INNOVATIVENESS AND INSTITUTIONAL LINKAGES IN THE TANZANIAN MANUFACTURING SECTOR WITH REFERENCE TO METAL AND ENGINEERING SUB SECTOR[1]

By

Diyamett, Bitrina D.

A Proposal Submitted to Institute of Development Studies (IDS), University of Dar es Salaam (UDSM), as Part of the Registration Process for a PhD

[1] By metal and engineering sector we imply two level digit data, for .ISIC 37 and 38.

CONTENTS

ABSTRACT

This thesis takes its point of departure from the premises that innovativeness in industries is a necessary condition if countries are to attain a meaningful level in both economic and social development. Due to importance attached to innovation in national economies, forces behind innovative activities have received much attention both from scholars of technological innovation and officials in the innovation policy arena. This fact notwithstanding however, our understanding of forces behind innovative activities are far from perfect, especially as it relates to the innovative activities in poor developing countries. Taking the case of metal and engineering sub-sector of the Tanzanian industry, this work is a modest contribution towards feeling these gaps. Specifically, the study is a modest attempt to find out the extent to which the interaction between, suppliers, producers and users, result into innovative activities in the Tanzanian metal and engineering sector. It is designed to explore the extent and nature of the market linkages in this sector, and relate this to innovative activities at firm levels. So while the unit of analysis is the firm, the focus is on the linkages. The specific objectives of the study are as follows:

- To find out the nature of market linkages in the Tanzanian metal and engineering sector
- To determine the extent to which each type of market linkages is accompanied by technological innovation.
- To identify factors that work for or against long term relationships in market linkages.
- To identify other sources of technological innovation
- To determine channel of information communication about innovation
- To identify the role of R&D institutions in second and fourth objectives above.

The rationale for the study is threefold: Firstly, the Study will help in establishing a framework for assessing and finally improving national innovation policy in Tanzania, especially with respect to the capital goods sector which is so vital in the growth of the economy. Generally, innovation studies are important because all the advances in matters of industrial technology policy in the industrialized world have come from an improved understanding of how firms operating in market economies deal with issues of technical change ad innovation. Of much importance in this is the interaction between producers and users that facilitate innovative activities. In most cases there is also a role to be played by R&D and other knowledge generating institutions in these interactions. The nature of these has to be determined to better inform policies on R&D. Second, lack of forward and backward linkages in the Tanzanian economy has been expressed as one of the major factors that work against productivity growth in the manufacturing sector in general. This specific case on metal and engineering sub sector can provide some useful pointers towards alleviating the problem. Finally, the study will be useful in augmenting the limited literature on National Systems of Innovation (NSI) in least developed countries such as SSA. The existing models seem to have been developed from observation made in more advanced countries and thus specific and useful only to those countries. As a framework for analysis, the study lends itself to the appropriate literature on the concept of National Systems of Innovation (NSI), defined as *that system which is constituted by elements and relationships between those elements which interact in the production, diffusion, and use of new and economically useful knowledge (*Lundvall (1992*)).*

Methodologically, the study will be limited to the large and medium scale industries (those with employees more than 10). Two types of methods will be used, namely surveys and case studies.

1.0 Introduction

1.1 Background

This thesis takes its point of departure from the premises that innovativeness in industries is a necessary condition if countries are to attain a meaningful level in both economic and social development. It is proposed to build on this proven foundation of empirical understanding.

As a result of the above realization forces which facilitate innovative activities have received much attention from both S&T policy makers and scholars. In particular, there has emerged some kind of a race on the part of scholars in trying to identify the best model of innovation. From **Linear Model** of innovation to a long debate on **Technology-Push** and **Demand-Pull** models. This finally led to an Interactive Model of innovation and more recently, to Systems of Innovation. The race seems to be gathering speed as we move towards increasingly globalised economy. Much as so much has been done on the process of innovation, the fact remains that forces working for or against innovative activities are far from being fully understood. Gu (1999) for instance argues that our knowledge about innovation system will never become perfect, simply because novelties-new technology, new institutions, and new patterns of relations are being created ever dynamically in innovation system. This tally well with the argument by Gregersen (1997), who argued that it is meaningless to search for a time independent theory of innovation and growth. Unlike Gu who used the word **never**, implicit in Gregersen argument is that there is a possibility of finding time dependent theory of innovation, for instance in the use of "general evolutionary theory". However the most important point here is that a useful, universally representative model of innovation is yet to be found, if at all there will be one. In this search one of the important gaps needed to be filled is that of uncovering, however weak, forces that operate for and against innovative activities in the least developed countries, where in most cases innovation studies have been conspicuously lacking. This study is a contribution towards this direction. It Begins by reviewing what has already been done in the area, what gaps still exist. This has adequately been treated in section on literature review and conceptual framework. Here only a brief mention will be made for the purpose of arriving at the research problem.

Most literature on productivity growth and innovation reveals that actually the **interactive** model of innovation, which is defined in the next section, is the best available model to explain innovative activities. The model seems to be the roots of more recent theories on networks and systems of innovation, that acknowledge the heavy dependence of innovative activities on the networking and linkages, especially those among and between firms and their users, suppliers, competitors and R&D institutions (Rosenberg, 1982, Lundvall, 1992, Gregersen et. 1997, DeBresson, 1999, Kwanjai, 1999, among others). However, there exists a conspicuous gap in the sense that most of the literature heavily relies on the observation almost exclusively made in developed countries. Little contribution has come from the least developed countries. So to what extent can these models represent a universally accepted innovation model? To be more specific, to what extent is the model also useful for the poorest countries such as those in Sub-Saharan Africa (SSA) in general and Tanzania in particular?

Recently there have been arguments, especially in literature on Innovation Systems **that** the way the actors in the system of innovation relate to each other and their relative importance in bringing forth innovation so much depend on a particular social economic and social cultural context. Additionally even within the same social economic context, it varies with time. This is from the fact that society is not static but dynamic, which makes innovation itself being a socially embedded concept, a dynamic concept, which calls for its variables under any social-economic and cultural settings to be redefined regularly.

As will be evident in the next section, in SSA in general and Tanzania in particular little has been written about innovative activities, especially those aspects specific to sectoral and firm levels. The reason behind this conspicuous absence is not fully known. It can either be because nothing is happening and therefore nothing to study, or there is no body to observe what is happening. The latter is so obvious to the extent that one is tempted to test the former. In most SSA African countries, S&T is normally understood in terms of science and engineering only. Courses such as technology management, S&T policy and innovation studies are therefore hardly offered at the universities. In relation to the former, there is some general belief among the scholars of technical innovation that continent like Africa can not involve itself in innovative activities. This belief is for instance reflected in Mani (1999, pp.18). Quoting him:

> *Most developing countries do not have a policy on innovation, as it is **normally believed** that developing countries do not engage themselves in any innovative effort at all. At best they **are expected** to do incremental innovations which are basically adaptation of imported technologies to local conditions* (emphasis mine)

The bolded words in the above quotation connote mere speculation. As we earlier argued, no body is too sure of what is happening in Africa as far as innovative activities are concerned. It is a black box that needs to be opened. It will be of theoretical and policy relevance to know whether the box is empty and why or if not what are the contents.

1.2 The Research Problem

In Tanzania much of available studies are on the performance of the manufacturing sector at the macro level, which kind of blankets all the industries together. This hides some of important variation between and among industries, and one can easily loose sight of innovative activities at firm levels and the behavior of the institutions involved. However minor the innovative activities are, their sources can be very useful pointers towards designing policies that can facilitate significant innovative activities.

As will be evident in section two, innovation are of different types and varying degrees and a complex multi-actor field, that some kind of institutions or actors must work together to bring forth innovation. The least developed countries can not be an exception in this process. The only anticipated difference is in the type of innovation and institutions, their relative importance and the way they relate to each other in the innovation process. In Tanzania the kind of innovation that is expected is largely those of the incremental type, which to a large extent is achieved through users',

producers and suppliers' interactions. **The work is therefore a modest attempt to find out the extent to which the interaction between, suppliers, producers and users, result into innovative activities in the Tanzanian manufacturing sector. It is designed to explore the extent and nature of the market linkages in metal and engineering sector, and relate this to innovative activities at firm levels. So while the unit of analysis is the firm, the focus is on the linkages.**

Specifically the study will be guided by the following research questions:

- What is the nature of the market linkages in the Tanzanian metal and engineering sector, that is whether the linkages are long-term and obligational or short-term and arm length
- To what extent is each type of market linkage accompanied by technological innovation?
- What factors work for or against long term relationships in market linkages?
- What are other sources of innovative activities?
- What are the channels of information communication about innovation?
- What is the role of the existing public R&D institutions in two and four above?

1.3 Objectives of the Study

- To find out the nature of market linkages in the Tanzanian metal and engineering sector
- To determine the extent to which each type of market linkages is accompanied by technological innovation.
- To identify factors that work for or against long term relationships in market linkages.
- To identify other sources of technological innovation
- To determine channel of information communication about innovation
- To identify the role of R&D institutions in second and fourth objective.

1.4 Significance of the Study

The significance of the study is threefold:

First, the Study will help in establishing a framework for assessing and finally improving national innovation policy in Tanzania, especially with respect to the capital goods sector which is so vital in the growth of the economy. Generally, innovation studies are important because, as already pointed out; all the advances in matters of industrial technology policy in the industrialized world have come from an improved understanding of how firms operating in market economies deal with issues of technical change ad innovation. Of much importance in this is the interaction between producers and users that facilitate innovative activities. In most cases there is

also a role to be played by R&D institutions in this interaction. The nature of this has to be determined to better inform policies on R&D.

Second, lack of forward and backward linkages in the Tanzanian economy has been expressed as one of the major factors that work against productivity growth in the manufacturing sector in general. This specific case on metal and engineering sub sector can provide some useful pointers to the problem.

Finally, the study will be useful in augmenting the limited literature on National Systems of Innovation (NSI) in least developed countries such as SSA. The existing models seem to have been developed from observation made in more advanced countries and thus specific to those countries. The use of such models in assessing the national systems of innovation in least developed countries could mean imposing inappropriate structures that might not only work but can also suffocate existing efforts towards innovative activities. The best way, the author suggest, is to uncover the spontaneously working forces at micro levels, especially those at sector and firm levels before applying any external manipulation at the national level, on which innovation systems theory is based.

2.0 Literature review

2.1 Theoretical and Conceptual Framework

The goal in this section is to develop a set of conceptual tools with which to analyze firm linkages and the resulting innovation in the Tanzanian context. Innovation at the firm level is considered a result of some kind of institutional linkages (e. g some kind of flow of information about the innovation or some kind of alliances in technology development whether hardware or software). Innovations are therefore traced to different types of market linkages. This should enable one to determine which linkages are most important, and what should be done to strengthen them. The point of departure is definitions of very basic concepts about innovation. In the course some propositions about the most important degrees and types of innovations in the Tanzanian context will be developed. The section then proceeds to explain different models of innovation. It is here where the concept of linkage, especially that between producers and users become relevant, and is in turn reviewed. In short the section is made up of two important conceptual issues: those on innovation and those on the two types of institutional linkages: namely market linkages and linkage between firms and public R&D institutes.

2.1.1 Definition of Innovation

The essence of innovation is novelty. Innovation is the process of introducing something new and the new thing itself. It is a concept of very general application. One can talk of innovation in education system, constitutional innovation, etc.

This study is mainly concerned with innovation in economic context, specifically technological innovation. This is successful creation, development, and marketing of new goods or successful application of new techniques or ways of working that improves the effectiveness of an individual and organization (Archibugi et al. 1994)

According to many scholars of technological innovation (Rogers 1983, Coombs, 1986; Rosenberg 1982; Budworth 1996) however, the above ideas do not need to be novel in the absolute sense of the term as long as they are new in the context in which their exploited. A new application of an old idea may be commercially very successful and economically important as the new idea. It may also give rise to many of the same problems and issues as does the exploitation of the genuinely new idea. This is demonstrated by the different success stories surrounding technology transfer. Why for instance, Japan and South Korea were so successful in the transfer of western technology, while SSA countries were great failures? So even successful adoption of old technologies already in use by other firms or countries are considered as innovation because it requires investments in learning.

2.1.2 Types of Innovation

Implicit in the above definition of innovation are two types of innovation: Product and process innovations. Product innovation is introduction of new goods-that is one which customers are not yet familiar with or new quality of goods. Whereas process innovation is the introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned or a new way of handling a commodity commercially (Archbugi et al., 1994)

The distinction of innovation into product or process technology brings some methodological problems, especially when it comes to measuring a total number of innovations made in a certain country. An innovation which is considered product by one firm can easily be a process by another firm: an oil press machine produced by a machine tool manufacturer and used by an oil processing firm is regarded as a product innovation by the former and process innovation by the latter. However product innovation can be of two types: those which are directly beneficial to the consumer and those which are used as capital goods or intermediate goods as process innovation (Trajtenberg, 1991).

2.1.3 Degrees of Innovation

These are of three major degrees namely incremental, radical and fundamental innovations (Budworth 1996)

2.1.3.1 Incremental Innovation

As the name suggests this is the type which makes small changes at one given time. By definition a technologically improved product is an existing product whose performance has been significantly enhanced or upgraded. A simple product may be improved (in terms of better performance or lower costs) through use of higher performance components or materials or a complex product which consist of a number of integrated technical subsystems that may be improved by partial changes at one of the sub-system. Similarly incremental innovation in the process technology involves significantly improved production method. This may involve small changes in production equipment or production organization or their combination. The method may be intended to produce technologically new or improved products or

essentially to increase the production or delivery efficiency of the existing products (OECD, 1997).

Incremental innovations are achieved through learning by doing (on the part of the product manufacturers) and learning by using (on the part of the users either as final consumer or as input in a manufacturing firm) (Rosenberg 1982). According to Rosenberg (1982), the cumulative effect of these small changes can be as large and bring productivity growth that major innovations are capable of generating. It is a source of technological innovation that is not usually explicitly recognized as a component of the R&D process which over lap with the development and receive no direct expenditure, which may be the reason why it is normally ignored (Rosenberg, 1982). Additionally, according to Budworth (1996), incremental innovations do not involve major investments or risk. This could be another reason they are ignored.

A word of caution is however in order in defining incremental innovation, especially in relation to methodological issues. According to OECD, (1997) incremental innovation should exclude the following:

- Making other creative improvements such as those in product differentiation where the novelty does not concern the use or objective performance characteristics of the product in the way they are produced or delivered but rather their aesthetic or other subjective qualities.

- Stopping doing something is not considered as an innovation, although it may improve a firms' performance.

- The purchase of more machines of a model already installed won't be considered as an innovation.

- A change in a price of a product or of the productivity of a process resulting exclusively from the changes in the price factor of production is not an innovation.

2.1.3.2 Radical Innovation

Radical innovation makes a substantial change but falls short of founding a new industry. The risk and required investments in radical innovation are usually considerably greater than for incremental innovation, and they offer more opportunity for new entrants to enter the new market.

2.1.3.3 Fundamental Innovation

Fundamental innovations are those which depend on major new scientific knowledge and open up completely new industries, causing a paradigm shift. One example is the discovery of the transistor, which depended on the electronic movements in solid as opposed to the electronic movements in vacuum, which characterised the electronic valve where first generation

computers were based. The discovery of a transistor led to the discovery of the integrated circuit which in turn led to the cheap and reliable computers.

The implication of the above types of innovation for this work is important, especially in terms of methodological issues. Fundamental innovations are hardly expected, because these depend on the paradigm shift which involves completely new industries, whereas the focus in this case is on the industry from older techno-economic paradigm, and also dealing with a poor country. As a result most of the innovation expected will be of the incremental nature which are normally not obvious to the outsider, especially in the case of process innovation. But the insiders can well know the improvements that have been made to increase productivity. This will also include successful adoption of foreign technology.

2.1.4 Models of Innovation

In literature three models of innovation can be identified: technology push, demand pull and interactive models of innovation.

2.4.1 Technology Push Model

According this model innovations are triggered as a result of basic research in science resulting into a wide spread marketing of a new product or widespread use of a new process (Coombs (1986); Rosenberg (1982); Budworth(1996). The role of the market here is a passive recipient of innovations, and there is linear progression from a basic research to production and marketing and by implication to economic success. Science is seen as a major driving force and all governments need is more scientists. However the model has been widely criticised as an oversimplification of the reality[2].

According to Rosenberg (1994) the model is not only dead, but buried. While we well agree with Rosenberg, it is also true that the ghost of the model still haunts some of the nations in the South. This is true for some of the least developed countries such as Tanzania. R&D structures have been erected specifically for the purpose of serving the linear model and although this has largely proved failure, no body has come up with an alternative model.

2.1.4 Demand Pull Model

According to the demand pull model, innovations are in some sense called forth or triggered in response to demand for the satisfaction of some classes of needs. This model seems to have gained wider currency in the innovation debate. Some scholars almost exclusively relate innovation to demand-pull. For instance Budworth (1996) when discussing possible sources of innovations mentioned the factors that are largely from the demand side. These are:

- Unexpected change in customer taste becoming evident in the market,
- Process needs

[2] For a detailed discussion on this consult Rosenberg, 1982, pp, 192-238….

- Demography which change the age structure of the population and hence the demand for such things as disposable nappies; retirement homes etc
- Change in perception of potential customers especially, how individual see themselves and their roles as consumers.

The above line of thinking was also stressed in the SAPPHO project (described in length by Rosenberg (1982). According to the project, understanding of the special needs and circumstances of potential future users of the new process or product was found to be important in innovative activities. Numerous studies since SAPPHO have confirmed the vital importance of the user–producer linkage (Lundvall(1985)). However, just like the technology push, the model has also got its share of criticism[3]. The major arguments are summarised in the following interactive model.

2.1.4. Iterative Model of Innovation

Of late, however there seem to be some consensus among scholars of innovation that the two extreme models of innovation on their own are inadequate. There has to be some interaction or coupling between the two processes. In relation to this, Mowery and Rosenberg (1979), and Rothwell and Zegveld (1985), argue that innovation is a complex interaction between the 'supply'(R&D labs, scientific and technical institutions) and the 'demand' (potential and actual users, and marketing organisations). Additionally, in support of the same point, Rosenberg (1982) made the following major conclusion:

> *Both the underlying evolving knowledge base of science and technology, as well as the structure of market demand, play a central role in innovation in an interactive fashion, and neglect of either is bound to lead to a faulty conclusion and policies (Rosenberg(1982), p.195)*

There is slight difference between radical innovation and incremental innovations in the above interaction. When it comes to incremental innovation, the experience of users is bound to be extremely important and will often predominate as a source of ideas for innovation. On the contrary, when it comes to fundamental innovations, in the early stage contribution of science and technical institutions such as R&D become more important (Coombs (1987); Rosenberg (1982))

The above contention is of paramount importance for this work. As already explained the type of innovative activities that are expected for the specific case of Tanzania in general and metal and engineering in particular are largely adoptive and incremental and may be some few radical innovations. This places a great importance to the user-producer interaction. However, because of the low level of education in the workforce, collaboration with public R&D institutions whose employees are relatively highly educated might also be very important. As we will see later in this work, there is also some evidence of collaboration between industries and R&D institutions especially in terms of consultancy services offered by R&D institutes to industry. The role of these consultancies in the firms' business well fare is not clearly understood. The hypothesis is that they also contribute to the innovativeness of the firms.

[3] See Rosenberg, 1982, pp.193-238

Such collaborative activities were also evident during the early industrialisation of the now industrialised countries (Nelson, 1993; Freeman, 1995). Japan for instance started industrialisation through import of foreign technology, integrated this into R&D and production departments. The Japanese R&D during this era, termed as catching up period (1945-1972) was largely on adaptive technology (Sunil, 1999). The system was also highly characterised by strong user producer and subcontractor network linkages. Even with the importation of foreign technology, Japanese seemed to be very close and interacting with their foreign suppliers, they themselves went out to Europe, selected the technology they wanted, and in some cases brought in expertise into Japan to assist in the installation of the technology (Watanabe, 1983). This was in contrast with other countries that are now less developed such as USSR and Eastern European socialist countries. The system in these countries have been characterised with linear model of innovation-which in some way, is very similar to that of Tanzania (Hewitt, 1997). The public R&D institutes in these countries are divorced from the production and imports of technology. Additionally, the systems in these countries are characterised by weak and non-existent linkage between marketing, production and procurement (Freeman, 1995).

2.1.5 Innovation Process: It's Specificity to Time and Socio-economic Context.

Perhaps what the early scholars of innovation did not explicitly pursued in the debate is the specificity of innovation in the social-economic and social cultural context and that it is a dynamic concept. These gaps have been filled by recent scholars on National Systems of Innovation (NSI), defined as *that system which is constituted by elements and relationships between those elements which interact in the production, diffusion, and use of new and economically useful knowledge.* In a way, this is nothing more than an extension of the debate on the innovation process that initially started with the linear model of innovation[4]. The concept seems to have taken its roots from the interactive model of innovation discussed in this work, where factors influencing innovation seem to have been expanded to the extent of including nearly every thing about a particular nation. However, according to many proponents of NSI, the elements are largely of two types: institutions and organizations. Organizations are formal structures with explicit purpose and they are consciously created. Some important organizations in the SI are companies (which can be suppliers, customers, competitors in relation to other companies,) universities, R&D organizations, venture capital organizations and public innovation policy agencies. Institutions are set of common habits, routines, established practices rules or laws that regulate the relations and interaction between, groups and organizations. The examples in the SI are for instance patent laws and norms influencing the relations between universities and firms (Edquist and John 1997). The concept of NSI, as already observed by some scholars, is ungeneralizable universally, but carries a very important value, especially for those developing countries that are so much fond of taking ready made things from the west. It emphasises on specificity of innovation to a particular socio-economic and social-cultural context. This aspect indeed is what motivated a close

[4] As such it is surprising to find out that historical review of this literature is conspicuously lacking in the literature on NSI.

look at the concept in relation to this work. The aim is to emphasise the point that innovation is a multi-actor field and that it is context specific.

One of the sources of complication and ambiguities in NSI literature might have arisen because of lack of clear definition of innovation in most of this literature. Innovations are of different types and degrees as discussed in this work. It really matters to what type and degree of innovation one is referring to, when discussing a certain NIS. For instance institutions which support fundamental innovation can be completely different from those that support, for instance, incremental type of innovation. Taking the example of factors influencing innovative activities given by (OECD, 1997, p.33), as shown below, one can actually attempt to assign degree of importance of factors or elements to different types of innovation.

According to OECD the following factors or institutions surrounds innovative activities:

1) Basic educational system for general population, which determines minimum educational standards in the work force and domestic consumer markets.

2) The communication infrastructure, including roads, telephones and electronic communication.

3) Financial institutions determining for instance the easy access to venture capital.

4) Legislative and macro economic settings such as patent law, taxation, corporate governance rule- and policies relating to interest and exchange rate, tariffs and competition.

5) Market accessibility, including possibilities for the establishment of close relations with the customers as well as matters such as size and ease of access.

6) Industry structure and the competitive environment, including the existence of supplier firms in complementary industry sectors.

While it is true that all the above factors affect the innovativeness of the firm, it does so in a complex interactive fashion to the extent that it is not easy to determine to what extent each of the above is contributing, or which factor is more important than the other. But if one starts with the definitions and degrees of innovation it is possible to assign some degree of importance of the above institutions to every type of innovations. For instance, for fundamental type of innovation the first and third types are extremely important. While for the incremental innovation fifth and the second are extremely important. However, this is not to say that the rest of the factors are not important for every type of innovation, but the mentioned ones are indispensable for that type of innovation.

For all types of innovations, special emphasis has been put on the relationships that are constituted through the market place such as those between users and producers (Lundvall, 1992, Edquist, 1997, Gu 1999). Haukness (1999) also argued that for most firms, the relations with the customers, suppliers and competitors are the most significant link to their environment to the extent that these argents constitute the major dimension of NIS.

The most important value added on studies on NSI, as mentioned above, lies on the realisation that innovative activities are actually context specific (Lundvall, 1992, Gu, 1999). Lundvall for instance, underscores the fact that basic differences in historical experiences, language and culture will be reflected in the above institutions, especially the way people think about them. This line of thinking is supported by studies on many performing clusters, such as the Italian industrial districts. It has been found that inter firm networking primarily emerged spontaneously as the result of the peculiar historical and social environment surrounding the SME's (Geglie G.,et al.,1991)

Additionally, according to Kwanjai, (1999), the composition of the various components, their relative weight of their influence and the way they relate to and interact with each other across countries and over time vary.

Gregersen B. and Johnson B. (1997) have also underscored the issue of time contextual innovation. They argued that in relation to the innovation process, history matters, and it is meaningless to search for a time independent theory of innovation and growth.

In short, throughout the review of literature on innovation, it is safe to conclude that innovation is certainly a multi-actor field. Where the actors most mentioned are: firms and their suppliers and users, R&D institutions, academic and financial institutions. Additionally, studies on networks also emphasised the plurality of actors in the innovation process. Most of these studies emphasise the role of firm-firm interaction that is firm and their suppliers and users, and firm and their competitors[5]. Given any set of the same institution, the way they relate, interact, the weight of each institution in the innovation process, however largely depend on the socio-economic and cultural situation of a given country[6]. This in turn naturally depends on the time because society is dynamic, socio-economic situation changes along with views of individuals about life and all that it entails.

Such findings or observations are of paramount importance for the least developed countries, where in most cases S&T policies have been a replica of S&T policies of more developed countries which have been formulated depending on the empirical findings based on the environment of these countries. In Tanzania and most of the SSA countries for that matter, innovation studies have not been a culture, especially studies related to factors behind innovative activities. We will shortly return to this point. At this point it is important to closely examine (from existing literature) the type of institutional linkages that was found most important in innovative activities, and to which our research intends to base. These are:

- Firm-Supplier
- Firm-User
- Firm-R&D Institutions and academia

[5] See for instance DeBresson (1999), for in depth discussion on this.
[6] At least this is what can be discerned from most studies on NSI

2.1.6 Linkages

Many meanings are attached to link and linkage. In its noun and verb form link refers to connecting, tying or joining together two or more objects. It is broadly defined as collaborative arrangements between different institutions such as firm and firm, firm and public sector, government and academics (Greek k., 1999). For the purpose of this work, analysis will be restricted to two institutions: firm-firm linkage in terms of producer-supplier linkages, firm-R&D and university. The role of these linkages in innovative activities of different firms will be discussed.

Linkage can vary in terms of content. There can be technological, organisational or social linkages (Goodman et. al., 1994). The focus for the work will be on organisational linkages in relation to markets. Above all, whether or not these are accompanied by technological linkages in terms of sharing of technical know how and skills, product specification and designs. User dissatisfaction of a certain product and communicating this to the producer, where finally the producer looks for solutions either inside or outside the firm is also one way of getting the technology right. It should be born in mind that technological innovation, especially incremental can not be separated from the market linkages. However this is not to contend that all market linkages accompany technological linkages, rather as it will shortly be shown, there are special types of linkages that are conducive to innovation. This point will shortly be returned to. But to the contrary most technological linkages accompany market linkages (Papola, et. al 1983)

Linkage can also vary according to the degree of interdependency. One can conceptualise a linkage in which all objects are highly interdependent versus one on which objects are loosely coupled. This point will be taken up again when discussing market linkages.

2.1.6.1 Firm-firm Linkages

These are of two types: vertical and horizontal linkages. Vertical linkages are normally referred to as market linkages, defined as frequent transactions between firms, where firms both small and large scale buy and sell among and between each other (Wangwe, 1997; Papolar T.S, 1983). This can be divided into input linkages and output linkages. Input linkages are relationship between the two firms in regard to supply of raw materials and machinery. While output linkages regard to the market or buyers (Watanabe, 1983). Horizontal linkages are linkages among the competitors. Output and input linkages can also be described in terms of backward and forward linkages. Backward linkages occur when a productive activity in one sector requires inputs from another. For instance agriculture may have a backward linkage with manufacturing when it uses fertiliser, pesticide and agricultural machinery in its production process. Similarly, when agricultural sector produces goods as inputs in the food-processing sector it establishes a forward linkage to manufacturing sector. Such types of linkages are very important for the healthy growth of the economy.

The technological linkages of the two parties can largely facilitate backward and forward linkages. For instance the decision for agriculture to purchase machinery and other inputs from the manufacturing firms will depend on the quality and price

requirements of the agricultural sector. This in turn will depend on strong interaction between the two parties in terms of getting technology right.

Taking the example of buyers and sellers, Kaplinsky (1989) differentiate the nature of inter firm relations based on mass production and that based on Japanese business structure (to be described later). According to Kaplinsky, the relations in the mass production model are essentially arm length negotiations between buyers and sellers. Finished product manufactures maintain large, shifting network of potential suppliers, using more than one supplier for each out-sourced product to preserve price competition. The relationship between buyers and sellers is therefore inherently unstable and short term, often extending only to a single purchase order so that they can switch suppliers easily if another one offers a better price. On the output side, overall marketing response is estimated on the basis of the market potential and the attractiveness of the firm's offering in relation to the offering of the competing firms. In this case the innovative activities can be triggered by the competition between sellers not interaction between sellers and users. Even though, there has to be some kind of market signals which should be clear to some of the firms, at least to know what users desire. Others can then follow suit as a result of competition. But all in all it is the competition between sellers not interaction between individual buyers and sellers which is assumed to determine the marketing effort. Mass media advertising is often used to attract anonymous customers and transaction takes place without much interaction between sellers and buyers (Nyastrom, 1990)

The above kind of relationship does not permit close cooperation between suppliers and individual buyers, so that the supplier has no incentive in investing in the equipment or skill development to produce component more tailored to the needs of the buyer. At the same time buyers are reluctant to provide the supplier with details of product design or to encourage the supplier to develop the component that would improve their finished product, but which the supplier could also sell to the buyers competitors. The above kind of market relationship can hardly contribute to innovative activities of the form of learning by doing or learning by using we earlier discussed. On the other hand close and long-term strategies as against mass marketing concentrate on establishing and maintaining business with number of important customers. Direct selling for instance by sales representatives and flexible individually negotiated prices are used to facilitate interaction and individual transactions are carried out with the intention of establishing and maintaining continued long term dealing with customers.

Two concepts in marketing relationships have been underscored by Nystrom (1990): vertical complexity and horizontal complexity. According to him vertical complexity means greater number of the distinctive uses for a given product or product category by individual buyers. In contrast, horizontal complexity means selling a product to many anonymous buyers. In this, just like in mass production discussed above, buyers and sellers may momentarily stop doing business with each other at any time; the only determining factor being the quality-adjusted prices of comparable competing products.

Greater complexity in use, that is greater number of distinctive uses for a given product or product category by individual buyers, will tend to greater vertical complexity. For instance if a customer uses a product in many different ways, a seller

has a number of options in differentiating an offer to fit the specific needs of this buyer, which together may make the customer more dependent on buying from that particular firm. The number of different products which individual buyers purchase from a firm will also influence the degree of complexity in marketing relationship. A large number of different products, frequently bought by buyers from a given firm will lead to a high degree of vertical complexity in relationship. On the other hand when different buyers infrequently purchase quite different products in small quantities from various firms, the degree of horizontal complexity will be high. In the former it is easier for seller to adapt to specific buyers needs, while in the latter it is difficult (Nystrom, 1990).

According to Nystrom, a more innovative way to achieve a high degree of complexity is to establish joint companies with buyers to develop radically new products and processes. The strongest instances of vertical complexity are usually of joint ownership, either mergers or co-operative ventures. Such close inter-dependencies between buyers and sellers are reflected in the Japanese model, where major manufacturers are increasingly becoming "sub-system integrators". The system operates as a close knit net-work of buyers and suppliers with long term relationship that encourage the pooling of technological resources and know how, co-operation to improve productivity, and exchange of detailed design plans and even proprietary information. These types of linkage enables finished products and component manufacturers to collectively enhance innovation and competitiveness.

Another way of enhancing innovative activity is through sub-contracting arrangements. This according to Watanabe (1983) is a business practice where a party offering a subcontract (parent firm, enterprise or company) request another enterprise (sub-contractor or ancillary unit or industry) to manufacture or process the whole or part of the product, but the first party sells as its own. This implies that the modification of a part or component of a product or process by one sub-contractor inevitably affect the manufacturing process as a whole. As a result the subcontractor must supply the product according to detailed specification which can only be modified within certain limits. To a certain degree this compels the parent company to offer advice and supply necessary technology to subcontractors so as to increase their economic and engineering capabilities. This result into upgraded subcontractors because of their specialised technology and equipment instead of the traditional low cost approach (Freeman, 1991).

Where industrial subcontracting is practised on a regular basis, production and investment plans, including choice of techniques of the two parties are interdependent. This means if the technological capability of the parent company is higher than that of the subcontractor, the latter's capability is pulled along. However a word of caution is in order here. Not all the subcontracting relations lead to technological capability building. As mentioned above buyers that enter into subcontracting agreement simply to acquire the cost benefit of cheap labour will not have an incentive to improve the technological capability or productivity of the contract firm. (Lavengood, ( ).

In concluding these few paragraphs on users and suppliers, it is important to reiterate some basic points. The following few paragraphs summarises the points.

Creating a new product or process, and where one person's product becoming another's process requires a complex process of heuristic interactions. Suppliers and users do not have the same point of view and do not do the same things in these interactions; but each is dependent on the other. Without problem identification and performance requirement from a potential client, a supplier most often cannot even start to conceive a technical solution. Additionally most often the potential user does not have competence to find the best technical solution to achieve best performance at lower prices. These are of best interest for both the suppliers and buyers (DeBresson, 1999). Such desired interaction is not possible if the relationship between the buyers and suppliers are arm length and short lived.

The above is somehow confirmed by the study on 'failed' attempt at innovation, particularly the project SAPPHO (discussed in length by Rothwel et al. (1974) and also by Rosernberg (1982). The most important finding of the study was that the commonest and most persistence cause of failure was on weak relationship between producers and users of an innovation. An equally important cause was the lack of horizontal communication between R&D departments and, production and marketing within the firm. In least developed countries there are no R&D departments. This then points to the importance of the public R&D institutions.

In relation to the above argument, Lundvall (1992) argues that it is obvious that product innovation would be rare and accidental if markets were characterised by anonymous relationship between producers and users. Producers would have difficulties in observing new users needs, and users would lack qualitative information on the characteristics of new products. The fact that product innovations are common implies that markets are not pure. Most markets involve an element of mutual exchange of qualitative information, and sometimes by direct cooperation between users and producers in the process of innovation.

Policy implications for the above are enormous. It means that modern economies are 'mixed' in a fundamental sense; not only does the private sector coexist with a large public sector, but the relative success of the market economies in terms of technical progress depend more on the impurities of the markets than their purities. This implies that government intervention is necessary in manipulating the relationships between users and producers. As Dulum (1992) puts it; government should take the role of match making: renovating or braking up old and establishing new user-producer relationships. In some countries such institutions already exist e. g Sweden and Switzerland; a few big firms have their own strategies, concerning the restructuring of the pattern of national user-producer relationships. In German banks played the roles. In Japan the most important function of MITI was to bring together parties which might have not co-operated spontaneously. However such matchmaking role require prior knowledge of the existing patterns of the internal dynamics at the firm levels. This is the major role the present study attempts to play.

2.1.6.2 R&D Institutions

2.1.6.2.1 The Origin of the Industrial R&D

R&D activities became evident during the first-world war and were envisioned essential for advancing military technology. The activities culminated in the

Manhattan project, with the manufacture of man ever made most destructive weapon- the atomic bomb. This was the result of the fundamental discoveries in physics. The discovery of the atomic bomb was not the only fundamental discovery during this period; the Anglo-German competition in the radar technology was employing thousands of skilled scientists and engineers, and was decisive for the British success in the battle of Britain (Freeman, 1992). After the second-world war the success of R&D in industrial development was so obvious and this was the beginning of its institutionalisation. Governments' expenditure on R&D also dramatically increased. While before the war R&D accounted for only small part of GNP (about 0.1%), 30 years after the war, expenditure had already increased to about 1-3% of the GNP in some of the developed countries (Freeman, 1992).

2.6.2.2 The Role of R&D in the Western Industrial Development

Later on two most important institutional innovations were made in the west, the in house industrial R&D departments and the institute of technology for professional education of engineers. The R&D departments were responsible for the regular and systematic improvement and scaling up of the product, taking into account new scientific developments outside the firm, as well as the experience of the users and the requirement of the entire technological system. In this way firms were able to develop new products and processes (Freeman, 1992). R&D departments therefore became the main point of entry when it comes to development of new product and processes, where many incremental innovations continued to be the major task of production engineers and shop floor workers without any necessary reference to R&D (Hollander, 1965, cited in Freeman, 1992). Today the organisations of R&D in the west have dramatically changed. More and more collaborative projects between firms and between firms and universities are increasingly being evidenced (Freeman, 1991)

The history of R&D development tallies with the history of innovation studies. It is obvious from the above that investment in R&D begun with the science based fundamental innovation such as those in military technology. The early scholars of technological innovation had a reason to purport the linear model of technological innovation. Science was decisive and was labelled the endless frontier. But later as things were unfolding, especially when the technology started to diffuse to the civilian industries, other factors such as the demand emerged, and organisation of R&D was radically changed, where the private industrialists came into the picture. This was possible because the culture of researching and learning about innovation dynamics was part of the system in the developed world. On the contrary, because of the lack of the research effort in the poor developing countries, they are still stuck with the long overdue linear model of innovation. There is therefore a need to redefine the role of R&D functions in these countries.

2.2 Innovation and Linkage Studies in the Tanzanian Context

The section gives an overview of the general innovation and linkage studies in the Tanzanian manufacturing sector before it lends itself in the specific case of metal and engineering sub-sector.

2.2.1 Innovation Studies

Comprehensive and systematic innovation studies, especially those specific to sectoral and firm levels are conspicuously missing in Tanzania. To the best knowledge of the author the only study that attempted an inquiry in this direction is by Komba 1984. The study is a modest attempt to evaluate innovativeness of Tanzanian manufacturing industries. The major objective was to identify factors that work against innovative activities. Besides the study being old, the focus was the firm and not the linkages. The study however found out that some of the firms; especially those in the engineering sector were relatively innovative. One of the private industry-Afro-Cooling Co. was found to be innovative to the extent that it worn an international Africa award as a recognition for its achievements. The firm is an integrated manufacturing firm, producing radiator components as well as assembling the final product. Up to early 1990's the firm was still found to be doing well (Bagachwa,et al.,1995).

Other studies related to innovativeness are those which addressed the issue of technological capabilities in its broadest sense (see for instance Wangwe 1993, Chambua, 1996). Most of these studies also lend themselves to a macro level policy analysis, which can hardly capture very minor innovative efforts at the firm level.

2.2.2 Linkage Studies

2.2.2.1 Firms Linkages with R&D Institutions

Before discussing the linkage between R&D and industry it is instructive to see first the origin and objective of the government R&D institutions in Tanzania.

In the early 1980's quite a number of R&D institutions were established in Tanzania. These were set up to serve the major sectors of the economy such as agriculture, industry, health, water and energy. The concern here is with those R&D institutions which were specifically set for the purpose of serving the manufacturing industry in general and metal and engineering in particular. These are:

(i) TEMDO

The Tanzania Engineering and Manufacturing Design Organisation (TEMDO) was established under the Act of the Parliament, No.. of 1980 and became operational in June 1982. Its major objective was to do R&D and produce prototypes for manufacture by the Tanzanian industries. Other objectives were providing technical extension services including training aimed at increasing the skills of the technical human power at all levels and establishments in the country, and to enable industry to produce products or processes for mass marketing.

(ii) IPI

Institute of Product Innovation (IPI) was established in 1981 under the provision of the University of Dar-Es-Salaam. It was a semiautonomous institution that was created to provide link between the faculty of engineering and the Tanzanian industry in terms of engineering research and prototypes development. Its major activities are:

- To carry out applied research and prototype developments, including all related software.
- To offer consultancy to industry including trouble shooting and manufacture of industrial spare parts/components.
- To contribute to the curriculum development at the FOE.

IPI was integrated in to the Faculty of Engineering and transformed to a college of Engineering and Technology on December 15th, 2001. In the new structure the innovation related functions have been taken over by the established Technology Development and transfer Center (TDTC).

(iii) CAMARTEC

Centre for Agricultural Mechanisation (CAMARTEC) was officially started in July 1982. It is a merger of two separate institutions: one formerly known as Tanzania Agricultural Machinery Testing Unit (TAMTU) and Arusha Appropriate Technology Project (AATP). The major objective of the institute is to carry out applied research and to facilitate the design and development of machinery and equipment suitable for use in agriculture and rural development.

The most talked about linkages are those about transfer of well proven prototypes from R&Ds to industry. Much has been said on this, mostly in conference and seminar papers, and there seem to be some kind of general consensus that the link between R&D and enterprises is weak. Additionally most of the arguments were based on the role of R&D institutions as conceivers of technologies as guided in a traditional linear model of innovation. As described above major objectives of R&D institutions in Tanzania is to conduct applied research and to develop prototypes, which after being well proven, are transferred to the industry for large cale manufacturing. Much of course is not happening in regard to this task (Chungu et al., 1994). The developed prototypes have hardly been taken up for commercial production by the potential manufactures. The sources of these weaknesses are two folds. First, R&D institute often developed prototypes that were technically visible but were not necessarily economically viable. Second, the environment governing the investment decision of manufacturers was not sufficiently competitive to induce a search for new avenues of investment in the developed prototypes (Wangwe et al., 1998)

It is against this major objective the linkage between R&D and industry and therefore their performance were judged. The possibility of vast consultancy service being offered by some of these institutions to industry as demonstrated in Chambua, 1996,

contributing to innovative activities and productivity growth in these industries has not been systematically explored. This is a serious research gap, especially now that R&D institutions have been left at the crossroad as far as funding is concerned. These were formally government and donor funded, but now that the government is 'broke' and donors have developed some kind of a donor fatigue, these institutes do not know to whom to turn to, though of course in principle they still belong to the government. Since these are so vital in innovative activities they need some kind of reorientation. To reorient R&D institutions meaningfully, requires detailed knowledge of their strengths and weaknesses, and areas where they can yield maximum payoffs. This knowledge as evidenced above, resides in those who use the technology, notably the firms, customers and suppliers.

In more developed world, it has been shown that those firms who keep contact with technical consultancy firms such as R&D institutions and the Universities, are more innovative than those who do not *(*Rosenberg 1982; Pavitt 1987; Dosi 1988; Senker 1995*).* It has also been shown that to a large extent, there is a positive correlation between keeping contact with consultancy organizations and the absorptive capacity of firms; that is, the more firms' employees are highly trained, the more the contact with consultancy firms *(*Cohen and Levinthal 1990; Vinding 2001).

2.2.2.2 Market Linkages

There is one study (By Wangwe et al., 1997) on market linkages between and among firms. The study market linkages as frequent transactions between firms, were firms both small and large sell and buy between and among each other. The study found out that in the sample of 74 firms in the metal, food and construction, about 80% of small firms sell about 50-100% of their products to large enterprises on the one hand and about 55.5% these firms sell between 10-50% of their products to other small scale industries. However since the study was conceived with purpose other than innovative activities, did not indicate the type of linkages as discussed in this work. That is, whether the relationships were arm length and short term or long term and obligational.

The same study also addressed the issue of sub-contracting activities. It was found out that over 60% of the firms were involved in the sub-contracting relationships

Other studies are those on firm clusters that revealed that enterprises on clusters cooperate in ideas on designs and mutual adjustment on prices (Musonda 1997, Aeroe 1992). About 96% of the firms in clusters are also engaged in subcontracting activities. While sub-contracting activities have been found to be very useful vehicles in innovativeness of firms in industrialized countries, no comprehensive study which relates the subcontracting activities to innovativeness has been conducted in Tanzania.

Additionally, the linkage and network studies on SSA in general and Tanzania in particular, are those on small scale and mostly in the informal sector. The studies provide useful information on the benefit of social interaction in business. They kind of benefit from mutual price adjustments, information about the design and adaptation of equipments and mutual help in time of business crisis (Sverrison, 1990,1992,1993, 1998; Aeroe, 1992; Musonda, 1997). However, the studies lack systematic and

empirical analysis of the innovative activities emanating from such networking. Moreover very little can be expected from most of these firms in terms of innovative activities. Having lived with and knowledge of some of these informal business operators, it appears that these are not real entrepreneurs. Most of these firms a mere survival strategies, they happen to be in their line of business not because of the special skills they poses for the business, but rather as a way of surviving. It is a hand to mouth business. Moreover as the experience of more developed world demonstrate, small-scale firms achieve their growth in conjunction with large-scale firms in terms of linkages between these sectors. Factors facilitating growth in the large-scale industries are thus of paramount importance.

Another form of linkage observed in Tanzania is that between Tanzanian firms and foreign equipment suppliers. It has been found out that more than 80% of the process technology in metal, food and construction firms is 100% foreign (Wangwe et al 1997). However it is not clear from the study whether the relationship is obligatory and long term or short term. Available literature such as Wangwe (1993), suggest that importation of hardware technologies had failed to build local technological capabilities in terms of adaptation to local conditions, servicing and fabrication of spare parts. However, the study was at a macro level of analysis. It would be interesting to direct the analysis at micro level to discern some of the differences at firm level, especially to uncover types of relationship with the suppliers and users, and how this has helped firms to be relatively innovative. As already mentioned Countries that were relatively successful in the transfer of technology such as Japan have always maintained a close contact with the suppliers of the process technology. However small in number, those with positive experience can act as useful pointers towards designing appropriate policies.

What the above brief review of literature indicates is that, while there are some studies on institutional linkages, the studies are far from comprehensive. They do not elaborate on the nature of linkages, that is whether these are arm length and short term or long term and obligatory. Additionally, the studies have not systematically addressed the issue of linkages and innovativeness, which is paramount in innovative activities.

3.0 Hypotheses

Finally as a result of the review process, the following hypotheses are developed:

- Innovative firms will tend to have long term and obligational relationship with their buyers and suppliers. While those which are non-innovative will have short-term relationship.

- Producers have a significant and positive correlation between long-term links with buyers and suppliers on one hand and R&D on the other hand. Implying that one of the most significant relationships between R&D institutions and firms is that of mutual solving of technical problems that becomes evident as a result of producer-buyer and supplier interactions.

- The more trained the firms' employees, the more contact with consultancy organizations such as R&Ds and Universities.

4.0 Methodologies

4.1 Choice of the Sector

Metal and engineering sub-sector was selected because of its smooth and gradual growth compared to that of the manufacturing sector in general. The sector's growth increased from 13.6% from 1980 to about 16.6% in 1988, declined to 9.3% in 1990.It again increased to 14.5% in 1993, and about 16.3% in 1995.Contrary to this the growth in the manufacturing sector in general was sporadic and short lived. It dropped from 11.7% between 1961 and1969; and to 5.8% between 1969 and1975. It further dropped to 0.7% between 1975 and 1981. In 1985 it reached its minimum value of –3.9%. After the launching of the ERP measures in 1986, the annual growth rate improved to an average of 2.5%between 1986 and 1990. It again dropped to 2.3% between 1990 and 1994. In 1995 the growth rate was 8.8% (Ministry of Industry, 1996). Such sporadic growth rate can be explained by the injection of more financial capital, leading to more capacity utilization rather than increase in productivity as a result of innovativeness of firms

Because of its relatively smooth growth, there is a reason to believe that some thing relatively positive is happening to the metal and engineering sub-sector. This could be asserted to some incremental innovations taking place as result of user producer interactions.

4.2 Scope, Data Sourcing and Collection

The research will basically be limited to medium and large category of metal and engineering sub-sector (employing more than 10 people).

This sub-sector has been chosen, firstly, because it is the one that has been found to be relatively more innovative according to the available literature.

Secondly, the sector was deemed strategic for the growth of the other sectors. The popular basic industrial strategy (BIS) of early 1970's was about to bring structural change in the economy, where the share of capital goods sector was to be raised. After almost two decades of the implementation of the strategy, it was found unsuccessful. Such desired structural change in the economy is still in the long-term objectives of the current industrial strategy, SIDP (Sustainable Industrial Development Strategy) (Ministry of Industry, 1996).

Since the study is designed to base on observed innovative activities, micro and small-scale industries (employees less than10) cannot be included because these are less likely to be innovative. Several studies on this sector indicates that the sector is biased towards labour rather than capital intensity (Bagachwa 1994)

Two research methods will be employed: Survey approach and case study approach. The case study will be on in depth study on two types of firms: those that are relatively innovative and those that do not show any sign of innovative activities.

4.2.1 Sampling Procedures

The study will include the entire medium and large-scale industries in metal and engineering sub-sector. That is, by Tanzanian definition, all the firms with 10 employee and above in the metal and engineering sub-sector.

4.2.2 Data Collection Techniques

- Structured questionnaire
- Semi-structured questions.
- In-depth interview (For the case studies).

4.2.2 Data Sources

4.2.2.1 Primary Sources

The structured questionnaire will be administered in the sample firms. While While unstructured questionnaire will be administered to both the sample firms, and R&D institutions.

4.2.2.2 Secondary Sources

Data based at Ministry of Industry and Trade, and R&D institutions.

4.3.0 Design of Questionnaire

4.3.1 Measurement of Innovation

As demonstrated from the definition of innovation and its systemic nature, measuring innovation presents a fundamental problem in innovation studies. The above difficulty notwithstanding, from available literature three ways of measuring innovation can be identified:

- A measure of the inputs into the innovative process, such as research and development (R&D) expenditure, or else a share of the labour force accounted for by employees involved in R&D activities.

- An intermediate output, such as the number of inventions that have been patented.

- A direct measure of the innovation output.

The first two measures have largely been criticized as inappropriate, especially as it relates to incremental innovations. This therefore will not be discussed. The third

approach is therefore chosen and discussed briefly. As the name suggests, this is achieved by directly looking at the innovation outputs.

Several researchers have used the above direct measure method, for instance SPRU used it to identify significant technical innovation that had been successfully commercialized in the United Kingdom since 1945. This was done by directly writing to the experts in each industry. The study also identified the firm responsible for the innovation (Pavit et. al., 1987, cited in Acs et. al, 1991).

Another work in which the direct measure was used is the compilation of innovation database for US Small Business Administration Innovation DataBase (SBIDB). The database consists of 8074 innovations introduced in the US in 1982. A private firm, The Future Group, compiled the data base and performed quality analysis for the US Small Business Administration by examining over 100 technology, engineering and trade journals, covering each manufacturing industry. From the sections in each trade journal listing innovations and new products, a database consisting of innovations by four-digit standard industrial classification (SIC) was formed. The above data has been utilized by researchers to analyze the relationships between firm size and technological change on one hand and market structure and technological change on the other hand (Acts, J.Z et. Al., 1991).

The study intends to use the direct measure by asking the experts at the firm level to identify innovations (new products or processes and/or any modifications made to these) they think have **contributed to the productivity growth of the firm.** The productivity growth is stressed to eliminate unsuccessful adoption of imported technologies. These can also be supplemented by measuring productivity growth of the sample firms over several years. Here special care will be taken to exclude all the non-innovative changes discussed in section two.

4.3.2 Measurement of Market Linkages

A number of dimensions adapted from Nystrom (1990) will be used to measure the degree of short term versus long-term market linkages. Nyastrom was relating the degree of commercial success to type of marketing strategy in Swedish paper industry. He therefore derived several dimensions to measure the degree of market linkages. Of these the study will only adopt those, which corroborate the conceptual framework, discussed in section two. These are:

- **Degree of Product Differentiation**

This reflects how well the product is adapted to individual buyer or how specific the product design is from the point of view of the buyer.

- **Production Technology**

Flexibility in switching between different products in the product range of the company.

- **Sub Contracting Activities**

If a firm is found to be a sub-contractor, assistance in equipment upgrading from parent firm is sought.

- **Buyer Characteristics**

-The proportion of the established customers
-The relative proportion of company sales which the largest customer accounted for.

4.3.3 Measurement of Factors Affecting Linkages and Innovativeness

These will be analyzed through a detailed case study of few selected firms from the two extremes that is those that are relatively innovative and those which do not show any sign of innovation.

5.0 Data Analysis Techniques

SPSS package will be used to analyse the quantitative aspect, while packages such as NUDIST will be used to analyse the case studies.

REFERENCES

ACS, J .Z. and Audretsch, B. D. (eds.) (1991), *Innovation and Technological Change: An International Comparison,* Harvester Whetsheaf.

Aeroe, A. (1992), "New Path ways to Industrialisation in Tanzania: Theoretical and Strategic Considerations" in IDS Bulletin, Vol. 23. *Flexible Specialisation: A New View on Mass Industrialisation, Sussex, IDS.*

Archibugi, D., Evangelista, R. and Simonetti, R. (1994), "On the Defination and Measurement of Product and Process Innovation" in Shionoya, Y. and Perlman, M. (eds.) (1994) *Innovation in Technology Industries and Institutions. Studies in Schumpeterian* Perspectives, University of Michigan Press, USA

Bagacghwa, M. S. D. (1994), *Structure and Policy of the Informal Manufacturing Sector in Tanzania,* Dar-Es Salaam, ERB UDSM.

Budworth D. (1996), *Finance and Innovation,* International Thomson Business Press.

Chambua, S. E. (1996), *Endogenous Technology Capacity and Capabilities Under.Condition of Economic Policies of Stabilisation and Structural Adjustment, ATPS Nairobi.*

Christensen, J. L. (1992), "The Role of Finance in National Systems of Innovation" in Lundval, B-A. (1992), National Systems of Innovation:

Towards a Theory of innovation and Interactive learning, Pinter Publishers, U.K.

Chungu, A. S. and Maige-Muller S. (1994), "Role, Relevance and Capabilities of R&D Institutes: Optimising For the 21st Century, UNDP and TEMDO Workshop Arusha Tanzania.

Cohen, W. and Levinthal, D. (1994) "Fortune favours the prepared Firms". Management Science 40(2)

Coombs, R., Saviotti, P. and Walsh V. (1987), *Economics and Technical Change,* Macmillan Education Limited,

De Bresson, C. (1999), "An Entrepreneur Cannot Innovate Alone; Network of Enterprises Are Required: The Meso Systems Foundation of Innovation and of the dynamics of Technical Change." DRUID Confrence on Systems of Innovation, Aalborg, Denmark, June 9-11, 1999.

Devandra, S. (1981), *Patterns of Technical Innovation,* Addison – Wesley Publishing Company, INC.

Freeman, C. (1991), "Networks of Innovators: A synthesis of Reseach Issues" in *Research Policy, Vol. 20, No. 5.*

Freeman, C. (1992), "Formal Scientific and Technical Institutions in the National Systems of Innovation" in Lundval, B-A. (1992), National Systems of Innovation: *Towards a Theory of innovation and Interactive learning,* Printer Publishers, U.K.

Goodman, S. P., Lerch, J. F. and Mukhopadhyay, T, (1994), "Individual and organisational Productivity: Linkages and Processes" in Harris D. H. (ed) (1994), *Organisational Linkages: Understanding the Productivity Paradox,* National Academy Press, Washington, D. C.

Green, K. (1999), Hull A, McMeeking, A. and Walsh, C. (1999), "The Construction of the Technoeconomic Networks in Research Policy, Vol. 28, No. 7 September 1999.

Gregersen, B. and Johnson, B. (1997), "How do Innovations Affect Economic Growth? Some Different Approaches in Economics", IKE-Group, Department of Business Studies, Aalborg University-Denmark. European Commision (DG XII).

Gu, S. (1999), " Implications of National Innovation Systems for Developing Countries: Managing Change and Complexity in Economic Development" Discussion Paper Series, UNU/INTECH.

Haukness, J. (1999), "Norwegian Input-Output Clusters and Innovation Patterns" in *Boosting Innovation, The Cluster Approach,* OECD.

Jamison, A. (1989), Technology Theorists: Conception of Innovations in Relation to Science and Technology in *Technology and Culture*, Vol 30, No. 3, page 505-533.

Kaplinsky, R. (1989), "Technology and Development in the Third Industrial Revolution" In European Journal of Development Research, June, 1989, page 5-37.

Kwanjai, N. N. (1999), "Applying General Systems of Theory to Put Together NIS Jig-Saw Puzzle Pieces: A Portrait of the Thai National Innovation System" Prepared for UNU/INTECH Research Programme 3.0.2 on Characteristics of National Innovation Systems in Developing Countries. Maastricht.

Lovengood, T. and Wad, A., "The Emerging Techno-Economic Paradigm, Inter-firm Linkages and New Manufacturing Technologies: The Implication for Contract Manufacturing Relationships for LDC Firms", Mimeo.

Lundval, B-A. (1985), *Product Innovation and User-Producer Interaction*, Aalborg, Aal University Press.

Lundvall, B-A. (eds.) (1992), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Pinter Publishers- U.K.

Mani, S. (1999), "Government and Organisation of industrial Research and Development: An Examination of the Japanese, Korean and Indian Cases," UNU/INTECH, Maastricht.

Ministry of Industry and Trade (1996), "Analytical Overview of the Experince of Perspective Strategies in Industrial Development in Tanzania". Mimeo.

Musonda, F. M. and Kweka J. P. (1997), "The Dynamics and Potential of Cluster Firms in the Growth and Development of MSE in Tanzania: The case of Three Selected Clusters in Tanzania," Dar-Es-Salaam, ESRF.

Nystrom, H. (1990), *Technological and Market Innovation: Strategies for Product and Company Development*, John Wiley and Sons, England.

OECD (1997), The measurement of Scientific and Technological Activities; Proposed Guidelines for Collecting and Interpreting Technological Innovations (OSLO MANUA)

Papola, T. S. and Marthur, R. S. (1983), "Inter-Sectoral Linkages in the Metal Engineering Industry in Kampur, India" in Watanabe, S. (ed.) (1983), Technology, Marketing and Industrialisation: Linkage between Large and Small Enterprises, Macmillan India Limited.

Prins I.. M. and Szirmai A. (1998), *Reconstruction of GDP and Employment in Tanzanian Manufacturing 1961-1995*, Eindhoven University of Technology, The Netherlands.

Rogers, E. M. (1983), *Diffusion of Innovations,* The Free Press.

Rosenberg, N. (1982), *Inside the Black Box: Technology and Economics.* Cambridge, University Press.

Rothwell, R. and Zegveld (1985), *Reindustrialisation and Technology,* Longman: Harlow.

Senker,J. (1995). "Tacit Knowledge and Models of Innovation". Industrial and Cooperate Change 4(2)

Trajtenberg, M. (1991), *Economic Analysis of Product Innovation,* Cambridge, Havard University Press.

Vinding, A.L. (2001). "Firms and knowledge Institutions-The Innovation potential in Low-Tech sectors and Small Firms." DRUID/IKE Group, Aalborg.

Wangwe, S. M. (1993), " Implications of Changing External and Internal Conditions for Industrial Restructuring in Tanzania" in Bagachwa, M. S. D and Mbelle A. V. Y. (eds.) (1993), *Economic Policy under Multipartism system in Tanzania,* Dar-Er-Salaam University Press, Dar-Es-Salaam.

Wangwe, S. M. and Diyamett, B. D. (1998), "Cooperation Between R&D Institutions and Enterprises: The Case of URT" in XI Bulletin, *Approaches to Science and Technology Cooperation and Capacity Building*, New York and Geneva, UNCTAD.

Wangwe, S. M., Semboja, H. H. and Kweka J. P. (1997), "Multicountry Comparative Study of Private Enterprises Development in Africa (MCC-PED)" Draft Report for Tanzania, Dar-Es-Salaam, ESRF.

Watenabe, S. (1983), "Introduction" in Watanabe, S. (ed.) (1983) *Technology, Marketing and Industrialisation: Linkage between Large and Small Enterprises, Macmillan India Limited.*