technology and create new knowledge and skills in response to a competitive business environment, is what is meant to be understood as technological capability.

2.2.4 System Dynamics and its methods

System dynamics is primarily introduced as a modeling technique by Jay Forrester (1961) in his landmark book, Industrial Dynamics. Since then, much progress has been achieved, and it is now a useful tool for representing, analyzing, and comprehending the dynamic behavior of complex systems in order to make decisions pertaining to strategy and policy. (Tesfamariam & Lindberg, 2005). In general, the word "dynamic" refers to something that is "in motion" or "changing over time." The factors that define dynamic problems are those that fluctuate significantly over time. "Reality" or some facets of reality are referred to as systems. A "collection of interrelated elements, forming a meaningful whole" is one definition of a system. Barlas, Y. (2007).

SD Modeling

Systems thinking is closely related to the System Dynamics approach. J. W. Forrester developed this technique at the MIT Sloan School of Management in Boston towards the close of the 1950s (Sterman, J. (2000)). System Dynamics analysis starts with a mental model that develops into a casual loop diagram. The system model is formalized using the diagrams. Meadows (1999) states that the goal of the field of systems thinking is to understand and enhance systems. And this study examines

how SME's might enhance their technological capacity to remain competitive. System thinking tools allow us to have an insight into the interactions between technological capabilities variables that form a given system in order to be competitive. These require the ability to notice and locate actions, as well as changes in system structures that result in essential and long-lasting effects.

Stocks and flows are fundamental to the dynamics of systems. The term "stock" refers to an accumulation, integration, or level, drawing on terms from several domains. The amount in the stock is altered by the flow. A statement that explains how the stock value in relation to a goal controls the flow is what determines it. These two types of concepts—stocks and flows—make up all systems, everywhere. Forrester, J. W. (2009)

Y. Barlas (2007). Add a few conventional stages from a system dynamics study. The general steps can be summed up as follows, while there may be modifications based on the type of problem and the modeler's style.

Problem identification and definition (purpose) :- The goal of a system dynamics project is to investigate a dynamic issue, either theoretical or applied. For the project to be successful, a relevant dynamic feedback problem must be chosen and articulated.

Dynamic hypothesis and model conceptualization:- Creating a theory or hypothesis that explains the reasons behind the problematic dynamics is the aim of this step.

Formal model construction: This stage involves constructing the formal simulation model. The following steps are involved in this:

- ✓ Build the model's structure and the stock-flow diagram.
- ✓ Describe all variables' cause-and-effect relationships mathematically.
- ✓ Calculate the initial stock values and parameter values in numerical form.
- ✓ Examine the model's internal consistency in comparison to the dynamic hypothesis (verification).

Model credibility (validity) testing:- Does the model adequately capture the true issue in relation to the goal of the study? There are two components to model credibility: structural and functional. Is the model's structure a meaningful description of the actual relationships found in the problem of interest? Furthermore, in terms of behavior, how closely do the dynamic patterns produced by the model resemble the actual dynamic patterns of interest?

Analysis of the model:- The goal of this step is to comprehend the key dynamic features of the model; this can rarely (and sometimes only partially) be accomplished through mathematical or analytical techniques. While it is mathematically impossible to find the solution equations for system dynamics models, it is sometimes possible to identify the levels of constant equilibrium and ascertain their stability.

2.3. Empirical review

2.3.1 General factors affecting competitiveness through technology capability development

According to Gao (2003) technological capability development is affected by three groups of factors:

- **R&D characteristics:-** Improvements in technological capabilities are particularly impacted by R&D features including the center of R&D, amount and timeliness of contributions, human resources in R&D, and engagement with the information frontier. Exclusive innovation is more likely to advance when research and development (R&D) has early beginnings, high levels of speculation, high-quality human resources, close collaboration with the information frontier, and a greater focus on knowledge incentive technology.
- **Organizational conditions: -** Organizational conditions including criticality, clarity, and resources in developing limiting technology directly impact R&D characteristics. R&D qualities that are more conducive to the evolution of technological capabilities are more likely to result from high criticality and high certainty.
- **Environmental conditions: -** Environmental factors like local market engagement policies, technology exchange policies, industrial coordination tools for technology advancement, and industrial coordination components for market access directly impact organizational conditions for technological capability enhancement.
- **Time: -** allows for the distinction of capability accumulation time-scale variations between functional domains and firms. The time (years) it takes a company to acquire a certain level of capability for particular technological functions is known as the rate (or pace) of capability development (Figueiredo, P. N., 2008).

There are hardly any works of literatures related to enhancing competitiveness of small and medium metal and engineering enterprises through reverse engineering. But according to Kim, L. (1999) the

major determinant of industrial competitiveness is technological capability. Focusing on technological capability development that directly affects can also be a means to enhance competitiveness. Here, technological capability is defined as the capacity to manage and effectively utilize newly acquired technology by incorporating the additional and distinct resources required for its assimilation and adaptation from foreign countries. Some factors that influence technological capability development is acquired from 9 works of literatures and the critical is identified.

Aw, B. Y., & Batra, G. (1998) emphasize the significance of firms' own investments in technological capability; the research also highlights the critical role of firms and suggests that firm-level efforts to obtain international knowledge may have higher payoffs when accompanied by complementary investments in the development of in-house technological capabilities. Based on their methodology, the authors estimate firms' technical efficiency using microdata from Taiwan (China), and they estimate the correlation of a firm's efficiency using a stochastic production frontier model. They proxy firm-level efforts at modifying or adapting technology by spending on R&D and on-the-job training. The relationship between environmental factors, such as laws and regulations, and the speed influence that affects technical efficiency is not explored in the research, though.

Regarding Kim, L. (1999) piece the three components of technological capability are invention, investment, and production. They offer the following five analytical frameworks:

- ✓ Technological trajectory,
- ✓ Absorptive capacity,
- ✓ Technological transfer,
- ✓ Crises constriction and
- ✓ Dynamic learning process

The above analytical framework enables the firms to identify, analyze and prescribe both external and internal elements that may influence the process of building technological capability. However they didn’t consider the speed (rate) of technological learning and transferring prosses affect the capability building as pointed out in the past 30 years or so, the late-industrializing community of scholars has failed to address the issue of the time-scale involved in the process of capability accumulation.

Otto and Wood (1998) state that to remain competitive, industry is continually searching for new methods to evolve their products and to address this need they introduce a new reverse engineering and redesign methodology. Three distinct phases embody their methodology,

- ✓ Reverse Engineering,
- ✓ Modeling and Analysis, and
- ✓ Redesign.

Reverse engineering, the initial phase, has two goals. A product is initially viewed as a "black box," tested within its operational boundaries, and examined in relation to client requirements, anticipated and/or conjectured functionality, product elements, and physical principles. The second stage of the reverse engineering process involves using the real product in both its shape and its function. This sub phase consists of the complete product disassembly, an analysis of the design for manufacturing, additional functional analysis, and the creation of the final design specifications. The creation and application of design models, analysis plans, model calibration, and experimentation are all included in the second stage. The third and final stage of the methodology then initiates product redesign based on the results of the reverse engineering and modeling phases. However, they only consider customer need or the market to adopt some product

Anwar A (1998) also identified 14 steps to reverse engineering on his thesis that can help to inport substitute and knowledge transfer .1) Identification of product, 2) procurement of product, 3) Work environment, 4) Disassembling of product, 5) measurement, 6} identification of materials, 7) Manufacturing Management, 8) machine selection, 9) material selection, 10) fabrication, 11) assembling, 12) testing, 13) feedback,14) Modification. But he doesn’t consider firm’s capability of observing capability; firms condition that if they have the resource and confidence to manufacture the parts and government policy.

A two-part analytical approach for technology transfer in poor nations is presented by Dehaghi and Goodarzi (2011). The technology trajectory and integration in developed and emerging nations make up the first section. The reverse engineering process is covered in the second. Reverse engineering, according to the article, starts the process of redesigning a product by disassembling, analyzing, testing, "experienced," and documenting its functionality, form, physical principles, manufacturability, and assemble ability. The goal of the reverse engineering process is to accurately comprehend and depict a product's current iteration. And on the result of this, inquiries show that, in short run, appli-

cation of reverse engineering method is one of the best solutions to decrease technological gap from that of industrial countries and to meet its mentioned purposes. In general, they illustrate how developing countries transfer technology to fulfill their knowledge gap and how R&D help that process but there are other factors like organizational and environmental conditions that they didn't consider to help the RE process

Omar and Kotabe (2009) in their study they created a demonstration model of the dynamic capability improvement components in Emerging Market manufacturing Firms (EMF). They recognized three dynamic capability improvement instruments: organizational learning, reverse engineering, and manufacturing flexibility. They created theories based on this framework, connecting these mechanisms with firm execution. They too demonstrate model the parts played by administrative utilization of two sorts of government policies: input supporting policies and marketing supporting policies. But they didn't reflect on environmental conditions other than market and organization conditions like policy which has effect on building effective operations and increase flexibility

Madsen, J. B., et al. (2010). They use an empirical framework to catch up the technological frontier and in their analysis integrate the interaction b/n educational attainment and distance to the frontier. The research examines the roles of technology transfer, research intensity, educational attainment, and the ability to absorb foreign technology in explaining cross-country differences in productivity growth. They didn't reflect on factors that influence the "catching up process" other than R&D.

Giachetti, & Lanzolla,(2016). On their article, product technology imitation over the product diffusion cycle, to begin with, they present product diffusion inside a more integrator hypothesis of product imitation. Second, they explore the time to imitation of a modern product technology: their standard theory is that the time to imitation decreases as the product diffusion within the market increments. Third, they expand their prediction by separating by the sort of innovator—i.e., the market leader and a member of the same strategic group—and by the type of product technology—i.e., functionality-defining advances technology and substitute technologies. Although the paper takes after a "multiple technologies–multiple innovators" approach (by testing the imitation timing related to a few things presented by a few firms). They don't consider the technical execution evolution of product technologies over time which may well be a figure that might slow down or speed up the times to technology imitation. They also don't distinguish between producers with in-house R&D divisions and those that outsource their product improvement efforts.

From the above literature Technology capability has 3 elements production, innovation and investment. And building the technological capability may influence by external and internal elements. The studies showed that firms R&D investment, on job training and efficiency has positive correlation, export and level of productivity has also positive relations. The studies also point that, in short run, application of reverse engineering method is one of the best solution to decrease technological gap from that of industrial countries and to meet its mentioned purposes and organizational learning, reverse engineering and manufacturing flexibility had significant impacts on Emerging Market Manufacturing Firm performance. Additionally, organizational learning combined with input supporting government policy upgrading performance, and the combination of manufacturing flexibility and marketing supporting government policies had an inconsequential impact on execution.

From the above 10 papers the following factors are identified.

Table 1 Factors that determine competitiveness of enterprises in Metal and Engineering

No	Factors from literature	Frequency		Rank
1	R&D characteristics,	1,2,3,5,7&8	6	2nd
2	organizational conditions,	1,3,7,8&9	5	3rd
3	on job training investment	2	1	Excluded
4	International linkage(market)	1,2,4,6,7,& 9	6	2nd
5	technological trajectory,	1,3,4,&5	4	4th
6	technological transfer,	3,4,5,6,7 ,8&9	7	1st
7	time to imitation of new product	1	1	Excluded

Therefore, from the several factors identified from literature that influence technological capability that has impact on competitiveness the above 6 is selected as critical. .

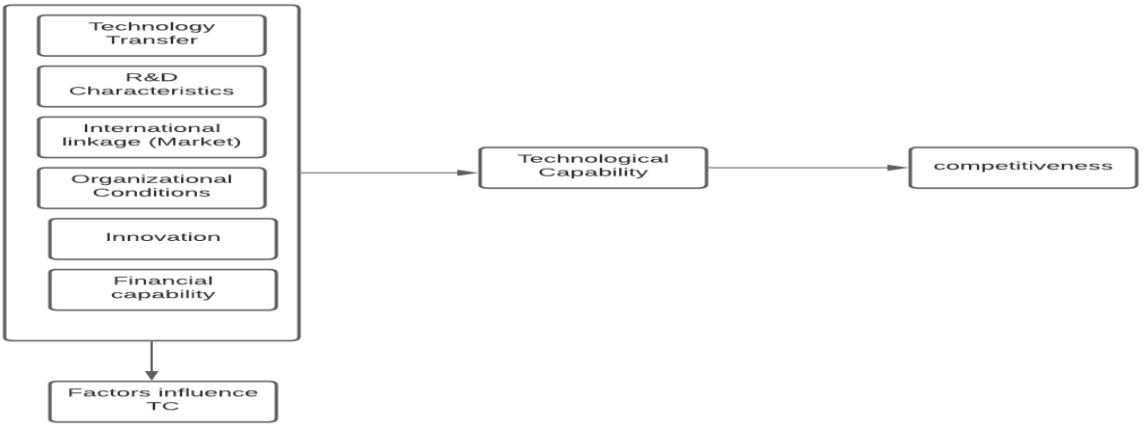

Figure 1 Factors affecting competitiveness on technological capability enhancing

The above literatures try to find and analyze factors affecting competitiveness on technological capability which is Technological Transfer, R&D Characteristics, International linkage (Market), and Organizational Conditions. Some consider organizational conditions and some consider environmental conditions. But they are all agreed on reverse engineering or imitation is important to developing countries in order to catch up on technology. At the current situation our enterprises cannot adopt, improved, reengineered, and disseminated to other similar industries at the desired level, so to improve these situations we first have to work on developing their technological capability that leads to improving their efficiency. Improving efficiency influence productivity improvement. And productive company can compete by adopting, improving, reengineering, and spreading. And to achieve that Innovation and Financial capability is additional factor.

Therefore, this research focused on factors affecting competitiveness and developed a model that fosters competitiveness to enhance their technological capability in the Arada sub city Metal and Engineering sector. This will bring a lasting solution enabling the sub-city to build a structural framework for its SME's competitive advantage. And the Enterprises will also be benefited in a way that enhances their ability to sell products that meet demand requirements (price, quality, quantity) and, overall the study will be helpful to primarily gain an empirical and extensive knowledge about competitiveness of SME's in metal and engineering sectors of Arada sub-city.

3. Methodology

3.1 Research Design

From the above literature we can conclude that Technological capability refers to the capability, which provides to an organization technological strength and gives opportunity to create competitive advantage. Studying this capability in this highly complex and dynamic transitional economy, the market environment changes rapidly, and new products, including both incremental and break-through innovation are introduced into the market at an unprecedented pace. To survive the competition and maintain the competitive advantage, firms must not only exploit their existing capabilities but also develop new ones that are specific to their behavior. Arada sub-city small and medium metal and engineering technological capability development exhibit behavior that cannot be easily captured by linear relationships or equations which makes it complex so we use system dynamics approach to the research.

3.2 Method of Data Collection

Both primary and secondary data collection tools are employed to obtain information from pertinent sources. Data was gathered via focus groups and observation in order to build the study model's variables. The purpose of this approach is to elicit particular data from the respondents. The majority of the examined factors can be measured due to the questions' design, which was created after a thorough assessment of the literature. In addition to identifying the crucial technological capability factors and examining the impact of each factor on small and medium-sized metal and engineering enterprises, it helps to confirm that the factors gathered are, in fact, the ones that affect the Arada sub-city and can be leveraged to improve competitiveness.

The questions also help to understand the firm’s knowledge acquiring processes and the capability of learning and make it their own and their output-based competences or market and try to measure these factors and identify how they influence firm’s capability and to feel the real natural atmosphere of the firms directly. While secondary data in the form of documents have been collected from government offices, TVET College and the enterprises,

3.2.1. Focus group discussion Participants

Focus group discussions were conducted with Manufacturing industry development institute, Ararda sub-city industry development office and Addis Ababa industry development bureau who are direct-

ly involved in development of Small and medium metal and engineering sectors. The FGDs were lead by the researcher, and notes were taken by the researcher and two assistants. The aims of the FGDs were introduced to participants at the beginning of each session. In all sessions, verbal permission was gained to all participate in the FGDs.

3.2.2. Focus group discussion settings

There were 3 focus group dissections conducted. The FGDs were undertaken in the Ararda sub-city industry development office with 6 members of experts, Manufacturing industry development institute office with 5 members of experts and Addis Ababa industry development bureau office with 5 members of experts. All participants FGDs were conducted in their offices meeting areas,

3.3. Method of data analysis

Technical and technological skills required to convert inputs into products are referred to as technological capabilities. From the literature it was found that some main factors influence this ability. These are technological Transfer, R&D Characteristics, International linkage (Market), Organizational Conditions, Technological Trajectory, Innovation and Financial capability. The identified critical factors were analyzed using system dynamics to model the best pattern. System dynamics modeling helps small and medium metal and engineering enterprises to gain insight into the causal factors influencing competitiveness

In addition, the data from the focus group discussion were analyzed qualitatively using narration with theory/ theories and model/s employed for the study as a base.

3.4. Research Framework

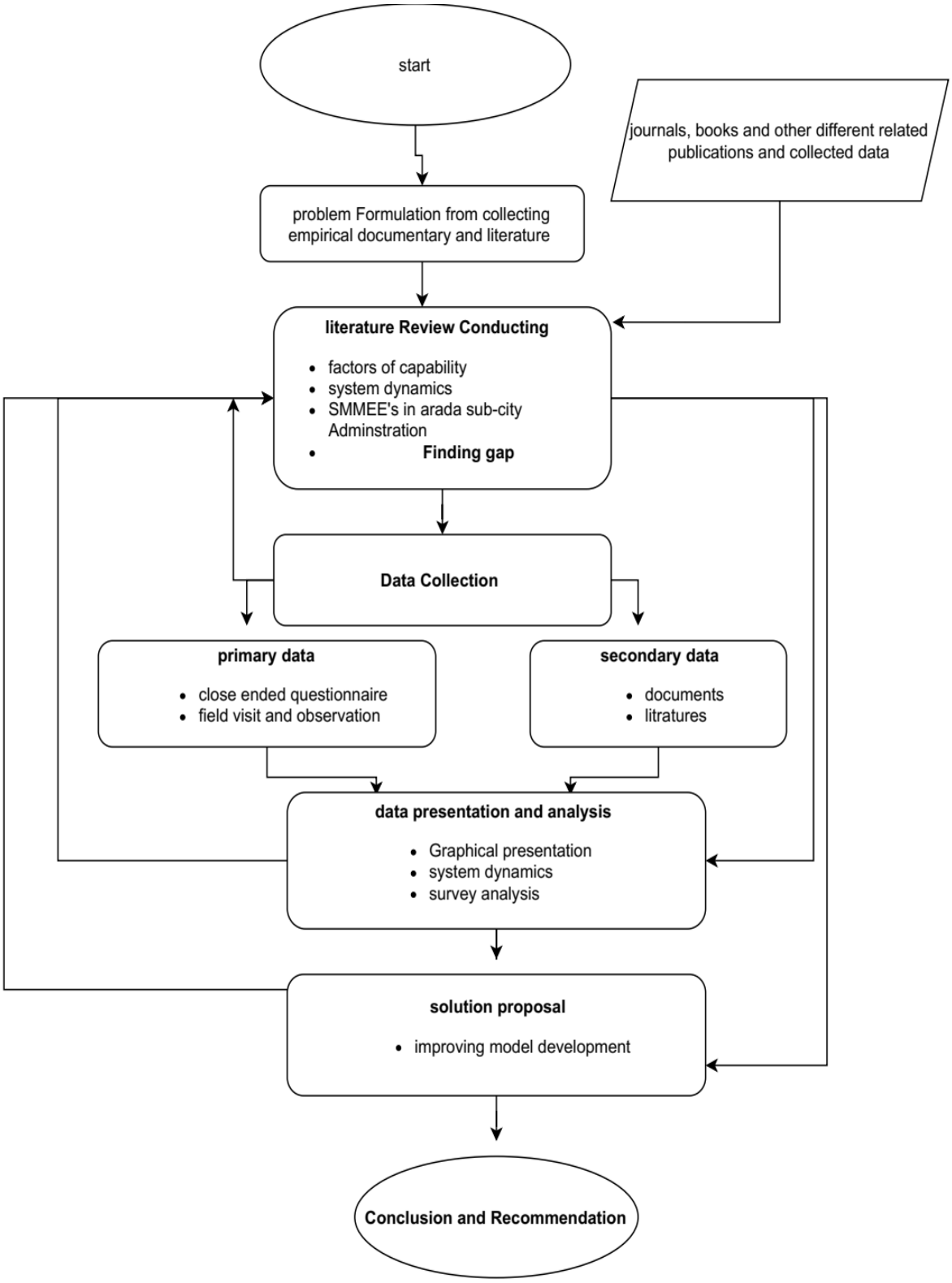

Figure 2 Research framework

4. Data Analysis

The role of small and medium enterprises for poverty reduction and economic growth were understood by the practitioners, policy makers and by the academicians. However, their technological capability is impacted by confluence of factors. Therefore, the central theme of this paper is enhancing competitiveness of Small and Medium Enterprises in Metal and Engineering sector in Arada sub-city through developing technological capability. Hence, this chapter presents the data collected and the analysis carried out based on the methodology described in chapter three. The results are presented below.

4.1 Results

4.1.1 System Dynamics Causal Loop Diagram

The causal linkages between the variables in a system are depicted by the causal loop diagram. In a causal loop diagram, there are two types of causal interactions between the variables. One of them is a negative feedback loop, represented by the sign -, while the other is a positive feedback loop, represented by the symbol +. The system status will rise in the case of a positive feedback loop and fall in the case of a negative feedback loop. Building the stock-flow diagram is made easier by the causal loop diagram, which serves as an early draft of the model architecture. Based on the many activities in each stage of the new product development process, we can create the causal loop diagram of the synergy process.

The creation and assessment of the connection between competitiveness and technological competence are the duties of the concept development stage. Technological capability affecting elements should be understood in order to complete the tasks and can aid organizations in understanding their capabilities. Following the generation of technical competence factors, businesses should make investments in these elements to advance and encourage the use of technology, which boosts their competitiveness. Consequently, the synergy process's causal loop diagram during the concept development stage can be seen as follows.

The task of the technological capability development stage considers other sub factors of the main factors that we came up in the literature part. Technological capability is influenced by innovation which has two types Technological and product innovation can be developed by firms

through R&D characteristics, which is the process of developing and commercializing new ideas, implementing new processes, or changing the way your business makes money. Technological and product innovation includes the ability to develop new products, meet current and anticipated future needs, and adapt to unexpected technological change. (Adler & Shenbar 1990). Additionally, obsolescence rate is the rate at which a technically advanced good or service, even if it is still functional, is no longer required or desired. Generally speaking, technological obsolescence happens when a new product is developed to replace an older model. Obsolescence and innovation have an odd connection, almost like two sides of the same coin. When one thrives, the other is frequently unavoidable. This essay examines the ways in which new technology can render goods, frameworks, or systems out dated, highlighting the complex dynamics of innovation.

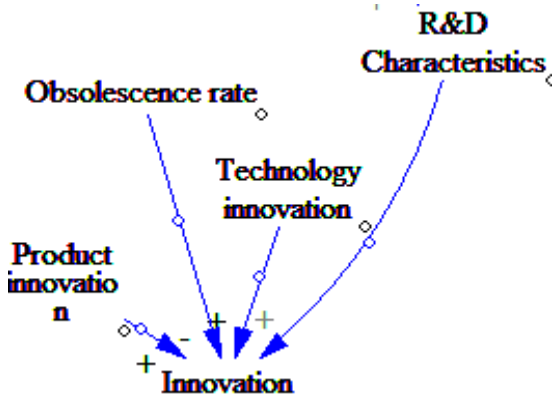

Figure 3 Causal Loop Diagram for innovation

Technological transfer is the other factor which influenced by organization learning capability which is affected by firms' absorptive capability From the perspective of organizational learning absorptive capacity is a limit to the rate or quantity of scientific or technological information and knowledge that an organization can effectively and productively internalize and use. And universities and government research organization gets to be an important source, as industrialization advances in developing countries. Foreign suppliers and unique gear producer buyers frequently exchange basic information to makers to guarantee that the producers' items meet the buyers' technical specifications. Printed data such sales catalogues, blueprints, technical specifications, trade journals and other publications in conjunction with perception of foreign plants serve as critical casual sources of new knowledge for firms in developing nations which is affected by Level of firms' technology their network.

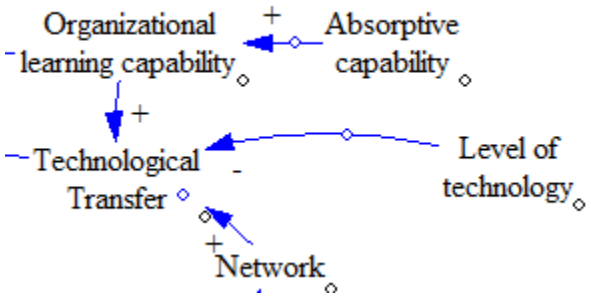

Figure 4. Causal Loop Diagram for technology transfer

according to Kim, L. (1999), capability is acquired through the process of technological learning, the capacity of an organization to learn from experience and experimentation, and effective technological learning requires organizational condition to absorptive capacity or organizational learning, which has two critical components: existing knowledge base and the escalated of effort. To begin with, existing knowledge is a basic component in technological learning, as knowledge nowadays impacts learning forms and the nature of learning to form expanded knowledge tomorrow. Gathering existing knowledge increments the capacity to create sense of, absorb and utilize new knowledge. Second, the other vital component is the intensity of commitment. The intensity of effort refers to the amount of energy relinquished by organizational members to solve problems. It is insufficient simply to uncover firms to the important outside information without applying exertion to internalize it. Learning how to solve problems is ordinarily built up over numerous practice trials on related problems. Hence, it requires significant time and effort coordinated at solving problems early, sometime recently moving on to understanding the more complex problem. The effort escalates interaction among the organizational individuals that in turn facilitates technological learning at the organization.Organization condition can be a product of their existing knowledge, investment, financial capability along with firms learning capability and commitment (intensity of effort).

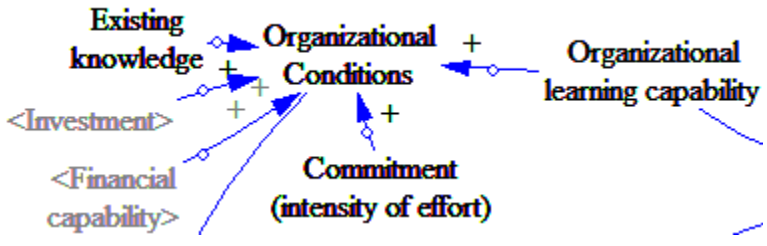

Figure 5 Causal Loop Diagram for Organizational conditions

In order to maintain the organization's financial stability, it is necessary to make investments in sound financial systems in addition to increasing board leadership and governance. This indicates that it is the ability to efficiently manage financial resources based on access, knowledge, and abilities. Services for financial capability are useful in establishing long-term financial security. these words, which are defined as firms' investment knowledge and investment in this study. Inflation has a detrimental effect on financial capability since it raises the cost of goods and materials and may also have an impact on trade expenses. The demand side is also affected; workers may demand greater pay, which increases costs that are then passed on to customers in the form of increased pricing.

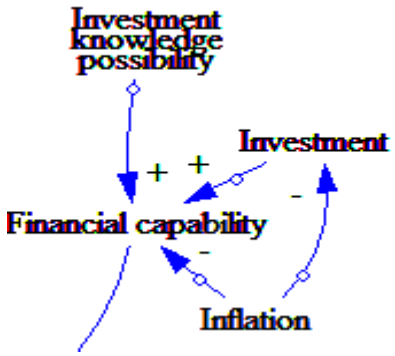

Figure 6 Causal Loop Diagram for Financial capability

Keeping an extensive awareness of all the pertinent alternatives and channels available to you as a marketer while evaluating the impact of technology is crucial for communicating with both current and potential customers. Therefore, demand conditions, market innovation, and their network can all contribute to international market linkage. True market competition is necessary for the entrepreneurial spirit to flourish in a nation. This could be described as a business environment where various companies, both domestically and internationally, are forced to compete with one another only on the basis of the quality of their products and services. These competitors have the ability to take market share away from organizations now or in the future, which could have a negative impact on financial capability.

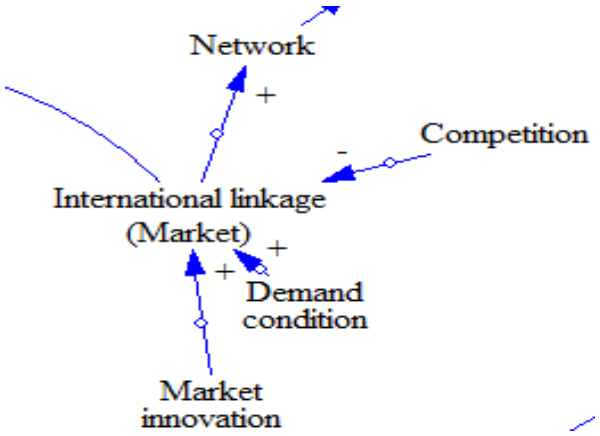

Figure 7 Causal Loop Diagram for Financial capability

The goal of research and development efforts is to help a business innovate new goods and services. One of the key goals of R&D is to help a business stay competitive by developing goods that improve and advance its present product line, which is influenced by the level of education.

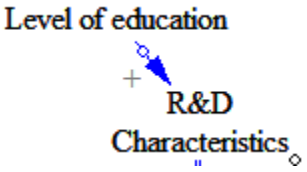

Figure 8 Causal Loop Diagram for Research and Development

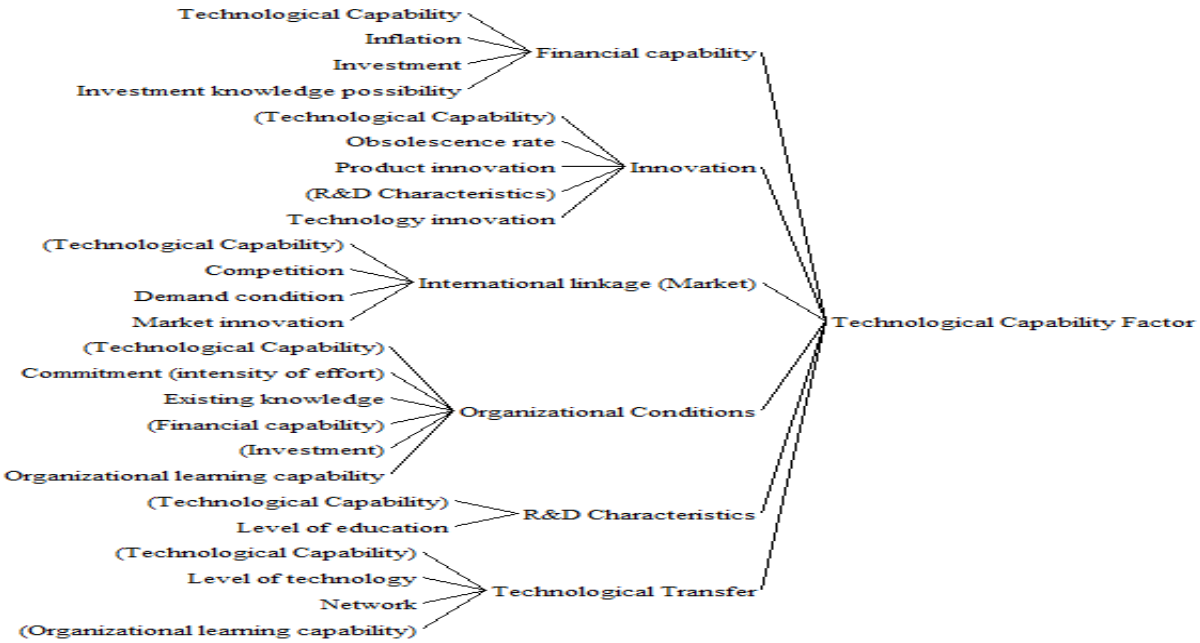

Figure 9 Causal Tree for Technological Capability Factor

all these factors affect the SME technological capability condition which centrals their technological usage, which negatively affected by poor infrastructure, the more they use the more they learn and specialize which help them to be more competitive.

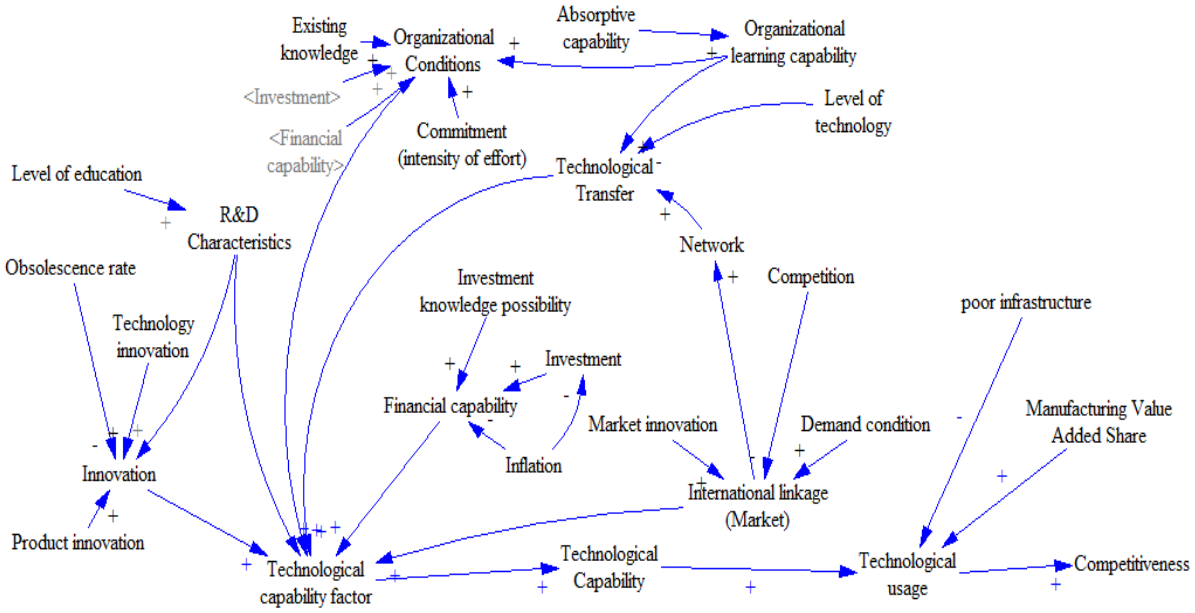

Figure 10 Causal Loop Diagram

4.1.2 Stock-Flow Diagram

The stock-flow diagram, which is based on the causal loop diagram, is the next phase in the system dynamics approach. The computer-executable model is the stock-flow diagram. The primary distinction between the stock-flow diagram and the causal loop diagram is that the latter should have equations to enable simulation, while the former is depicted using arrows. The stock-flow diagram illustrating how technological competence affects a firm's competitiveness can be built using the causal loop diagram shown in Fig. below.

4.1.2.1 Mathematical Formulation

There are three types of variables in the stock-flow diagram, namely stock variable, flow variable, and auxiliary variable. The variable types and initial values of the variables in the three stock-flow diagrams are shown in Table below.

Equations should be used to express the relationship between the variables. Stock development can be used to characterize both technological and competitiveness developments. based on earlier studies. Within the three stock-flow diagrams, we have the equations.

A. Technological Transfer: - according to Kim (1999) firms in developing nations have numerous alternative instruments for obtaining outside technology. Foreign direct investment (FDI), foreign licensing (FL) and turnkey plants are major sources of formal technology exchange. Contract inquires about with local colleges, universities and government research organization gets to be an important source, as industrialization advances in developing countries. Foreign suppliers and unique gear producer buyers frequently exchange basic information to makers to guarantee that the producers' items meet the buyers' technical specifications. Printed data such sales catalogues, blueprints, technical specifications, trade journals and other publications in conjunction with perception of foreign plants serve as critical casual sources of new knowledge for firms in developing nations. In expansion, reverse brain-drain or return of local foreign-trained experts and moonlighting foreign engineers significantly increase the technological learning of firms in developing countries. In the event that firms in developing nations have absorptive capability, they can successfully obtain foreign technology informally without any transaction costs.

Technological Transfer = (Network + Organizational learning capability)/Level of technology*Technological Capability

B. R&D Characteristics: - The primary purpose of conducting R&D alliances is to acquire essential technologies. Such technologies may be any process by which basic understanding, information, and innovations move from universities, research institutions, or government laboratories to firms (Huang et al 2010). Building technological capability depends fundamentally on the firm's own investments in R&D and on the development of human resources and skills, particularly on-the-job training (Aw, B., & Batra, G. 1998). R&D with the characteristics of, high level of investment, early beginning, high quality human asset, profound collaboration with the knowledge frontier, and centering more on knowledge intensive technology are more likely to lead to the advancement of exclusive technology. (Gao, X. 2003)

R&D Characteristics =Level of education*Technological Capability

C. Organizational Conditions: - according to Gao, X. (2003) characteristics of R&D are straightforwardly influenced by organizational conditions such as direness, certainty and assets in creating exclusive technology.

And according to Kim, L. (1999), capability is acquired through the process of technological learning, the capacity of an organization to learn from experience and experimentation, and effective technological learning requires organizational condition to absorptive capacity or organizational learning, which has two critical components: existing knowledge base and the escalated of effort. To begin with, existing knowledge is a basic component in technological learning, as knowledge nowadays impacts learning forms and the nature of learning to form expanded knowledge tomorrow. Gathering existing knowledge increments the capacity to create sense of, absorb and utilize new knowledge. Second, the other vital component is the intensity of commitment. The intensity of effort refers to the amount of energy relinquished by organizational members to solve problems. It is insufficient simply to uncover firms to the important outside information without applying exertion to internalize it. Learning how to solve problems is ordinarily built up over numerous practice trials on related problems. Hence, it requires significant time and effort coordinated at solving problems early, sometime recently moving on to understanding the more complex problem. The effort escalates interaction among the organizational individuals that in turn facilitates technological learning at the organization.

Organizational Conditions= ("Commitment (intensity of effort)" + Existing knowledge + Financial capability + Investment+Organizational learning capability)*Technological Capability

D. International linkage (Market):- As market environments become more dynamic, firm capabilities also require corresponding changes (Malik, & Kotabe, 2009).According to Aw, B. Y., & Batra, G. (1998) findings confirm the positive correlations between exports and the level of productivity found in other developing countries using recently available micro data. Contact with foreign purchasers by itself is associated with higher levels of technical efficiency, particularly in the more modern industries. Some evidence indicates that firm-level export activities have higher payoffs in case they are accompanied by complementary ventures in the improvement of in-house technological capabilities, although this relationship appears to be industry specific.

International linkage (Market) = (Demand condition + Market innovation/Competition) * Technological Capability

E. Innovation: - According to Cirera, X., & Muzi, S. (2020) The Oslo manual defines innovation as "the implementation of a new or significantly improved product (good or service) or process, a new marketing method, a new organizational method in business practices, workplace organization or external relations". Innovation is the motor of the Schumpeterian handle of "creative destruction" where innovative firms and entrepreneurs persistently drive allocative productivity and efficiency development (Schumpeter, 1942). According to Cirera, X, & Muzi, S. (2020), Innovation requires the transformation of knowledge capital or innovation inputs into innovation outputs, such as the introduction of new products or processes, increased quality of existing products or processes, marketing or organizational changes, and patented intellectual property.

Innovation = ((Product innovation + "R&D Characteristics" + Technology innovation) / Obsolescence rate)*Technological Capability

F. Financial capability: - According to Mundy, S. (2011) financial capability is defined as having the knowledge, understanding, skills, motivation and confidence to make financial decisions which are appropriate to one's personal circumstances. The UK's Financial Services Authority distinguished 1 five components of financial capability 1. making ends meet 2. keeping track of your finances 3. planning ahead 4. choosing financial products, and 5. staying informed about financial matter. According to Sen's capability theory (1993) cited in Çera, G et al (2020)., Financial capability is the ability of individuals to manage their financial affairs when they possess the appropriate information, skills, attitude, habits, and motivation. It also refers to their ability to obtain fundamental financial products and services. Similarity: Taylor (2011) defined financial competence as an individual's capacity to understand, manage, and take charge of their financial situation. Making sensible financial judgments, managing credit and debt, and determining suitable goods and services are all mentioned in this idea (Xiao, Chen, & Chen, 2014).

Financial capability = (Investment + Investment knowledge possibility) / Inflation * Technological Capability

G. Technological capability

S-shaped growth is a common mode of behavior in dynamic systems; growth is exponential at first, but then gradually slows until the system reaches an equilibrium level. The curve has the shape of a stretched-out "S." In statistics, the logistic model (or logit model) is a statistical model that models the probability of an event taking place by having the log-odds for the event be a linear combination of one or more independent variables.

$$f(x) = \frac{1}{1 + e^{-x}}$$

The logistic curve is also known as the sigmoid curve. The exponential function in the denominator completely determines the rate at which a logistic function falls from or rises to its limiting value. Note: Carrying capacity is the population limit or the maximum population that the environment can support.

A function that models the exponential growth of a population but also considers factors like the carrying capacity of land and so on is called the logistic function. It should be remembered that the logistic function has an inflection point. Logistic growth is a type of growth where the effect of limiting upper bound is a curve that grows exponentially at first and then slows down and hardly grows at all.

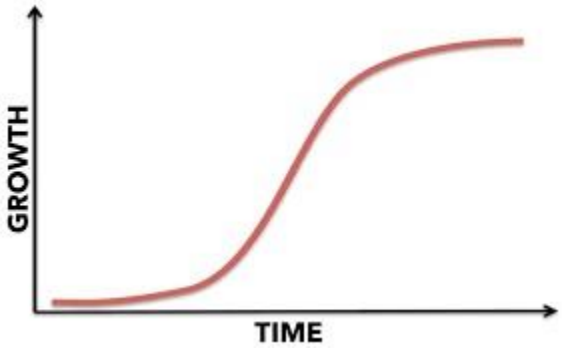

Figure 11 Typical S-curve

Technological capability is assumed to exist in very small amount in any firm functioning in

Technological environment. Its development tends to be slow during initial periods.no real quantity can grow (or decline) forever eventually one or more constraints halt the growth. A commonly observed mode of behavior in dynamic systems is S-shaped growth-growth is exponential at first, but then gradually slows until the state of the system reaches an equilibrium level.

Technological Capability= INTEG (Technological Capability/(1+EXP(Technological usage/(Technological Capability Factor))))

Technological capability is influenced by its factor which are Technological Transfer, R&D Characteristics, International linkage (Market), Organizational Conditions, Innovation and Financial capability which we consider as the intake for the bath tab which is technological capability from that the out flow will be the technological ability these relationship shows as working on technological factors to develop their technological capability will enable the SME shows progress on their on their technological usage (technologically they are able) which makes them competitive.

SME technological ability or usage with manufacturing value added share gives us the competitiveness. Manufacturing, value added (% of GDP) in Ethiopia was reported at 4.6053 % in 2021, according to the World Bank collection of development indicators, compiled from officially recognized sources. Ethiopia - Manufacturing, value added (% of GDP) - actual values, historical data, forecasts and projections were sourced from the World Bank on December of 2022. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs.

Competitiveness= INTEG (Manufacturing Value Added Share* Technological usage

The following data is extracted from experts to use as an input to the model (experts opinion)

Table 2 for system dynamics model input from collected Data

s.no	Main factor	Sub factor	Current value	Remark
1	Technological Transfer	Level of technology	0.5	
2	R&D Characteristics	Level of education	0.3	
3	Organization condition	Existing knowledge	0.5	
		Commitment	0.7	
4	International linkage(market)	Competition	0.6	
		Demand condition	0.8	
		Market Innovation	0.4	
5	Innovation	obsolescence rate	0.6	
		Technology innovation	0.4	

		Product innovation	0.4	
6	Financial capability	Inflation	0.9	
		Investment	0.5	
		Knowledge to manage	0.7	

Sources:- Field survey, 2021.

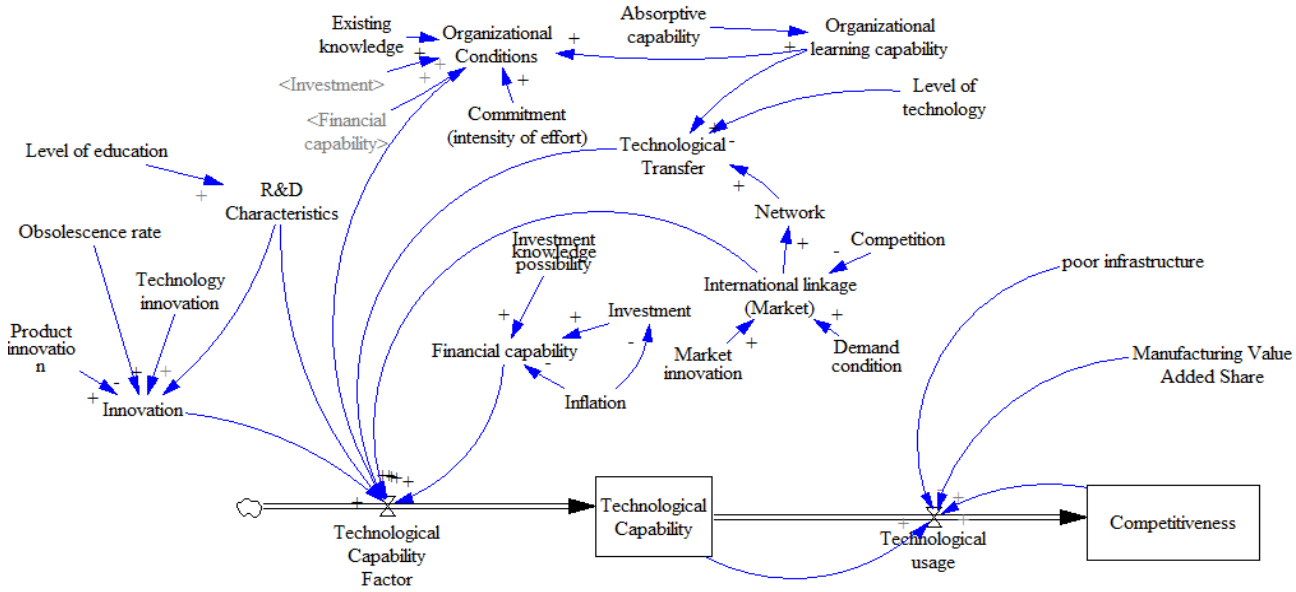

Figure 12 Stock-Flow Diagram

4.1.3. Model Validation

This paper validates the model validation through multiple tests. First, the structural validity of the model is tested in this work. This paper's system dynamics model building is based on theoretical analysis, which guarantees the model's rationality. Every equation is also examined to make sure the left and right halves are identical. Second, to see if the system dynamics model acts realistically, we perform extreme-condition tests in this paper. For instance, we determine whether competitiveness is constant by determining whether technical capability factors equal zero. The outcomes are in line with reality, proving the validity of the system dynamics model developed in this work.

This paper then uses Vensim software to carry out the simulation. The simulation period is 10 years. This paper firstly simulates the impact of the technological capability on competitiveness. Then, this paper further distinguishes technological capability factor affect technological capability to enhance competitiveness.

4.1.4. Simulation Result on the model

After the analysis of the showed results, we can notice that technological capability is minimal at the binging and increase through time and in almost 6 years it is going to be stable so that it reaches to maximum. And competitiveness is increasing accordingly after almost 4 years. When the technological capability increases the competitiveness also continue to enhance as the fig. blow shows.

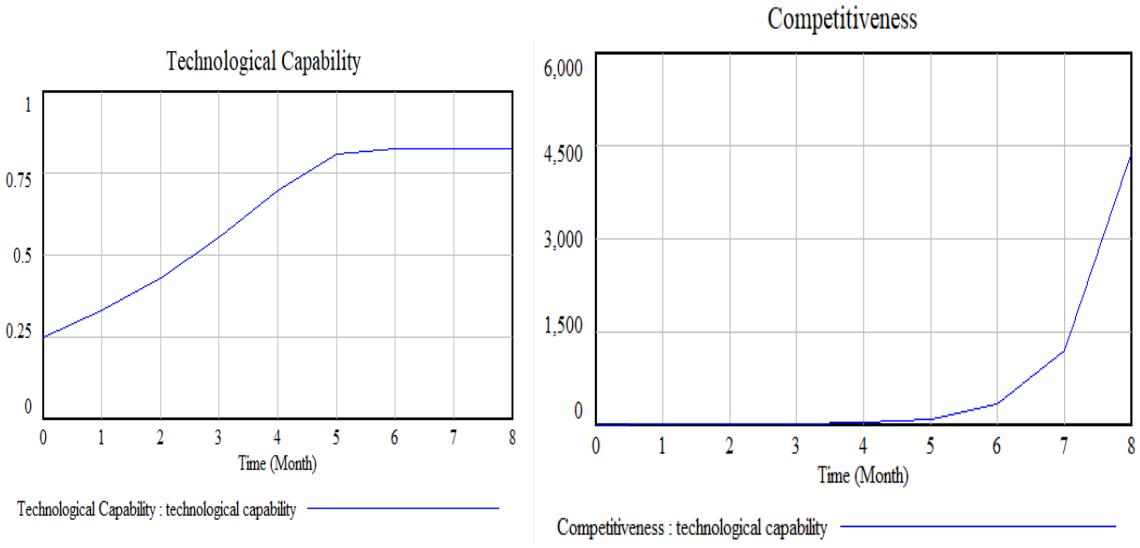

Figure 13 simulation result for technological capability from the data collected

The second simulation analysis indicate that if we did not consider the financial capability values decreses has segnificant effect on the growth of technological capability, it reches the the maximum which is 50% up to the first 4 years then it reches the equlibrum.whereas the compitativeness will increse by small rate up to 7 years.these shows finantial capability is essential for one SME in order to increse its technological capability and so its compitativeness.

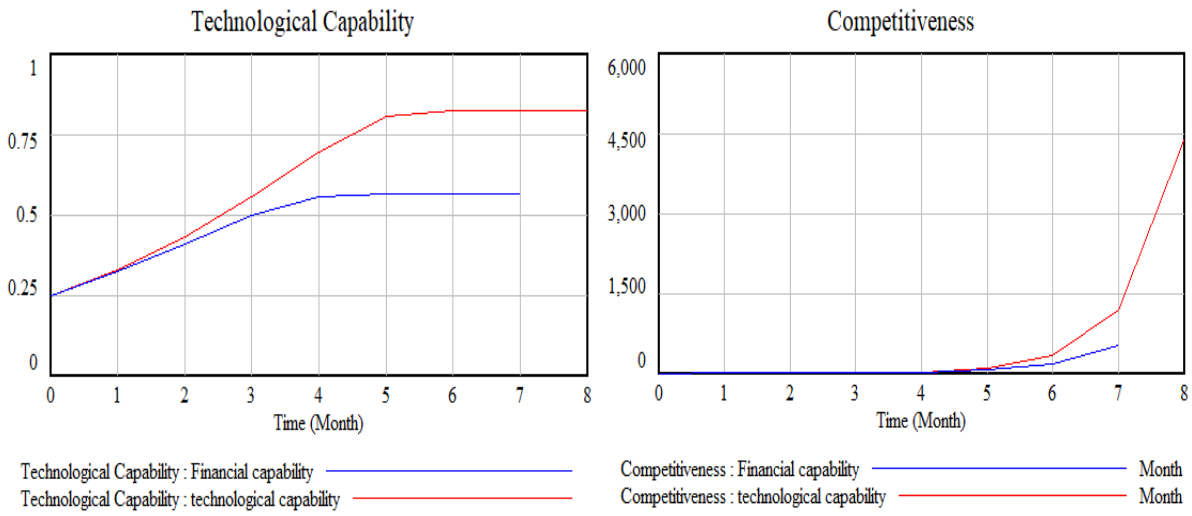

Figure 14 Comparison between technological capability and financial capability

The other simulation coducted is if we decrese the orginaizational condition the technological capability growth will decrese up to 70% before it rechese the maximum and the compitativeness will increase by small rate compared to the current situation.

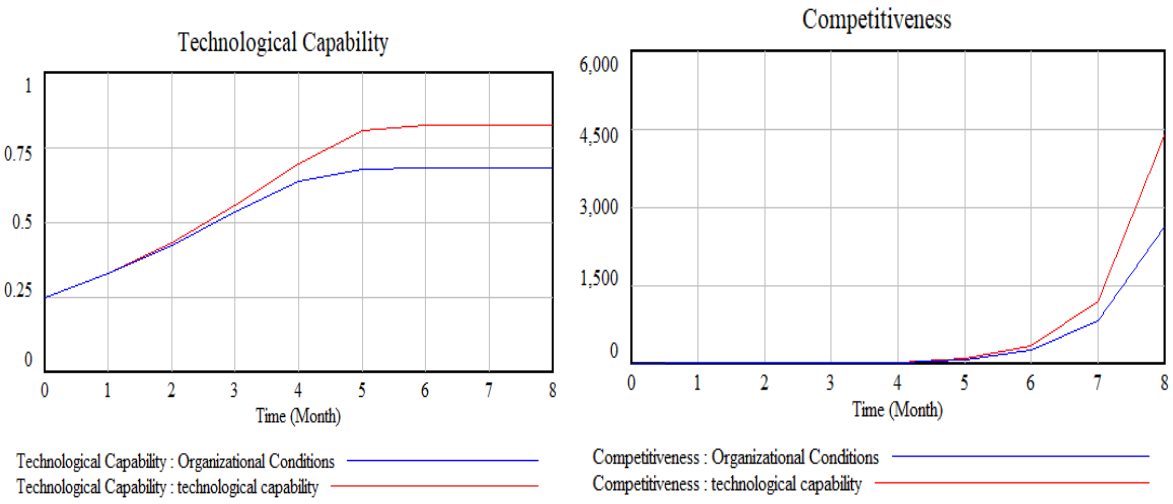

Figure 15

Figure 15 comparisons between technological capability and organizational condition

If we decrese the the R&D characterstics thereis a change in technological capability about 77% the grouth countinew for almost for 6 years and the compitativeness growing rate is decrese in small rate.

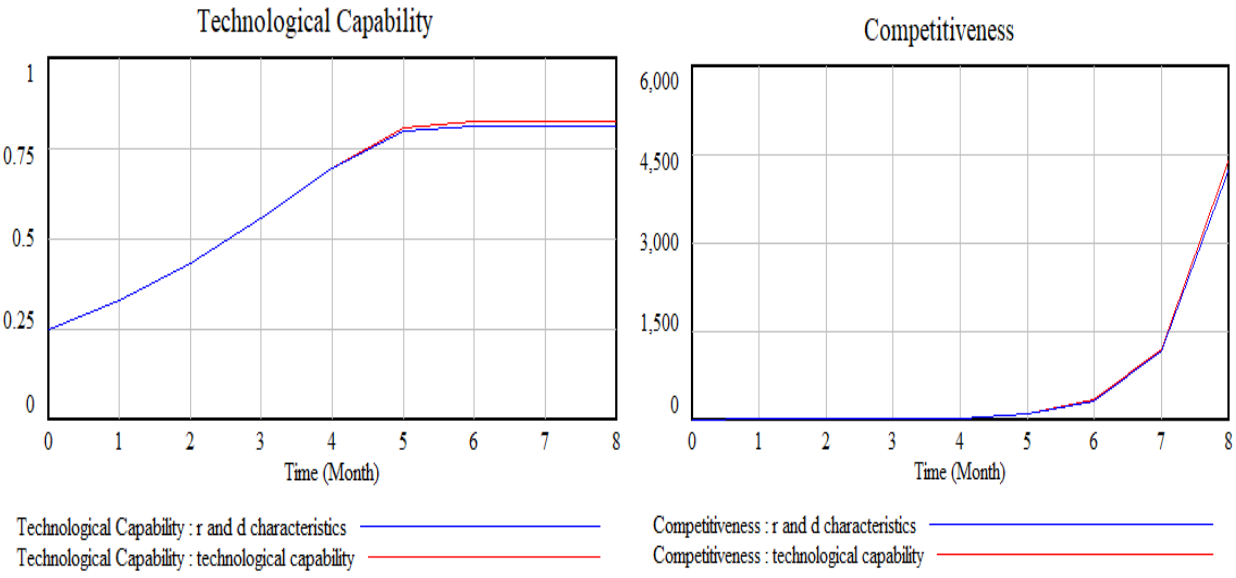

Figure 16 comparisons between technological capability and R&D characteristics

The other factor is innovation if we decrease the value of innovation there is a change in the grouth of technological capability the grouth is 76% on its maximum the growth will countinu for almost 6 years and the compitativeness is growing but in smaller rate .

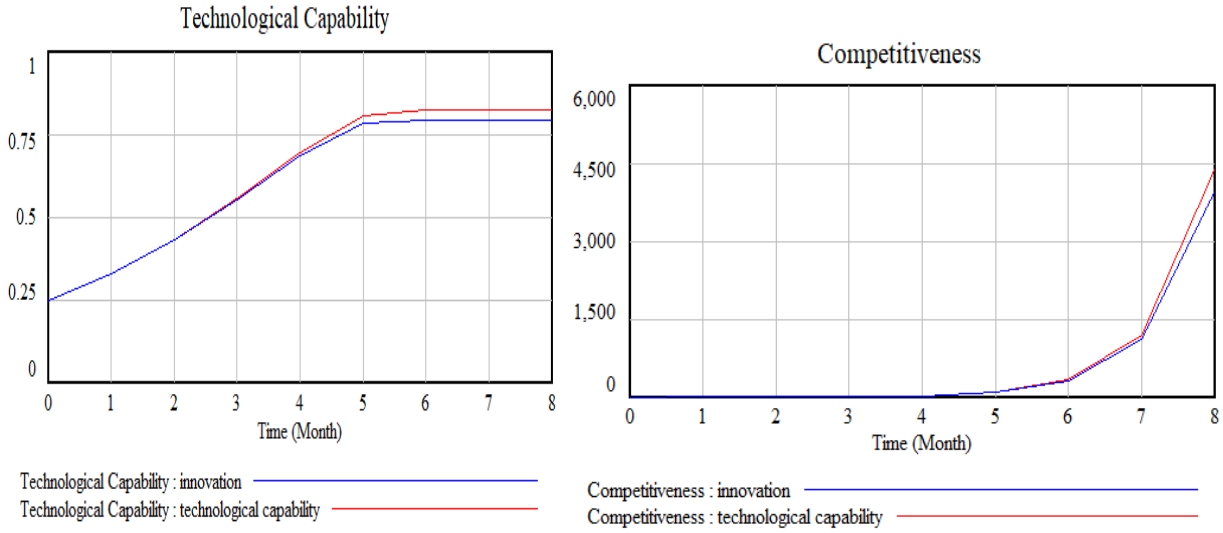

Figure 17 comparisons between technological capability and Innovation

When we decrease technological capability there is a change in growth of technological capability around 79%. And competitiveness is growing but in smaller rate compared with the assumed value.

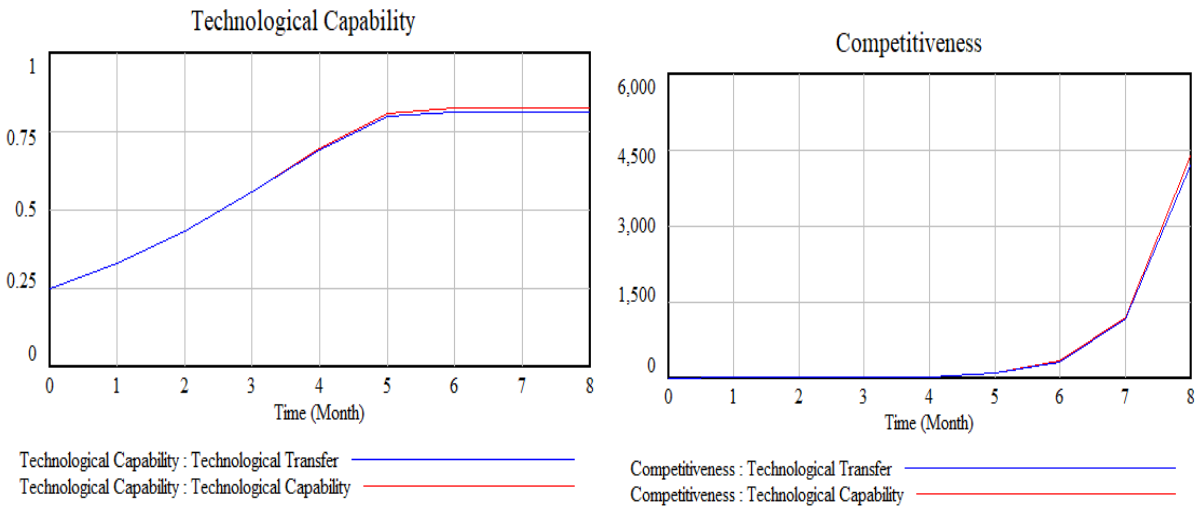

Figure 18 comparisons between technological capability and Technological Transfer

Reducing the international mareket factor will deduse the growth compared to the assumed curent sittuation but is is growing around 78% for almost 6 yeares the compitativeness also growing but in not grater than the assumed situaion.

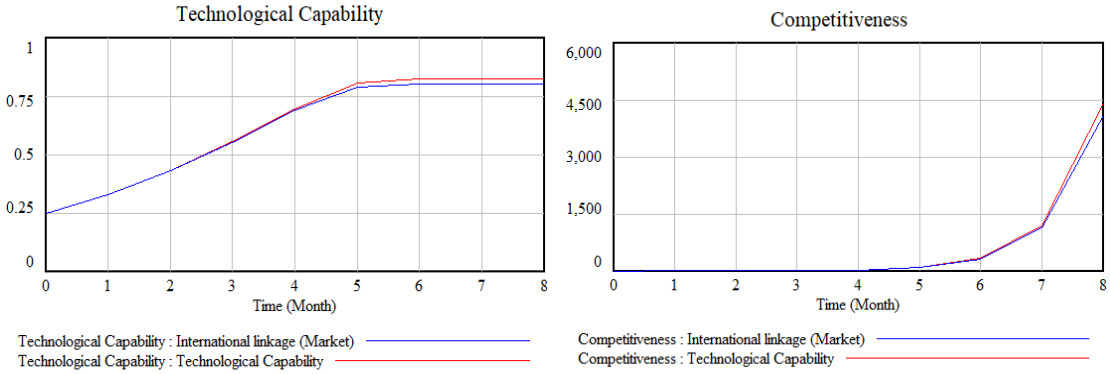

Figure 19 *comparisons between technological capability and international linkage (Market)*

4.2. Qualitative Data Analysis

We have discussed in the following section the results of qualitative data to support quantitative results.

- **Technological Transfers**

It is well researched and established that technological transfer is one element of technological capability. In line with this data collected from focus group discussion indicated that technological transfer is a crucial component for firm's technological capability thereby allows firm's competitiveness. Respondents boldly assured that knowledge outside the firm plays a central role for enhancing productivity.

However, The technological transfer capacity and for that matter interests of small and medium scale metal and engineering enterprises is very weak, as per the interview results. For instant a respondent indicates that *"technological transfer more specifically networking with developed world high level industries or local high level industries there is a poor connection. Its role for technological advancement, improved productivity and for large to be competitive it is undeniable. But it is in its infant stage, not to say absent."*

Technology transfer can be assumed via foreign direct investment, turnkey plant projects and contracts with local colleges, universities and government research institutions. In this regard the practice of small and medium scale metal and engineering enterprises in Arada sub-city founds closer to null. Respondent 4 confirmed that "*in Arada sub-city No enterprises highly or loosely works with foreign enterprises or think thank groups to share and transfer technological knowledge.''*

Another respondent also confirms that *"in Arada sub city to small extent government TEVET colleges work with small and medium metal and engineering enterprises to share and transfer technological transfer. In this regard the role of the universities were to minimal."*

The qualitative analysis conforms to the quantitative analysis, though it requires the application to other sub cities and other sector enterprises.

Technology transfer makes it possible to create priceless, unique core competences that make it easier to produce high-quality goods and inspire process improvements that other companies are unable to match, giving the innovative company a competitive advantage over its rivals. Through technology transfer, early-stage intellectual property can be developed into instruments that the

research community can use directly, or into the foundation for new platforms, goods, or services that can be turned into goods that the general public can utilize.

- **R&D Characteristics**

Another factor mentioned by the respondents which contributes for technological capability and thereby allowing competitiveness is R&D characteristics. For firms R&D practices have a rewarding result for technological advancement. Building technological advancement and capability always emanates from strong practices of R&D through huge investments. Cognizant with these facts respondents were asked the practices of R&D characteristics or departments associated with it. The result indicates that in Arada sub-city small and medium scale metal and engineering enterprises have no a department or a practices of R&D other than small research conducted by the firms in order to satisfy customer requirement.

Another important issues rose in this discussion were the role played by R&D activities for small and medium enterprises technological capability. In the existing and extant literatures high quality human asset, profound collaboration with the knowledge frontier, and centering more on knowledge intensive technology are more likely to lead to the advancement of exclusive technology always emanates from R&D. In this regard a respondent mentioned that

> "*it is a crystal clear R&D contributes to avoid time consuming, extravagant practices and thereby increases productivity. The existing world is full of serious competition emanates from the local and international markets. Small and medium enterprises may not use a high level and complex technologies for their daily operations. However, imitating a little bite advanced technologies and allocating some budgets and giving strategic emphasize for R&D may produce a promising result. However firms in arada don't conduct this kind of research at large but they do mini researches to do new customer orders"*

Another respondent also confirms that *"in Arada sub city to small extent government TEVET colleges and universities are expected to cover this issue by working with small and medium metal and engineering enterprises But thire role were minimal."*

Businesses that outperform their competitors in a way that is difficult for them to imitate get a competitive edge. It is simpler to outperform rivals if R&D activities result in an enhanced business process, such as lowering marginal costs or raising marginal productivity.so the government should act as there Rand D department so that they can enhance their competitive advantage. This characteristics can help these Small and medium metal and engineering enterprises in arada

sub-city with the other variables like their innovation, technology transfer, improving their organizational condition, to solve or find a way though their market barrier and work though their financial capabilities.

- **Organizational Conditions**

The existing and the extant literatures boldly showed that firm's technological capability is determined by a confluence of factors. Among these organization conditions is undeniable. The qualitative result originated from the focus group confirms that an organization condition has its own linkage with technological capability. A successful firm can learn a lesson from its own historical tracks. Capability comes from technological learning, organizations commitment to learn from its experiences and experimentations and absorptive capacity.

Cognizant with the above facts respondents were asked about organizational conditions in their working area. As the interview result indicates the practices of keeping historical tracks or drawing lessons from poor experiences is weak, in Arada sub city small and medium scale metal and engineering enterprises. Commitment matters. One respondents further confirmed that *"Small and medium scale enterprises in Arada sub-city were not willing enough, motivated and committed to solve internal problems by themselves."* Another respond3ent further adds that "*small and medium enterprises in Arada sub-city shall began allocating efforts and time to solve existing and internal problems by themselves, unless technological capability would be a night dream."*

This finding conforms to the quantitative finding presented earlier.

A creative and innovative workplace culture can foster team-based problem-solving and decision-making that advances organizational objectives. Attracting and keeping great people is another benefit of having a strong corporate culture. This can improve their market, quality and productivity

- **International linkages (market)**

Additional theme emerges from the interview is international market linkage. The role of every enterprises is profitability, usually emerges from successful penetrating of local and international markets. Unless there is no marketing productivity is nothing and thereby competition can be dreamed. International marketing requires high level technical knowledge to deal with effectively. When we speak out international marketing by default we are speaking about demand. Win-

ning peoples demand requires good technological capability to produce the demand and to get competitive advantageous.

As the interview result indicates the capability of small and medium scale enterprises in joining international marketing is very poor. One respondent confirmed that *"the practice of innovation among small and medium enterprises is in its infant stage. Poor quality technology practices never allowed producing new fashioned and competitive product in the market. More often, there is poor demand for small and medium scale metal and engineering enterprises in the international market.''* Another respondent also insist that *"both demand and competition matters for SME to join the local and international market."* Therefore, SME owners are required to deeply understand the critical factor in this regard.

Businesses can increase their competitiveness by lowering costs or increasing availability, for example, to make their products or services more appealing to customers. By putting together a logical and comprehensive marketing mix a close marketing mix the competitive advantage of a business can be influenced by its marketing strategy, which includes product, pricing, promotion, and place.

- **Innovation**

Innovation is a new way of thinking and doing business. It ranges from supplying new products, services to methods and marketing practices. Innovation requires the transformation of process, usually shortening time of production and minimizing production cost thereby allows profitability.

In this regard respondents indicated that *small and medium scale metal and engineering enterprises in Arada sub-city produces most commonly similar products. They produce similar products and tries to sell in similar fashion. Neither the product nor the marketing approach is new. The production means is obsolete.* The rate of productivity is to minimal. Another respondent also adds that *"majority of small and medium scale metal and engineering enterprises innovation ability and capacity is poor."' Therefore, is possible to conclude that* poor innovation ability handicapped their technological capability furthermore competitiveness.

Market dynamics and structure can be affected by innovation, which can also force out existing competitors, prevent the admission of new ones, or alter the business plans of those that wish to

continue competing. For a variety of reasons, businesses that innovate tend to gain a competitive advantage. Creating less expensive, higher-quality items than those made by rivals is the key to becoming more competitive through innovation.

- **Financial Capability**

In the existing and extant literatures financial capability is identified as components of technological capability further plays its role firms competitiveness. Financial capability in this paper can be understood as financial capability refers to people's ability with the right sorts of knowledge, skills, attitude, habits, motivation, as well as their opportunity toward accessing the basic financial products and service that are equipped to manage their financial matters.

Therefore, in the interview result it emerges as central factor for small and medium scale metal and engineering enterprises. One respondent indicated that "*Small and medium scale metal and engineering enterprises in Arada sub-city suffers from shortage of finance.*" In this way raw finance becomes a problem.

Another respondent also adds that *"besides the shortages of finance, providing financial decisions and for that matter reading financial statement is rare. Both lack of basic accounting literacy and decision making skill is common characteristics of owners and operators of Small and medium scale enterprises in Arada sub-city"*

Financial capability has a strong link with technological capability. Therefore, the qualitative analysis shows that financial capability more specifically financial management. Technical knowledge and even the focus given for it are very low.

The foundation of any business is its ability to achieve improved profitability and better performance through increased access to financial capabilities. Financial aptitude increases growth, profitability, and sustainability, which has a beneficial impact on entrepreneurial success in arada sub-city. It is essential to success and can be enhanced by better financial environment and financial education.

- **Technological Capability and Competitiveness**

Technological capability becomes a central component for organizations success. Successful business entities give strong emphasize for it. It can be viewed as a base for sustainable competitive edge. A Technologically capable firm can bet easily its contenders and can exist long in the market. Cognizant with this facts respondents were asked to gauge the technological capability of small and medium scale enterprises of metal and engineering enterprises in the Arada sub city. Therefore, the interview result indicated that the majority of small and medium scale enterprises are not technologically capable. There is poor financial capability, poor innovation, low research and development characteristics, and poor commitment to learn from experiences, experimentation and learning from poor decision made by earlier or unwilling organizational condition, poor international market linkage and minimal technological transfer is the common characteristics of small and medium scale Metal and Engineering enterprises in Arada sub-city. Therefore, the majority of small and medium scale Meta and engineering enterprises have no competitive advantage and even fail to compete effectively with the local firms.

Technological capability is a key component of a company's competitive advantage since it makes it easier for businesses to use their technical expertise to develop and deliver novel products that customers would find valuable. This has an impact on a company's overall business performance as well as its performance in developing new products.

5. Summary of Findings, Conclusion and Recommendation

5.1 Introduction

An overview of the study's key findings and conclusions is covered in this chapter. Finally, recommendations were made based on the findings and conclusions for how to improve the competitiveness of small and medium-sized enterprises in the engineering and metals sector in Arada sub city through the development of technological capability, both for the relevant stakeholders and for future researchers.

5.2 Summary of Major Findings

The main purpose of this study was to enhance competitiveness of small and medium metal and engineering enterprises in Arada sub-city through improvement of technological capability. The research was guided by the following two basic questions those were stated in chapter one:

- ✓ What are the factors that determine competitiveness through technological capability of small and medium enterprises in the Metal and Engineering sector in Arada sub-city?
- ✓ How technological capability can foster competitiveness of small and medium enterprises in the Metal and Engineering sector in Arada sub-city?

The research approach was concurrently mixed i.e. both quantitative and qualitative research approach were used to explore the factors of technological capability that influence the competitiveness of small and medium enterprises in the Metal and Engineering sector in the Arada sub-city. The factors that influence technological capability is selected and analyzes using different literature and focus group discussion.

According to the analysis and discussions, the following summaries of major findings were presented in accordance with the above two basic questions.

The major findings in relation to identifying the factors impact on competitiveness of small and medium metal and engineering enterprises in Arada sub-city is that the researcher adopted six different variables of interest. These are technology transfer, Research and development, international market linkage, organizational condition, innovation and financial capability. The above independent factors are derived from different literature reviews and adopted by the researcher as well.

The following are the main findings regarding analyzing the factors impact on competitiveness of small and medium metal and engineering enterprises in Arada sub-city.

- ✓ The respondents expressed that there is insufficient technology transfer practice by the targeted metal and engineering firms.
- ✓ It is revealed that there is lack of international market linkage by the enterprises.
- ✓ Respondents disagree with the use of research and development factors to enhance competitiveness of enterprises.
- ✓ There is a lack of proper organizational condition to improve the competitiveness of enterprises.
- ✓ Enterprises have been found to be very poor in terms of acquiring technology ideas from the government.
- ✓ Majority of the respondents also agreed to the poor innovation and financial capability to be a competitive firm.

The second and final research finding was the adoption of Systems model that would show working on technological capability will enhance the competitiveness of metal and engineering enterprises as presented in the previous chapter. The model used all the factors mentioned above. The researcher at last recommended the integration of related factors which give insight to enterprises to construct their own strategic plans.

5.3 Conclusion

The main objective of the study was to improve competitiveness of small and medium metal and engineering enterprises in Arada sub-city through development of technological capability. The researcher tried to formulate its improving model and research design in such a way that it aligns with the research questions and provides answers to them. This research attempted to answer the research objectives after identifying and going through deep analysis of selected variables. Based on the major findings of the study, the following conclusions were drawn:

The results of the first question which is identification of the factors affecting the competitiveness trough technological capability of small and medium metal and engineering enterprises in Arada sub-city are technology transfer which affected by level of technology, their network and organizational learning capability, research and development which is influenced by their level of education, international market linkage which is affected by the market innovation ,demand

condition and competitors', organizational condition which is influenced by their existing knowledge financial capability ,investment and their commitment , innovation which affected by product and technology innovation, obsolescence rate and r and d characteristics , and financial capability which affected by inflation , investment and investment knowledge possibility.

The next step was to analyze the factors impact on competitiveness of enterprises. Accordingly, all the factors are significant on growth of technological capability. This study also revealed the lack of technology transfer practice by the enterprises. Poor international market linkage and use of research and development by the enterprises is also identified by this study. In addition, the targeted enterprises lack organizational vision for development of technology. In general, it can be concluded that, competitiveness of metal and engineering enterprises in Arada Sub City is found to be unsatisfactory. Finally, the research present with a general model that would serve a base up on which metal and engineering enterprises will be able to competitiveness while answering the last research question. According to the model financial capability is the main factor that influences technological capability the foundation of any business is its ability to achieve improved profitability and better performance through increased access to financial capabilities. Financial aptitude increases growth, profitability, and sustainability, which has a beneficial impact on entrepreneurial success in arada sub-city. It is essential to success and can be enhanced by better financial environment and financial education. The second most basic factor is organizational condition which include their commitment, existing knowledge and learning capability. A creative and innovative workplace culture can foster team-based problem-solving and decision-making that advances organizational objectives. Attracting and keeping great people is another benefit of having a strong organizational culture. This can improve their market, quality and productivity. the other most important factor is innovation. This factor explores the enterprises technology and product innovation along with their obsolescence rate. Market dynamics and structure can be affected by innovation, which can also force out existing competitors, prevent the admission of new ones, or alter the business plans of those that wish to continue competing. For a variety of reasons, businesses that innovate tend to gain a competitive advantage. Creating less expensive, higher-quality items than those made by rivals is the key to becoming more competitive through innovation. And the other factor is research and development characteristics that show their level of education and innovation. Businesses that outperform their competitors in a way that is difficult for them to imitate get a competitive edge. It is simpler to outperform

rivals if R&D activities result in an enhanced business process, such as lowering marginal costs or raising marginal productivity. Though they don't use this as they should the government should act as there Rand D department so that they can enhance their competitive advantage. This characteristics can help these Small and medium metal and engineering enterprises in arada sub-city with the other variables like their innovation, technology transfer, improving their organizational condition, to solve or find a way though their market barrier and work though their financial capabilities. Technological Transfer is other most important factor to improve technological capability that shows their level of technology and absorptive capability. Technology transfer makes it possible to create priceless, unique core competences that make it easier to produce high-quality goods and inspire process improvements that other companies are unable to match, giving the innovative company a competitive advantage over its rivals. Through technology transfer, early-stage intellectual property can be developed into instruments that the research community can use directly, or into the foundation for new platforms, goods, or services that can be turned into goods that the general public can utilize. International market linkage is shown among with competition, network demand condition and market innovation. Businesses can increase their competitiveness by lowering costs or increasing availability, for example, to make their products or services more appealing to customers. By putting together a logical and comprehensive marketing mix a close marketing mix the competitive advantage of a business can be influenced by its marketing strategy, which includes product, pricing, promotion, and place.

Working on these basic factors enables the metal and engineering SME to improve their technological capability so that they can enhance their competitiveness. Technological capability is a key component of a company's competitive advantage since it makes it easier for businesses to use their technical expertise to develop and deliver novel products that customers would find valuable. This has an impact on a company's overall business performance as well as its performance in developing new products.

5.4 Recommendations

5.4.1 Recommendations for Government stakeholders

Finance is the core element for the development of any enterprise. The financial status of Arada sub-city metal and engineering enterprises has been weak in supporting them to be competitive by enhancing their technological capability. Rigid collateral requirements to get access to credit from banks for metal and engineering enterprises are major impediments. In order to effectively address this challenge and avail the financial needs of the metal and engineering enterprises in Arada sub-city, the following possible actions are recommended to be taken by the government bodies as well as relevant stakeholders and financial institutions such as banks, MFIs;

- ✓ Facilitating access to credit for metal and engineering enterprises and providing a stable environment for business transactions. The government stakeholders should create a strong linkage between small enterprises and banks, micro finance and other financial institutions.
- ✓ Provision of technical assistance in the form of trainings and workshop exhibitions that would help the metal and engineering enterprises to make them capable of producing a wide range of products that will grow their competitiveness
- ✓ Beyond financial and technical assistance, the government stakeholders should also develop and implement new assistance that will inspire the metal and engineering enterprises to adopt technological tools and methods through stimulating the use of new techniques in line with international best practices.
- ✓ The government bodies should also facilitate plans in which the metal and engineering enterprises participate in mega projects in the form of subcontracting or internship manner with both bigger domestic and international companies in such a way that the enterprises will be able to have a better technological transfer exposure.
- ✓ The government bodies should also Promote innovation by the metal and engineering enterprises and the application of technologies in creation of products by providing incentives in the form of promotion or other means.

5.4.2 Recommendations for small and medium metal and engineering enterprises

- ✓ The enterprises by themselves should adopt innovation practices to attract and stay firm in the ever-changing marketing conditions. They also need to devise plans to address the

knowledge and skill gap they have by participating in formal as well as informal training. They also need to be risk-takers in terms of adopting new techniques or new products to possess the existing market.

5.4.3 Recommendations for Further Research

- For further research works on related research topics, the researcher recommends the improvement of other variables other than technological development to enhance competitiveness of small and medium metal and engineering enterprises in Arada sub city.
- Foremost. It is advisable to conduct a comparative study regarding competitiveness of metal and engineering enterprises through technological development between enterprises of different sub-city.

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Appendix I: Research questionnaire

Dear Sir/Ma'am,

You are invited to participate in this survey. Therefore, this questionnaire has been developed as part of my post graduate program research at Addis Ababa institute of Technology, this is a questionnaire to collect data for the research entitled as "Enhancing Competitiveness through technology capability development". The objective of the questionnaire is to identify critical factors for improving technological capability of your firm through reverse engineering which in turn will improve your competitiveness. Your participation is voluntary and your responses will be confidential. If you have questions, you may direct me.

Thank you very much for your support to this research. We further hope you too may find this exercise useful in thinking through your firm's technological capability strategy.

Part 1:- Interview Guide Questions

1. What do you think are the factors affecting competitiveness of small and medium scale metal and engineering enterprises in Arada sub-city?
2. How do you observe and gauge Technological capability of Small and Medium Metal and Engineering enterprises in Arada sub city?
3. How do you see the importance and relevance of small and medium scale enterprises in technology transfer in Arada sub-city? Emphasize on Networking and level of Technology.
4. Is there a practice of R&D or a department associated with R&D in Small and Medium metal and engineering enterprises in Arada sub-city?
5. What are the roles of R&D activities to build small and medium scale enterprises technological capability?
6. What are the challenges of entering to international marketing of small and medium scale metal and engineering enterprises of arada sub city? More emphasize on competition, demand conditions and market information.

7. How do you see the organizational conditions more specifically commitment to learn, acquire new knowledge, motivation and willingness to invest on of small and medium scale enterprises in Arada sub-city?
8. How do you see the ability and the capacity of small and medium enterprises product and technology innovation?
9. How do you see the impact or importance of technological capability for firm's competitiveness?
10. How do you see the financial capability of small and medium scale metal and engineering enterprises?
11. How financial capability affects technological capability and competitiveness of firms in Arada sub city?

Part 2:- Technological capability Factors

Please rate the following factors through percentage from 0-100%

s.no	Main factor	Sub factor	value
1	Technological Transfer	Network	
		Level of technology	
2	R&D Characteristics	Level of education	
3	Organization condition	Existing knowledge	
		Commitment	
4	International linkage(market)	Competition	
		Demand condition	
		Market Innovation	
5	Innovation	obsolescence rate	
		Technology innovation	
		Product innovation	
6	Financial capability	Inflation	
		Investment	
		Knowledge to manage	

Thank you!!!