

The Role of Technology, Technology Transfer and Technology Roadmap in Regional by Negede Yeshak¹

Abstract

Countries development is measured through the advancement of technologies which have a higher advantage for human beings by means of minimizing their effort in tedious works and making their living styles quite simple. The drastic changes in technologies from time to time and the potential of scholars to bring out new technology outcomes in different sectors make them to distract one another and lead to establish a dramatic connection among countries. Inadequate understanding of the meaning of technologies, strong requirement of time and effort of researchers, dynamism of technologies from place to place, geographical location of countries, institutional structures and arrangements, lack of clear setup to identify new technology visualizers and their outcomes, lack of clear guidance between technology recipients and senders, misuse and right allocation of funds, improper usage of information centers, secretes of basic science of some technologies, and natural need of technology trial risk taking bodies are some of the main issues that make technology transfer at infant stage in regional integrations. In addition, technical skill and knowledge development from higher educational institutions have an everlasting advantage for the technological advancement of a country. This paper focused on the four kinds of technology; Hardware, Info ware, Orgaware, Human ware and on the two kinds of technology transfer models- Vertical and Horizontal. In addition, the study observed the technological development of roadmap relying on the prepared document by Ministry of Science and Technology. In conclusion, it displays the strategic measures considered to select and utilize technologies, specifies technology transfer approaches, and measures to be taken in time of collaborating with other similar institutional structures and technology roadmap development based on the Korean approach.

Key Words: Integration of Institutions, Technology Transfer, Technology roadmap, Technology, Strategies, Memorandum of Understanding, Linkages of Higher Education

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1) Introduction

Technology transfers are majorly done through the working environment of higher institutions and industries. Linkages between higher institutions and industries in Ethiopia have been worked between a single university and industry based on their geographical location. Still now, they are at infant stage because of different barriers they are facing in continuing the relationship. One of the main barrier is the two institutions don't have a collaborative agreement that relies on the ground. Secondly, even if they know the admittance to cooperate and facilitate technology transfer; they require a pillar between them to facilitate cooperation and to be secured. Thirdly, they don't have clear vision about technology transfer and its outcomes under the linkage. Fourthly, they focus on their own tasks rather than collaborative activities. Fifthly, the industries are highly engaged on businesses so they may not give attention for the cooperation and they have frustration of using productive machine for learning and research purposes. The last but not the least, the number of students is radically increasing so leads universities and colleges mainly to focus on subject matters and minimize quality of education given by them. The above drawbacks

between universities and industries vary from countries to countries. In some countries these relations grow up to business activities because of strong leadership, well developed structure, full effort engagement on relationship activities and having technology flow dimensions. We talk about technology roadmap development because it plays a massive role for the transfer of technology and this consequently allows a massive development in the country. So setting a clear understanding of technology transfer and technology roadmap development approaches allows each actor to play their roles in the country like Ethiopia. Currently, the government has setup a procedural directive under Ministry of Science and Technology which was ratified in September 2013 as a facilitator tool to moderate the relationship between universities and industries. But still now the target couldn't be achieved mainly because of lack of detail awareness about the structure and willingness of the institutions. The 'Triple Helix' concept has also been used as an operational strategy for regional development and to further the knowledge-based economy in Sweden (Jacob, 2006) and Ethiopia (Saad et al., 2008) and recently Amsterdam has been adopted it as practical model of economic development (Leydesdorff, 2012). A study on Korea shows that collaboration activities among University Industry Government (UIG) largely increased across three developmental phases from 1980 to 2012. In the early periods, strategic R&D alliances between industry and government sector were set up to strengthen enterprises' innovation capabilities. When the Korean large conglomerates become dominant driver of domestic innovation activities, the primary agents of the collaborations shifted from industry-government to industry-university. [15]Technology transfer within the country almost entirely can be done through university industry relationship. So knowing and putting clear definition of 'technology' and the 'transfer ways' will allow the actors to play their role and responsibilities effectively. In this condition, the main strategic roadmap measures that should be set up in consideration to transfer technologies under the relationship relies on three stages. First, both actors should focus on reinforcing the relationship and do problem solving and demand driven researches. Second, it is necessary to develop innovative capability through the relationship and lastly, to come up with new innovative solutions to make businesses. These strategies can be effectively implemented through: 1) Having a clear idea of technology and understand the transfer modes, 2) Setting of target and expected outcomes in order to transfer technologies, 3) Developing a memorandum of understanding and reach on agreements, 4) Specifying the roles and responsibilities of the actors, 5) Working highly on pre-request facilities and resources (Strengthen the intellectual property rights), 6) Setting up the management system (By whom the linkage shall be facilitated), 7) Building the capacity of the actors (use the high level engineers and doctors to leverage the technical resources), and 8) Setting up selection mechanism through roadmap development.

Focusing on the above points, we can achieve or built university industry relationship with the aim of transferring technologies from university to industry or vice versa for continual and concrete development.

1.1 General Objective

- Demonstrating technology transfer and roadmap development methods under university, and industry relationship in order to strength their regional integrations.

1.2 Specific Objective

- To guide the linkage between universities and industries in the use of technologies.

- To demonstrate the role of each actor in memorandum of agreement and develop their specific target in the linkage.
- To demonstrate technology transfer ways.
- To display the role of technology roadmap development

1.3. Scope and Limitation

The study focuses on technology roadmap development and university industry linkage that is currently implemented by the Ministry of science and technology. It assesses the current university industry linkage roles of some universities and different scholars or professionals written documents. The study covers its limits on the current gap studies in eight sectors which were justified by the Ministry, technology transfer experts and available documents on the websites.

2) Technology

2.1. What Does It Mean by Technology?

Different scholars have given different definition for the meaning of technology. In this relation let me bring some descriptions which are helpful to understand the meaning of technology:

Working Definition- [1]

- Technology is the rational process of creating means to order and transform matter, energy, and information to realize certain valued ends.
- Technology is the set of means (tools, devices, systems, methods, procedures) created by the technological process.
- Technology is the knowledge that makes the technological process possible. It consists of the facts and procedures necessary to order and manipulate matter, energy, and information, as well as how to discover new means for such transformation.
- Technology is subset of related technological objects and knowledge. Computer technology and medical technology are examples of technologies.
- Technology is the system consisting of the technological process, technological objects, technological knowledge, developers of technological objects, users of technological objects, and the worldview that emerged from and the drives the technological process.

Other definition – [4]

- Application of tools and methods: the study development, and application of devices, machines, and techniques for manufacturing and productive processes,
- Method of applying technical knowledge: a method or methodology that applies technical knowledge or tools,
- Machines and systems: machines, equipment, and systems considered as a unit,
- Cultural anthropology sum of practical knowledge: the sum of a society's or cultures practical knowledge, especially with reference to its material culture.

The above two ways of description clearly define the meaning of technology and in here I mainly define technology based on our organization activity and some scholars' expression into four main parts:

- **Technology Hardware:** It is the equipment, facilities, tools, apparatuses, designs, infrastructures, and machineries that we observe in our eyes and can modify it and adjust it based on the requirement of the customer or the need of the society in order to modify or make different products to accomplish processes.
- **Technology Software:** It mainly focuses on the internal and unseen parts of the hardware. It is used to function and control the hardware through working on code systems (System, rules, conventions, guides, policies, strategies, businesses...).
- **Technology Human-ware:** A person that can control or operate on the above two dimensions of a technology. The human-ware has a potential to do and control all the necessary conditions and setups in order to improve or transfer that technology from one place to the other. In this case, capacity building is the backbone in order to say we can implement this technology effusively In this context, we can relate human-ware vs. human beings. The human-ware can be the knowledge, skill, appearance, health, behavior, observation, and education.
- **Technology Orga-ware:** This largely holds three of the technology parts. In this regard, the orga-ware targets on the collaboration of the above dimensions of technology. Most of the time human-ware can also lead orga-ware; hence it is the output of the human-ware. In this context, we can relate orga-ware as any organization. The orga-ware has a target, vision, structure, position, teamwork, relationship, arrangement, management and so on.

Based on the above four dimensions or definition of technology, it is well known that we found technology in every aspect of our life. As expressed above, the four parts mainly deal either in a small level like that single human being to that of a broad level like that of leadership of a country.

- Technology affects:-
 - a. The values of a society,
 - b. The country's economy, and
 - c. The environment

3) **Technology Transfer**

On the above, we have setup what is meant by a technology and in here we focus on the meaning of transfer. When we say the word "transfer" it is clear that it is the movement of things from one place to the other. To setup a clear idea or relation between technology and transfer, let us observe a simple example on transportation. If you want to travel from one place to the other, you need to have first the transport material (Car, airlines, trains...). Secondly, we need the facilities (Road, railway, money...). Thirdly, we need the aim or plan to use that transportation. And lastly, the transported person or thing. In here all the transport requirements to go from one place to the other can be specified as the ways of transfer and the things that lets us to change position can be determined as the technologies.

Therefore, technology transfer can be stated as an exchange of expertise, knowledge, machines and plans from possessor to the recipient of technology through different ways like

trade agreement with the outside body or education and development with the interior institution. By definition, a transfer of technology means a definite change in process, in product, in power, in attitude, in want and desires, and also in situations that are political, social, economic, or environmental.

3.1. The Existence of Technology Transfer

On the above, we specified what it means by technology transfer. But where does this come from? The main aim of this is because technologies are able to simplify our day to day activities. They have the potential to manage and organize and even to guide our life status. They have the potential to work broad tasks that a single person may not work through his life time. For example, if you want to travel from the capital city of Ethiopia, Addis Ababa to that of London it may take more than a year with bare foot but a day's travel with an aircraft. Let us see another example in the country, if you want to send a letter from Mekele city to Mizan city, by land it takes a lot of months, by car it may take days and by internets and faxes it is a matter of minutes.

In addition to the above major aspire, technology transfer exists because of the existence of two pillars, receiver and sender. In this case, it is fully understood that technology is transferred when the receiver accepts that technology and utilizes it adequately and effectively. This means, we can say we transfer that technology when we apply it directly for the required purpose or understood when the sender develops that technology.

3.2. How Technology is Transferred?

Technology mainly transferred from one place to the other in different ways. Currently, the rapid development of information and communication technologies on the internet has established a dramatic connection between countries and the growth of transportation (Cars, airplanes, ships...) facilitates to move things from place to place easily. In this connection, the desires and facilities available in the accepter country or institution makes the technologies to be transferred in rapid way. That is why countries and governmental institutions as well as universities and industries need to follow demand driven economy and research activities which are useful for the development of wealth or prosperity.

It is clear that grasping technologies are so advantageous for the development of a country. In this junction, it is important to note that the technologies transfer shall be based on the demand or need of nations, to solve the problem of the nations and for the economic growth. We can apply this in a broader sense like the transfer of technologies from one country to the other or in a smaller level like between university and industries. I divide technology transfer into four main parts which is useful to clearly setup the technology transfer problems and helpful to show the futures of technology transfer that can be specified as the following (Figure 1):-

- (vi) Internal to Internal Technology Transfer
- (vii) Internal to External Technology Transfer
- (viii) External to Internal Technology Transfer and
- (ix) External to External Technology Transfer

These four technology transfer modes applied in a wide manner. The technology transfer can be applied at larger scale (Between two or more countries), medium scale (Between two or more institutions) and smaller scale (Between two or more persons or groups). This study

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mainly focused on medium technology transfer scale, mainly between universities and industries.

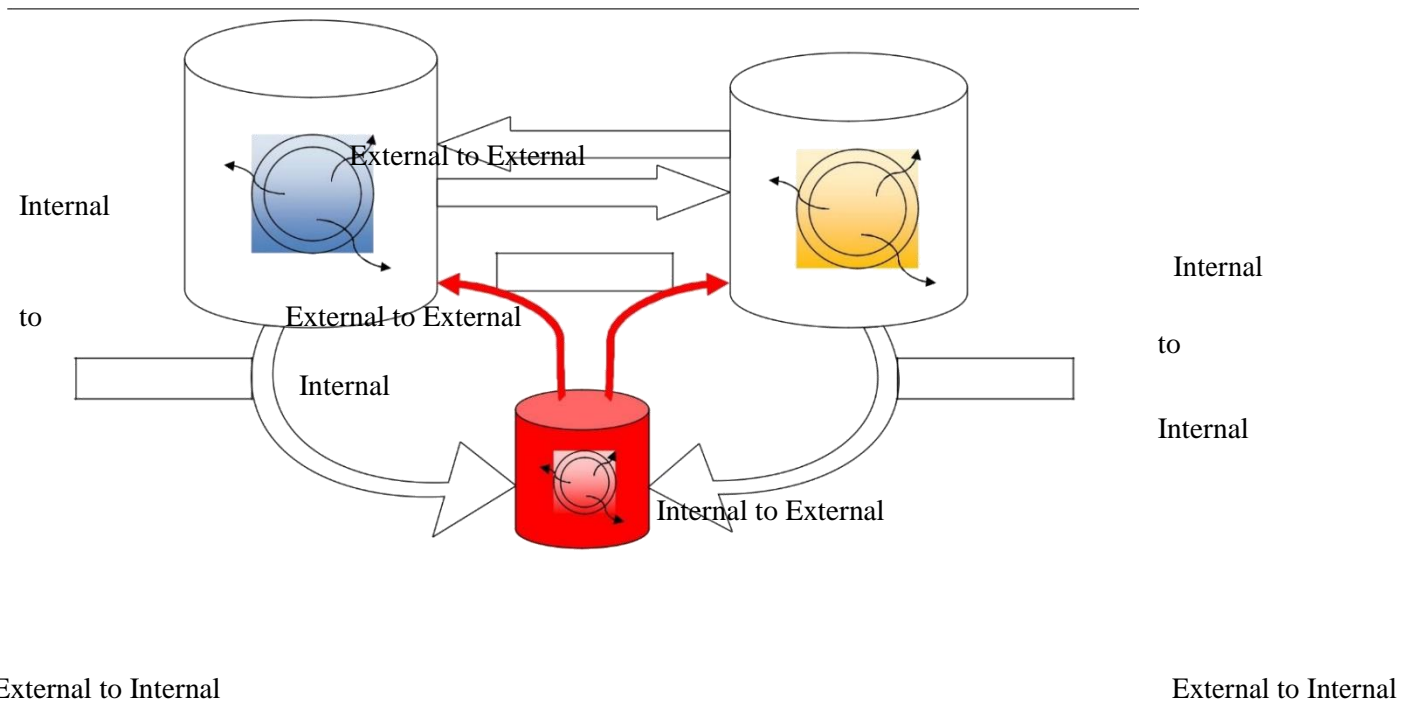


Figure 1 Technology Transfer Modes

In this paper, I mainly focused on the internal to internal technology transfer modes relying on the procedural directive of the Ministry of Science and Technology and specially focusing on the linkage that takes place between some universities and industries through indicating the memorandum of understanding signed between them.

3.3. Technology Transfer Methods

When we need to transfer the technologies, we should setup a clear agreement between the two channels for the mutual benefit of the two sides. The connection roles are mainly derived by the business opportunity that is created by the receiver. In today's world, the receiver should be strong and well educated to choose the best technology or should setup a clear agreement that does not cost him in the future/entire time. Currently, technologies are transferred from one place to another through different methods. They mainly depend on the receiver's potential to adequately implement that technology. To make this come true, the receiver by his/herself should set a clear vision and understanding among his/her members and should develop a well-organized and unambiguous structure in his/hers institution/country. In addition, it is required to create conducive environment for the mutual benefit of its members. In here, the technology transfer methods are presented according to Denis (2013) [10].

Licensing: It is an agreement under which the owner of patent, trademark or other intellectual property gives permission to another company to use the technology in a certain period of time.

Support Contract: According to this agreement, the technology owner participates in the technology implementation, providing at each stage of the transfer technical support, as well as personnel training. The involvement of technology developer in the technology transfer process ensures a closer cooperation between two parties which favors a complete transfer of all knowledge and skills related to the technology.

Joint Venture: A joint venture is an agreement concluded between two or more companies in order to execute a particular business. The joint venture implies mutual assets, management, risks, profit sharing, co-production, services and marketing.

Franchising: it is an agreement where one company grants another company the right to use its trademark and business model.

Strategic Alliance: A strategic agreement is usually concluded between two or more big companies in order to use specific skills of each of them in the development of new innovative technologies. Strategic alliance could be in form of joint laboratories, research programs, production and promotion of a new product.

Turnkey Agreement: The general contractor is responsible for all the procedures related to technology transfer, such as technology design, financing, equipment supply, construction and commissioning.

Equipment Acquisition: Equipment Acquisition is a simple and, therefore, one of the most common methods of technology transfer.

Management Contract: Technology can be transferred through a competent expert, who could be “entice” from another company.

Foreign Company Acquisition: A company may acquire a foreign startup which is developing a new technology. As a result, the company will not only get the technology, but also has a team capable to develop it in the future.

Direct Foreign Investments: Direct foreign investment is one of the main methods of technology transfer at the state level. Generally, a foreign company invests in developing countries in order to create a new market, remove export barriers and get an access to cheap labor.

Buy-Back Contract: A buy-back contract is a form of agreement between developing countries and large foreign companies. Under this agreement, a foreign company supplies industrial equipment in exchange for profits derived from the sale of raw materials or goods produced on this equipment. This kind of technology transfer is often used in the construction of new plants in the developing countries.

Original Equipment Manufacturer (OEM): OEM can be considered as a form of subcontracting, where a local firm starts manufacturing according to the foreign company specifications. A foreign company transfers a part of its technologies and equipment. It conducts training and management reorganization.

4) **Internal to Internal Technology Transfer Mode**

In this study, the internal to internal technology transfer mode is assumed to be within the country i.e. among universities, industries, and governmental institutions. The technology transfer mode depends on the economy and cultural values of the country. The technologies that are developed within the countries can be duplicated very easily. The internal to internal technology transfer modes can be done through industries, universities, governmental and non-governmental institutions, private sectors, villages, homes, hospitals and so on within the country. With this insistence almost more than 90% are hold by the universities and industries. Under the four categories, university industry linkage interaction falls under internal to internal interactions. Interaction between them has superior potential in increasing the country’s economic growth and development considerably. In this sense, the industries don’t have all the capabilities to be innovative, and they need such ones in order to compete in the global market. On the other hand, the universities are engaged in research and knowledge development, but are not dedicated to the economic development of these ideas into products and services by means of innovations in product, process or organization systems [2]. Esham, in 2008, describes that university-industry linkages have significantly become one of the most important agenda of higher education policy-making, as well as in the economic environment of both the national and institutional levels. In the context of knowledge intensive economies, the importance of higher institutions of learning as strategic actors in both national and regional economic development cannot be underestimated given their potential to upgrade skills and knowledge of the labor force and contribute towards producing and processing innovation through technology transfer notes. Dr. DinahW. Tumuti, (2013) specified that the strength of universities lies in their science base; the strength of industry is technological development. Today the challenges facing both

organizations have never been greater and both must adapt to rapidly changing circumstances. Failure to do so will have significant and far-reaching consequences for all concerned. Other study also shows that undesirably the skills, knowledge and training that students receive at many African universities do not prepare them adequately to meet the requirement of industry and the job market. This mismatch between what student learn and what industry needs- coupled with under-training in the critical skills of problem-solving, analytical thinking and communication- is blamed, at least in part, for the emerging high graduate unemployment and under-employment, many African counties are witnessing. As relied on this point, it is necessary to put university industry linkage based on a strong concrete. [14] The study also recommends that the government should play an important role in creating a conducive, incentivized environment for strengthening such linkages by putting in place policy frameworks for Science and Technology strategies, appropriate legislation for the protection of intellectual property rights, and funding R & D, among others.

In Ethiopia, the manufacturing sector focuses on the production of items even though it is characterized by low productivity and weak competitiveness due to low skills, shortage of capital and lack of modern technology. And the universities are engaged on generating new student even if the students lack capability and skill to effectively engage on the industries working activities. So it is important to leverage the linkage between them to create conducive and competitive environment.

5) Technology Development Roadmap

5.1. Technology Development Roadmap

Roadmap shows a way of paths that are helpful to show dimensions for travelers to migrate or travel from one place to another. Travel from one place to another destination place has an alternative dimension. Selecting the destination place requires appropriate developmental approaches so that integration among institutes relies on those stages. As we have defined technology in four dimensions, roadmap development targets on product planning, service/capability, planning, strategic planning, program planning, and process planning. [16] There are five main successive steps to develop roadmap as shown in the figure below.

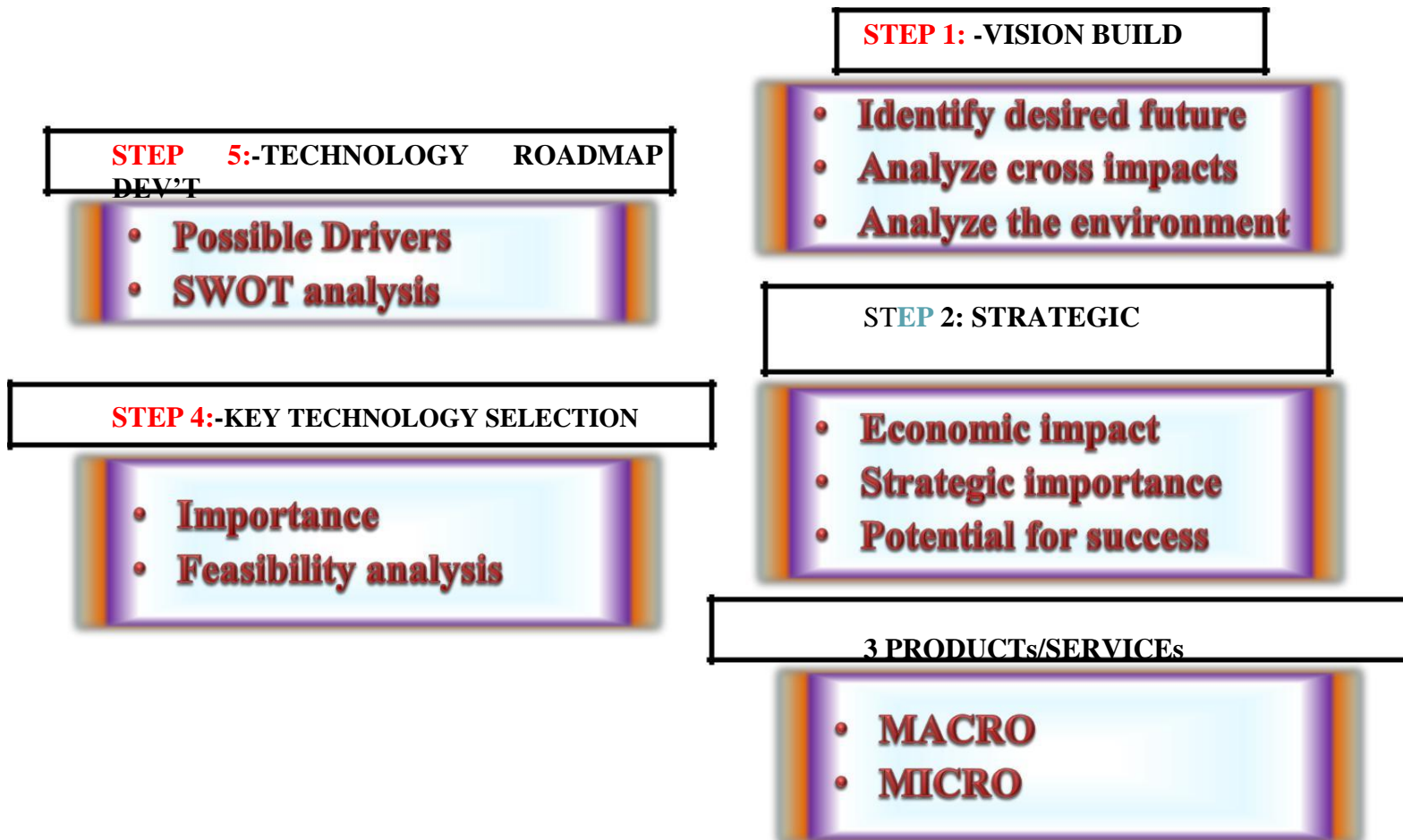


Figure 2, Vision Driven Technology Roadmap Development

The Ministry of Science and Technology has organized and developed the **National Technology Roadmap** in 24 sectors targeted to interlink sectorial product outputs to that of critical/core technologies identifications.

The NTRM development has been completed for *Agro-Processing (Meat and Coffee), Agriculture (Crop and Livestock), Building Construction, Cement, Chemicals, Energy, Environment, Fertilizer, Information and Electronics, Irrigation, Leather, Metal, Mining and Petroleum, Pharmaceutical, Railway, Road, Sugar, Textile, and to be completed shortly are Edible Oil, Space, Nuclear and Emerging Technologies.*

Each of the develop documents are well developed by professionals from different institutions including that of industries which make it more relevant in application time. But as countries development and need of using research outcomes vary from time to time. We need to revise and equip those selected products with their technological advancements.

As the technology roadmap develops based on the National Growth and Transformation Plan target, it shows major tools for the linkage between higher institutions and those of manufacturing sectors. In addition, it also follows a need driven approaches which allows seeing the market flow of the world. So higher education institutions are required to understand the basic science of how the technology roadmap development is done to definitely implement the document.

Linking between higher education institutions and industries is a strong opportunity for the implementation of the technology roadmap. The next chapter shows the procedural directive under Ministry of Science and Technology which was ratified in September 2013 as a facilitator tool to moderate the relationship between Universities, Industries, Technical and Vocational Education and Training (TVET), small scale enterprises and Research Institutes. Usage of this linkage as a tool for the technology development roadmap facilitates its execution and understanding among its institutions.

5.2 Common Features of Technology Development

- An effective technology roadmap defines technology pathways that show how incremental innovations, often happening in parallel, can add up to new technologies and products in the future.
- If roadmaps are to be used to guide Research and Development investment decisions, it is essential to indicate the relative priority of roadmap activities, particularly in today's environment of increasingly scarce resources in both the public and private sectors.
- The roadmap can be tailored to produce a useful planning tool that aligns decision with that strategic intent.
- A roadmap ultimately must influence people to make decisions that support the overall strategy. Engaging these stakeholders during the roadmap development process goes a long way toward ensuring these people buy into the roadmap's priorities, both figuratively with

their support and literally with their R&D budgets. A roadmap developed in isolation and then delivered in its final form without this continuous engagement is more likely to be rejected or ignored.

- Simple picture, diagram, or dashboard helps well to quickly summarize and convey the key roadmap priorities and status at a glance.
- Understanding the use of roadmap, one can be sure the roadmap contains the information, structure, and support necessary for success.
- Roadmap process can be structured in a way that builds shared commitment, helps align missions, and defines roles and responsibilities across organizations.
- Start with small and appropriate groups for specific activities, like the most senior executives for visioning and goal setting. As the roadmap progresses and grows, pull in more people to contribute, confirm, add, validate, and ultimately act upon your roadmap.
- To remain relevant and useful, roadmaps must be “living” documents that are monitored and updated regularly to reflect new data, technology advances, and changing business conditions.
- Since there is no one size fits all and someone external to your organization cannot understand the challenge of your organization better than you have to customize your roadmap to your unique situation and requirements.

6) University-Industry Linkage in Ethiopia

6.1. History of University Industry Linkage in Ethiopia

Ethiopia aims to become a middle income country within a short period of time. And one of the ways to accomplish this aim is through creating an organized and strong relationship between universities and industries. Most of the universities have established University- Industry Linkage (UIL) office under the universities since the industrial development has grown. This is mainly because they are expected to train up a large number of quality graduates and skilled professionals in various disciplines which have the potential to contribute for the economic development. Eng. Teshome Sahle-Mariam, in March 2014, mentioned that “As center of education, training and research, universities are expected to generate scientific techniques and knowledge that are required by and applicable to manufacturing and service enterprises apart from producing skilled manpower. And added that as the players were lenient and there was not such a strong linkage among them, it is now believed that making the link among the players, i.e. educational institutes and the industry, will enhance the technology transfer among the entities”.

During 29th National Transformation Council Assembly meeting in Dilla University, Dr. Kaba Urgesa has mentioned that lack of professionals in all Engineering and Technology Faculties has necessitated employing assistant graduates as an option to fill the gap. He also specified that the number of assistant graduates should be minimized as soon as possible to ensure quality of

education by upgrading their degrees. Speaking on the problems related to researched. Kaba emphasised not only publishing findings in international journals but also employing the researches to solve the problems in the community are very essential. It was also discussed by the council that some researchers who are paying for a fraud research publication should be carefully managed as it endangers the academic credibility and quality of education. [6] The government has set a policy and is actively engaged in reducing poverty level. One of the strategies in this regard is the creation of efficient, capable and problem solving workforce through-university industry network in tackling our long history often associated with poverty. [12] The engagement of universities in research and development has great impact on strengthen the linkage. Even up to now, the research and development outcomes are not in depth shared by universities, industries and governments which markedly lead to be influenced by external competitors. This shows that the government has to play a major role in managing, coordinating, and facilitating as the current government of Ethiopia does. But, still it shows that the gaps can be fulfilled through implementing the research and development outcomes of the universities. The competition of overseas industries undercuts the largest business of a country so creating a well-organized structure as the current MoST facilitates and targeting on the implementation of agreement signed between universities and industries will create broad-ranging results.

The two linkage dimensions that currently enrolled in different countries are:

- 1) University and Industry link (UIL) and 2) University, Industry and Government link (UIG).

6.2.The Current Relationship Obstacles to Transfer Technologies

In a developing country, the transfer of technology is not that much adequate due to the following major issues as I identified through assessments: -

- From the university:
 1. Poor facilities to bring out new technologies (Absence of research centers)
 2. Lack of strong agreement and interaction with the industries.
 3. Repetitiveness of research and absence of research buyer and seller facilitator (Shortage of Commercialization).
 4. Most of the engineers and doctors give much attention for lecture rather than bringing out new ideas or innovations.
 5. Fear of the researcher and innovators concerning the execution of patent rights.
 6. Lack of information regarding supportive institutions(Lack of information centers)
 7. Insufficient capacity and capital to bring out different researchers
 8. The output of researches isn't that much relevant and some of them may not be useful and accessed by the productive sector.
 9. Studies are not implemented or tried even in smaller scale (Incubated).

10. Researchers and innovators focus on researchers' benefits rather than the benefit of the research.
11. Lack of initiating and awarding first degree level outstanding researchers
12. Lack of research outcomes competency among universities either in regional or abroad
13. Absence of commercialization body and incubating centers
 - From the industries: -
 - Focus on the business activities rather than establishing partnership with universities
 - The need of short term investment return
 - They don't give much attention for the research development and new innovative activities
 - They do not adequately accept the quality of education given by the universities
 - Lack of agreements and common plans with universities

6.3. The Current Procedural Directive Linkage in Ethiopia

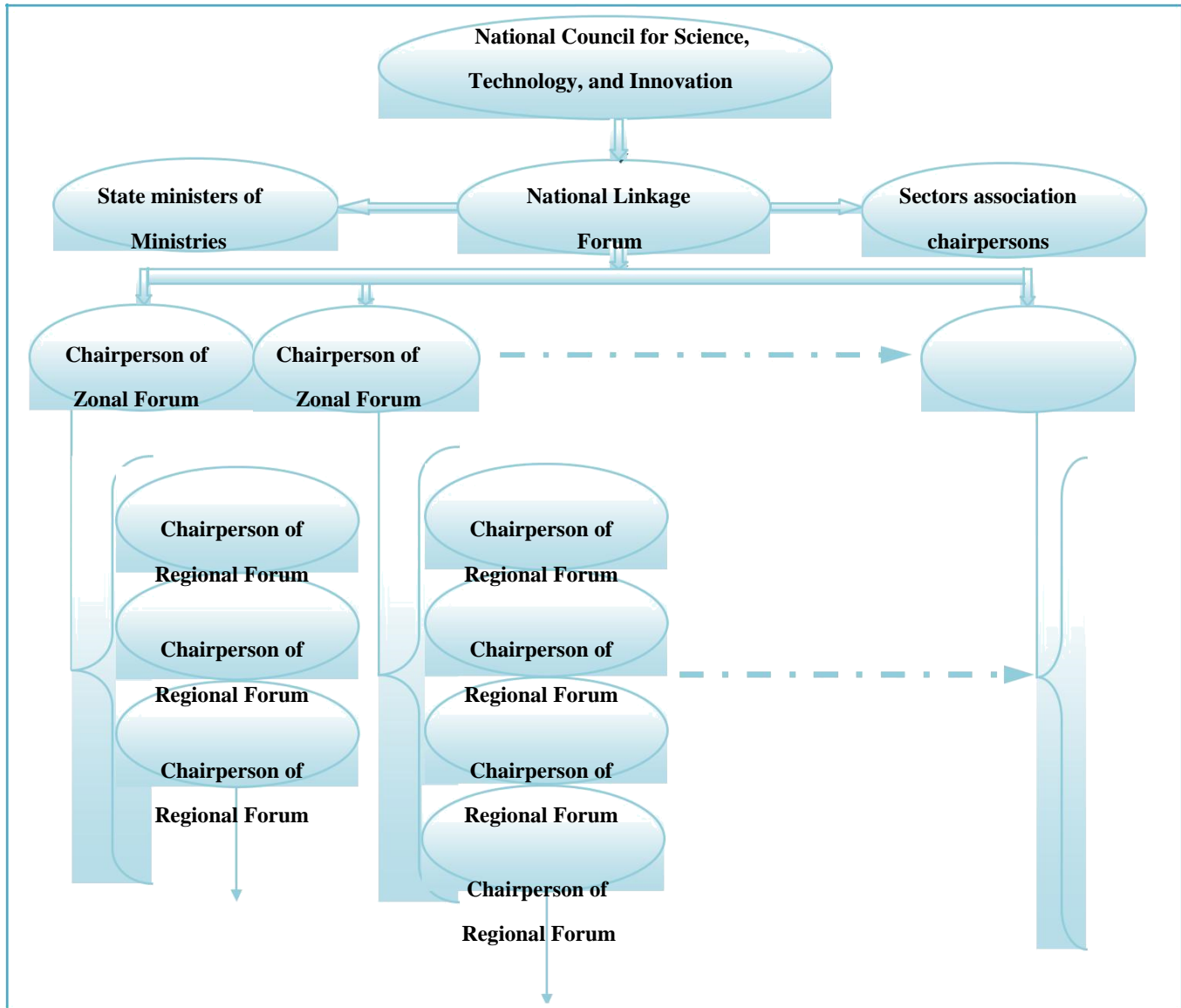
Government plays a great role in running the development of a country. Recently, the Ethiopian government initiates teachers, students, researchers and innovators to remarkably contribute their role in the country. U.S. government has also established laboratories to achieve specific objectives such as improvement in weapons, sanitation and farming practices in 19th century and also manages the progressive income tax, public assistance programs, economic development programs and managing the economy. In Korea, we see that government policy is the main determinant that drives Korean universities to play the role of knowledge provider for industrial innovation. [13] Interaction among University-Industry-Government, as relatively independent, institutional spheres, is the key to improve the conditions for innovation in a knowledge-based society. The change in the role of the state from public partner in dual relationships, with either industry or university, to one of three participants in Triple Helix relationships increases government involvement in innovation issues, irrespective of the political system or development level. [3]

As we observed the above university industry linkages, the requirement to create relationship comes from the university. Even if the current universities are maximized and become a lot, their quality of education especially in relation with skill upgrading should be strong and should have standard to create a well-organized relationship. The reform and modernization of Europe's higher education depends on the competence and motivation of teachers and researchers, yet staffing levels have often not kept pace with expanding student numbers, putting further pressure on already strained capacities. Better working conditions, including transparent and fair recruitment procedures, better initial and continuing professional development, and better recognition and reward of teaching and research excellence, are essential to ensure that Europe produces, attracts, and retains the high quality academic staff it needs.[11] To assure this a well-built structure should be established among the institutions..

The introduction of a “Triple Helix structure” in Ethiopia from May 29 to 31, 2006E.C was leading a great opportunity for the universities and industries collaboration through using government as a facilitator [3]. And this allowed directing a well develop structure from one to one university industry linkage to a massive linkage in 17 sectors. The procedural directive has ratified entitled “Procedural Directive for the linkage of Education and Training, Research Institution and Industries” (FDRE 2013).

The aims of the directive are:

- 1 Ensuring that the procedures through which practical training are given to teachers and students in manufacturing and service provision enterprises are in the spirit of cooperation, with appropriate plans and according to procedures;
- 2 Facilitation of research and technology transfer activities to be operated based upon the need of solving problems related to competitiveness of the industry;
- 3 Improving the roles and capacities of education and training as well as research institutions such that intellectuals develop the ability to consult manufacturing facilities and service provides;
- 4 Developing the culture of joint planning and operation among education and training institutions, research entities and the industry by bringing together their resources;
- 5 Improving the capacities of the actors of the linkages to implement education and training, research, consultancy and technology transfer,



**Figure 3 Structure of the directive
Assessment of the Seventeen Zonal Forums**

The zonal forums are specified under this table according the guideline prepared by the ministry. Implementation of the structure was started at the end of 2013. But still now, it requires more effort and willingness of the organizations to create a conducive and competitive environment in order to allocate and maximize each sectors’ growth under the linkage. The current status of the zonal linkage forums are described in the table below and the drawbacks and consecutive futures and the required rearrangements are also displayed in the table below (latest technology transfer directorate

information 2015). Establishing the structure have a great advantage if it is grasped and adequately implemented by the lower sub-zone regions. The study of “Strengthening University-Industry Linkage in Africa” also shows that the development of strategic plan with a focus on engagement with the productive sector is the top inhibiting factor which was cited by respondents.

Advantage: -

0. It creates a structure from Top level to Bottom level, which allows the actors to present their problems and obstacles to the decision making hierarchy.
1. It is open for the participation of TVET, Private colleges and SME.
2. Allow the Bottom level actors to use their resources together.
3. Minimize the time spending by the universities and manufacturers in dealing with routine tasks.
4. The Bottom level actors will have potential to solve their problems and to knock the door of the leading actor.
5. Information can be accessed very easily and horizontal learning process can be improved.
6. Easy technology transfer and dissemination process will be established between the linkage actors.

Disadvantage: -

- One institute may require signing up a lot memorandum of understanding or collaboration agreement and it may seem to be tedious.

Table 1 Zonal linkage forums status

No	Zonal forums (ቀጠናዊ ፎረምዎች)	Have plan for 2008e.c	Total number of planned Sub-zonal linkages to be established	Established Sub-zonal Linkages (Sign MoU)
1	Food, Beverage and Pharmaceutical zonal linkage forum (ምግብ መጠጥና ፋርማሲዩቲካልስ ቀጠናዊ ትስስር ፎረም)	✓	7	6
2	Meat and Dairy zonal linkage forum(የሰጋና ወተት ቀጠናዊ ትስስር ፎረም)	✓	6	2
3	Textile and Cloth zonal linkage forum (የጨርቃ ጨረቅና አልባሳት ቀጠናዊ ትስስር ፎረም)	✓	7	6
4	Leather zonal linkage forum (የቆዳ ቀጠናዊ ትስስር ፎረም)	✓	7	1
5	Metal and Metal goods zonal linkage forum (የብረታ ብረት ቀጠናዊ ትስስር ፎረም)	✓	6	2
6	Railroad zonal linkage forum (የምድር ባቡር ቀጠናዊ ትስስር ፎረም)	✓	-	
7	Mining zonal linkage forum (የመወከስ ቀጠናዊ ትስስር ፎረም)	✓	-	-
8	Energy zonal linkage forum (የኢነርጂ ቀጠናዊ ትስስር ፎረም)	✓	10	7
9	Water and irrigation zonal linkage forum (የውሃና መስኖ ቀጠናዊ ትስስር ፎረም)	✓	11	3
10	Electronics, telecommunication and information technology zonal linkage forum (የኤሌክትሮኒክስ፣ ቴሌኮሚኒኬሽን እና ኢንፎርሜሽን ቴክኖሎጂ ቀጠናዊ ትስስር ፎረም)	✓	5	2
11	Road zonal linkage forum (የመንገድ ቀጠናዊ ትስስር ፎረም)	✓	5	5
12	Construction and house zonal linkage forum (የኮንስትራክሽንና ቤቶች ቀጠናዊ ትስስር ፎረም)	✓	-	-
13	Cultural and Tourism zonal linkage Forum (የባህልና ቱሪዝም ቀጠናዊ ትስስር ፎረም)	✓		
		✓	11	3
14	Agriculture zonal linkage forum(የግብርና ልማት ቀጠናዊ ትስስር ፎረም)	✓	-	-
15	Sugar zonal linkage forum (የስኳር ልማት ቀጠናዊ ትስስር ፎረም)	✓	7	7
16	Health zonal forum (የጤና ቀጠናዊ ትስስር ፎረም)	✓	-	-
17	Chemical and construction input zonal linkage forum (የኬሚካልና ኮንስትራክሽን ግብዓቶች ቀጠናዊ ትስስር ፎረም)	✓	12	6

Drawbacks to Effectively Implement the Directive

- The procedural directive is not accepted from some top level actors.
- Some institutions are running by themselves rather than playing their roles in the structure.
- Most of the institutions lack awareness and detailed information about the directive.
- Most of the manufacturing sectors sent their representatives during agreement.
- The organizer ministry does not have much power to force the establishment of the linkage among the institutes.
- Regional industry offices are assigned differently in the regions, which is an obstacle for decision making and for the implementation of the linkage procedural directive for example: City and Industry development office, Industry office, Investment and Industry office.

To strength the linkage, the following measure points should be set: -

5. Establish a website that will allow all members of the linkages to come together and to facilitate the horizontal learning teaching process.
6. Awareness should be reached to all organizations so it is necessary to use medias and some fliers
7. Willingness of the Bottom level actors to use their resources together has a big role in bringing out new technologies and ideas. So they should have collaborative plan and agreement ratified/signed by them.
8. The Ministry requires maximizing its potential through creating awareness and insuring the Bottom level agreements and plans either they are owned and agreed by the linked actors or not.
9. The sub-zonal linkages mainly shall focus on applied researches (Industrial Researches).
10. The manufacturing sectors willingness can play a big role for strengthening the linkage among the institutions. So it is mandatory to discuss and agree with the managerial and top decision making professionals of the industry.
11. A well organized and agreed memorandum of understanding between them is necessary to minimize the gaps and put future plans.

6.4. Memorandum of Understanding/Agreement

Why we need memorandum of understanding/agreement?

Lesson Learnt:

A study shows that the development efforts of individual inventor entrepreneurs such as Hall, Eastman, Bell and Westinghouse (Schmookler, 1957) in America have brought to establish a number of manufacturing firms. After a long term of this period in 1900s, some authors claim that there has been a UICP (University Industry Cooperative Programs). However, there is very little research to sustain this assertion due to lack of attention of

researchers towards UICP in those years. From 1940 to 1969, research laboratories expanded their status rapidly, but not at the rate the investors expected, partly because scientists were unwilling to undertake the tasks of development and commercialization. By 1950, the National Science Foundation (NSF) has been the principal agency of the Federal Government, envisioned becoming the principal source of support for all basic scientific research in institutions of higher education. At the beginning of 1970s better result obtained, however, there continued to be disagreements, problems and constraints, with universities defending basic research and industries attempting to carry out applied research in order to obtain innovations which would allow them to subsist in a long term throughout the income of utilities. This allows the establishment of better agreement between the industries and universities. [9]

The above short study briefs that memorandum of agreement between institutions is relevant in order to sustain, technology transfer and develop innovative improvements. The agreement shall clearly show the following measure points:

Table 2 Memorandum of Understanding/Agreement Key Points

Estimated Problems and obstacles with solving mechanisms	Objectives
Mandates, guidelines and patent rights	Signature and ratification

6.5. Role of the Actors to Transfer Technologies

The role of the actor should be clearly setup and their benefit from the outcomes of the study mainly to transfer technologies. The table below shows the role of actors:

Table 3 Role of Universities and Industries to Transfer Technologies

Role of universities in the linkage	Role of Industries in the linkage
• Bring out skilled and knowledgeable employer.	• Generate energetic and competitive employers for further education.
• Be innovative based on the company's needs	• Buy and implement innovative solutions and research activities.
• Show economic development dimension	• Equip the employer's knowhow on TQM implementation.
• Develop basic science and its application in technologies.	• Lead the industrial technology development (Attempting to carry out applied research)
• Identify industrial problems	• Take demand driven studies and business (For modification purpose)
• Establish university industry relationship office	• Establish business facilitator/incubator office
Role of both sectors in the linkage	
To have agreement and plan in each year. (Check, Plan, Do and Act)	
• Clearly understand responsibilities and roles	
• Facilitate resources through communicating one another	
• Support researchers and build capacity	
• To set intellectual property rights/ patent directives	
Incubate and implement new innovations	
Adapt and learn from internal and external role model linkages	
Dissemination of technologies and new ideas	
Internship and externship programs allocation	
Bring out ethically grown and hard worker citizens	

7) Strategic Elements to Strengthen the Linkage:

1. To Prepare Memorandum of Understanding or Agreement Between the Institutions

The first requirement between the receiver and sender is interaction. And this interaction will come when the receiver needs the providers' material, support, and facilities to bring out their drawbacks or to fill the gaps. To facilitate the interaction among this institution, it is mandatory to have a well interactive system and vastly setup the sharing activities between universities and industries.

- **Each of the zonal forums leaders and Sub-zonal forums activators shall have one medium of interaction place in each year.**

Identification of relationship obstacles and bottlenecks through continuous assessment and setting of target to solve their solutions by themselves can maximize effectiveness and efficiency and also useful for the horizontal diffusion and teaching learning achievements. The outcome of the linkage shall be assessed every year and recognition shall be given for the institutions.

- **Grown and Their Interest Should Be Kept in Mind**

Make standards in the quality of learning and teaching process. The business by itself requires a competent and aggressive potential manpower and lean on well-developed behavior and patriotic persons for the country. The learning and equipping of person's shall rely on quality of education and shall be minimized as much as possible through observing economic growth sites.

- **Support Financially fThe Industrial Demand Driven Projects.**

This mainly drives the industries and business sectors to be attracted by the new idea and project. Understanding the need and heart of the industry (In which way the business is flowing) can guide the role of the universities. In developing countries like Ethiopia, it is difficult to immediately grasp the current sophisticated technologies which are rapidly grown in the productive sectors. So it is mandatory to classify the technologies era of development in each sectors and to set focus points through considering the growth and transformation plan and societal developments.

- **To establish a large research centers mainly helpful for the industrial development of the country.**

The research institute shall mainly targets on applied researches. The rehabilitation and production of big machineries those are helpful for the development of equipment's, motors and production of materials. In here, we can also try to fabricate our own brand cars, machineries through reengineering methods. The target may focus on establishing Agro-processing machineries and agricultural tractors. Hence, we have a lot of agricultural lands.

- **To create a conducive environment for internally grown knowledge's and cultural heritage technologies to strength and drive their participation in the global economic growth.**

It has a massive advantage for the development of the country through selling home grown products and creating an opportunity to international markets. If we take "Shimena", there are many designers and manufacturing SME's which have not got the chance to compute in global market and design computations. Bringing out such products through creating modernization by means of focusing on the designs, quality, aesthetic value, standardization and material product can bring a massive advantage in the global market competition.

- **To establish manufacturing centers those are useful for the production of research and development equipment's.**

Molding machineries are important in order to produce and maximize the industrial growth. Currently, the cost of these machineries is very high but can bring a huge advantage for the industry because one of their main drawbacks is spare part facilities. So taking adequate study on the current machines gear system, design, raw material and construction through allocating standards allows to produce and to bring the required instrument.

- **Free Tax The Merchandizers to Input Research and Development Equipment**

This can be done through taking product selection assessment on industries, marking the beneficiary of the study and observing the technological roadmap of the country.

- **Implement the Develop Technology Roadmap**

Implementation requires an effort of each actor. In this case, we may face continues obstacles and burdens but finally allows a good strength for our educational institutions because of its focused target on products and there technological advancements.

8) Conclusion

Technology roadmap development can be done not only as a national level but also as a single institution by that of universities, industries or other endeavors. This deeply sees the need of the customers or market movement throughout the world. In addition it minimizes the gap between the institutions. The relationship of universities and industries can be used effectively and efficiently if they mainly agree each other and have willingness to cooperate and strength the business activities. The government shall play a great role in linking the universities and industries until they agree each other and start a ground work. Technology Transfer can be easily grown if and only if the actors have an **agreement** and when they start gaining money from the fruit of their collaborative tasks. In here, the universities specifically shall understand the **directions and developmental dimensions of the country and industrial developmental stage** so that they can cope up and guide the industries. With side to this, the government shall focus on the establishment of a well **develop guidelines and research institutions** through adapting different countries growth. **Plans** have a great aspect for technology transfer in the relationship, so in each step everyone should have clear awareness and target in the implementation of strategies which basically help understand the technology roadmap. Using the potential of youngsters through **creating conducive environment for their research out comes and working on their behavioral development** can fasten the relationship. Relationship between universities, industries, TVET's, Colleges, Regional agencies, Regional industry offices, Regional trade offices, and SME, as in the current procedural directive, has broader idea so needs a **higher decision from every top level actors and awareness creation** shall be strong so that they can guide their task force in the required way.

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