T.C.
ISTANBUL COMMERCE UNIVERSITY
FOREIGN TRADE INSTITUTE
DEPARTMENT OF INTERNATIONAL TRADE
INTERNATIONAL TRADE PROGRAM

STI POLICIES AND INTERNATIONAL TRADE

MASTER THESIS

EMİNE BENAN GÜLGÜN
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Istanbul, 2018

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Advisor: Assist. Prof. Ahmet Oğuz Demir

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T.C. İSTANBUL TİCARET ÜNİVERSİTESİ

T.C.
İSTANBUL TİCARET ÜNİVERSİTESİ
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ABSTRACT

The Science, Technology, and Innovation Policy is an integral part of the overall policy of an economy. It determines the direction in which the economy is headed and also the amount of spending that will be allocated to research and development. STI policies are an important factor in the economy as it also determines the kind of products that will be produced by the industry and the innovations that will be implemented in the economy. This study has analyzed the STI policies and their impact on trade for Turkey. In addition, four other economies (Brazil, India, Russia, and South Africa) have been analyzed in order to draw comparisons to Turkey since they are all emerging economies. The study has been conducted over a 20-year period from 1996 to 2016. Through a descriptive analysis, the study finds that Turkey's Research and Development (R&D) expenditure as a percentage of Gross Domestic Product (GDP) has increased about 0.5% over the examined time period whereas, this expenditure percentage has remained relatively consistent for the other countries. However, it must be noted that the actual R&D expenditure in these countries has increased exponentially as they have grown over the years. In addition, the exports of all countries have increased greatly over the years while the middle and high technology manufacture exports have also increased which shows the positive impact of R&D expenditure on the composition of exports.

Keywords: *Science, Technology, Innovation, National Innovation System, STI Turkey*

ÖZET

Bilim Teknoloji ve Yenilik Politikası bütün ekonomi politikalarının tamamlayıcı parçasıdır. Bilim Teknoloji ve Yenilik Politikası ekonomi başlıklarının yönünü ve araştırma-geliştirmeye tahsis edilen harcamaların miktarını belirler. Bilim Teknoloji ve Yenilik Politikaları endüstri tarafından üretilecek ürünün çeşidi ve ekonomide uygulanacak yenilik politikasının belirlenmesi yönünden de ekonomide önemli bir faktördür. Bu çalışmada Bilim Teknoloji ve Yenilik Politikaları ve bunların Türkiye'deki ticarete etkisi incelemektedir. Ek olarak Türkiye gibi gelişmekte olan dört ekonomi (Brezilya, Hindistan, Rusya ve Güney Afrika) ekonomileri karşılaştırmalı olarak incelenmiştir. Bu çalışma 1996 yılından 2006 yılına yirmi yıllık bir dönemi baz almıştır. Betimsel analiz yöntemi ile çalışmada Türkiye'deki araştırma-geliştirme harcamalarının gayrisafi yurtiçi hasılaya oranı incelenen periyodda 0.5% artmış iken, bu harcama oranı diğer ülkelerde nispeten sabit kalmıştır. Fakat gerçekte bu ülkelerin araştırma-geliştirme harcamaları gelişimlerine bağlı olarak katlanarak artmıştır. Ek olarak bütün ülkelerin ihracatları yıllar içerisinde geniş ölçüde artarken orta ve yüksek teknoloji ürün ihracatı da artış göstermiştir ki buda araştırma geliştirme harcamalarının ihracatın kompozisyonu üzerindeki pozitif etkisini göstermektedir.

Anahtar Kelimeler: *Bilim, Teknoloji, Yenilik, Ulusal Yenilik Sistemi, BTY Türkiye*

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LIST OF ABBREVIATIONS

AKP Justice and Development Party

BTP Department of Scientific and Technological Policy

BTSTP Platform of Science Technology Industry Discussions

BTYK Meeting of the Tupreme Council for Science and Technology

ÇÜ Çukurova University

DNA Deoxyribonucleic Acid

DEÜ Dokuz Eylül University

DPT State Planning Organization

ERC European Research Council

FP7 Framework Programme 7

FP8 Framework Programme 8

GDP Gross Domestic Product

IT Information Technologies

ITU Istanbul Technical University

NATO North Atlantic Treaty Organization

NGO Non-Governmental Organization

NIS National Innovation System

OECD Organization for Economic Cooperation and Development

ODTÜ Middle East Technical University (metu)

OSD Association of Automotive Industry

PREST Policy Research in Engineering, Science and Technology

RRI Responsible Research and Innovation

R&D Research and Development

SCST Supreme Council for Science and Technology

SME Small Medium Enterprises

STI Science Technology Innovation

SWOT Strengths, Weaknesses, Opportunities and Threats

TAA Technological Activity Areas

TAYSAD Association of Automotive Parts and Components Manufacturers

TESID Turkish Electronics Industry Association

TF Technology Fields

TMMOB Union of Chambers of Turkish Engineers and Architects

TTGV Turkish Foundation for Development of Technology

TUBA Turkish Academy of Science

TUBISAD Turkish Informatics Industry Association

TUBITAK Scientific and Technological Research Council of Turkey

TUENA Turkey National Information Infrastructure Main Plan

UK United Kingdom

UNESCO United Nations Educational, Scientific, and Cultural Organization

UNIDO United Nations Industrial Development Organization

YOK Higher Education Council

I. INTRODUCTION

Science and technology is not only our perception of the natural world and natural world's relationship with human welfare but also constraints due to lack of resources. Essentially all public policies are established from the realities of the natural world and continued on the ground of constantly changing presumptions about our understanding of nature. So we can say perspective of science and technology is thus base to the formation of public policy.

Nations have foresights and socio-economic goals for their future. The most efficient tool to reach prescribed goals is a nation's competency of science technology and innovation (STI). Nation's STI policies show ways and procedure to reach/pursue this competency. For self-determined development STI may contribute ecological and social aspects of development through finding solutions for particular problems and strengthening a knowledge base (Sumner et al. 2009; STEPS Centre 2010). In addition, according to Bechmann et al. (2009) and Hornidge (2011), governments that can direct Science, Technology and Innovation (STI) processes concerning knowledge-based economies have higher economic growth and prosperity than countries that don't implement such STI processes. But, the impacts of STI on society are more complex than their analysis.

The current study analyzes the impact of STI policies on international trade through examining the export composition of five countries; Brazil, India, Russia, South Africa, and Turkey. It is predicted that stronger STI policies that lead to higher Research and Development (R&D) spending lead to higher international trade and improved export composition. Study is

focused on Turkey; however, it compares the Turkish export composition to other countries in order to draw comparison among different emerging economies in the world. It is important that different emerging economies be analyzed among each other in order to realize whether if their R&D policies are in fact helping them to grow and improve. The study is not without limitations, there are a limited number of years that have been examined (20) and furthermore, only five total countries have been selected for this study hence limiting the results to be generalized for only these countries. A generalization outside of this group would be unreliable. The rest of the thesis is broken down into three chapters; chapter 1: literature review; chapter 2: methodology; and chapter 3: discussion and conclusion.

II. LITERATURE REVIEW

The literature review will focus on different aspects of STI, STI policies, and STI policy of Turkey. The review itself begins with defining science, technology, and innovation and further studies the relationship between globalization and STI policies. In order to better understand STI policies, the literature also focuses on the relevance of science in the world today and different perspectives of STI policies. In addition, the history of STI policies are examined to further understand the development of STI policies over the course of time. Later, the literature focuses on the impact of STI policies on capacity building, economic growth, international trade, and social development. The national innovation system is also studied to improve the understanding of the system itself in terms of STI policies. Finally, this section focuses on Turkey's STI policies and strategy over the years while also examining the current STI policy of Turkey under the title of *'Turkey Vision 2023'*.

1. Defining science, technology and innovation

1.1 What is science?

Science can be characterized as the deliberate investigation of the physical or material world (regular science) and of society (sociology) that produces, or makes, learning from which information and data is drawn. Innovation can be characterized as the utilization of logical learning to create methods to deliver an item as well as convey an administration or as the use of logical information for viable finishes. There are many broad definitions used to describe the three terms, science, technology and innovations. However, these all are interlinked and associated with each other one way or another especially in today's 21st century. They have different concepts but with overlapping drivers and ecosystems. The systematic study of the material as well as physical world is characterized and defined as science or in other words natural science, also of the society which creates, generates the knowledge from which the information is draw. This can be further termed as the social science. All these terminologies are interlinked with each other.

1.2 What is Technology?

The application of the knowledge particularly scientific knowledge for the development and inventions of new techniques for the production and delivery of a specific service to meet

practical demands, this is termed as technology. Many authors have defined this technology in their understanding; however, this is the far most comprehensive definition of technology.

1.3 What is innovation?

Innovation can be seen as the most diverse terminology amongst the three terminologies, as many authors see it very differently in various situations (Kemp, 2010). The deriving benefits from a significantly new and improved product let it be service or a good, or a process or any new organizational method let it be business practices, organizational relations etc. is termed as Innovation (Mortensen, 2005). Innovation can be differentiated from improvement in many several ways, innovation has more impact economically, socially as well as in environment from the products, services as well as processes which are existing, or from the amalgamation of new science as well as technology for the development of new services as well as processes (Baregheh A. R., 2009).

1.4 Social innovation

The term social innovation also holds great power; this can be defined as the as the merge of social needs with the creation of new social collaborations as well as relationships. Shortly it can be said that basically it is the innovation which shaped the society in every way and furthermore it enhances the capacity for action (Horbach, 2012). STI can be taken as the integrated life cycle in which there is development of new technologies led by science which results in the development of innovations. The various ways which can be taken as innovative can influence the scientific development, how the technologies are improved and put forth and which further in turns defines and influence the process of innovation. (Baregheh A. R., 2009)

1.5 Definition of innovation

The term innovation has always been associated with the economic as well as technological change, long before the concept of STI was put forward, and however it was also considered extremely important. (Mulgan, 2012). Innovation can be considered as the blood and life of the growth and survival of corporate growth. Innovation may be recognized for playing a role being central for the development and sustaining values as well as advantage being competitive (Gallego-Alvarez, 2011). While describing the importance of innovation on the growth and renewal explains that in any organization, innovation plays an integral part in

representing the core renewal process. However, that may not be the case unless it offers the way which it creates and delivers the offerings in risk and growth prospects (Lindič, 2011).

Innovation is a strategic and key policy issue. It is linked and coupled with constant change, the term innovation and its practical uses have been used by all kinds of organization as a tool for influencing the environment (Kotsemir, 2013). Innovation may also include a vast range of various types of change which furthers depends on the resources, strategies and requirements of an organization. Innovation may often include advancement and improvement of any existing product, service or policy in any firm being organizational. Because of this innovation can be of importance for the researchers as well as practitioners who are shaping the environment (Van den Hoven, 2013).

Some scientists as well researchers have suggested that the most difficult challenge that innovation face is the agreement of various schools of thoughts to one particular definition. Thus many researchers say that the term innovation is ambiguous and rather notorious and unclear in many different prospects (Adams et al., 2006, p. 22). Innovation as described by Thompson states that innovation is the acceptance, implementation as well as generation of new processes, services or new ideas. Similar to the notion of Thompson, West and Anderson (1996) and quoted as recently as 2008 by Wong et al. (2008, p. 2), Innovation can be explained as the application being effective on processes as well as products which might be new to the organization and designed to benefit the stakeholders

Nord and Tucker (1987) explained innovation in technological form that innovation can be taken as a new product which might be related and linked to new technology. According to the scientist (Plessis, 2007), innovation can be called as the development as well as creation of ideas which are novel and not been implemented earlier, furthermore the idea and notion can facilitate the outcomes of the business, which might aim to improve the business process which might be internal or external for the creation of market driven services as well as products.

2. Globalization and STI

The phenomenon of globalization is interlined with science, technology as well as innovation as that of culture, production, information. The scientists, scholars, researchers have aimed to study the changes which have taken place over the passage of time with the increase in

globalization phenomenon. To understand the impact and advancement of STI, it is very important to understand the phenomena of globalization, which according to researchers is not just a single term but rather a diffusion of all the aspects of society which include innovation mostly. It can be summarized that globalization may be the intensification of the social relations of the globe which are linked with different localities in a way that happenings around the globe may shape the events which are occurring many miles or continents away. (Greenspan, 2004). Thus globalization refers to the increasing degree of interrelatedness as well as interdependency amongst various geographically dispersed actors. Principally speaking there might be intense globalization with the same involvement of internationalization. (Edquist C. &., 2009)

Innovation as well as technology may be used for the definition of globalization. The applications economically of new novel ideas as well as knowledge is not just technical in its true forms, it might also be managerial, organizational as well as institutional. The new novel technologies which have taken the world by storm such as the Information technology and biotechnology have played a major role in the intensification of the science, as well as technology. These associations are connected with the processes of organizational, infrastructure and institutional change (Gorodnichenko, 2010).

Globalization of innovation, in the modern context can be used for explaining and describing the scope of the generation along with the fusion of many technologies internationally as well as at national level. The technology which is adopted by one nation, which seem to produce good change and which might be beneficial for mankind is then transmitted from one nation to another. Although the learning processes of the development and technological knowledge are long and tiresome, yet the transmission of technology, innovation and science always met less resistance as when compared to the spread of a religion, ideology, political or cultural habits. Technology has always come across fertile meetings amongst different societies which are culturally and religiously different. In the past however there were some barriers in the transmission of innovation and technology, however in the modern 21st century, it is taking place with quiet a rapid speed which is unmatchable. The new technologies shape and make globalization phenomenon possible (Gaubinger, 2015).

The modern world is characterized and identified by its technological as well as innovative ideas like Information Technologies (IT), aeronautical etc., which have made globalization possible.

These technologies shape and give rise to transmission as well as diffusion of knowledge which is superior as compared to the past. Thus the technology has made the modern world a global village as said by many researchers and scholars. The international trade, economic development as well as direct investments have broadly increased internationally, and these all are integrated into one another. Globalization pace and the technological innovation are more or less accompanied side by side and these are correlated (Griffiths, 2010). Thus the idea of the globalization of innovation has come up to be the bridge between two phenomena of the modern economies they include the superior integration of economic activities internationally as well as the importance of knowledge in the ongoing economic processes (Helfer, 2006).

3. Taxonomy of the globalization of innovation

Three categories were identified by (Archibugi and Michie, 1995; 1997a):

1. the exploitation of international technology which is produced on a national level.
2. The generation of innovations globally.
3. The technological collaborations globally.

These three categories are not mutually linked but these are complementary and very important. The large firms generate innovations in all the above listed categories. Historically speaking, these categories are emerged from three stages being successive.

3.1 The exploitation of technology produces at a national level:

This category includes the innovators which attempt to maintain the advantages economically by the exploitation of their very own technological ways which are available in their local market. The term international is being used rather than global because the actors of innovators use their national identity in although the innovation is diffused and it is sold in various different countries. This category is labelled as ‘international’ rather than ‘global’ as the actors introducing the innovations preserve in the main their national identity, even when the innovations are diffused and sold in multiple countries or the necessary knowledge has been sourced elsewhere.

International trade isn’t the only way through which the innovative firm can be benefitted from the competence being technological. The innovator might add more advantage if he sell the innovation to foreign firms. This strategy is convenient when there are some obstacles in the

international trade. However, selling of innovation isn't always easy for the host country. Such a technological innovation must be coded and the country who is buying it must know all the pros and cons of the innovative technology. The transfer of technology needs to be more stringent in this regard (Narula, 2005).

Exploitation of international innovation can also take place by foreign direct investments. It should also be kept in mind that this category must include the productive activity which is being operated in the host country however which does not involve the creation of additional local technological capacity (Castellani, 2006).

3.2 The global generation of innovations

The second category which includes the innovations which are conceived globally from the time they are generated and are open to the market. The innovations created by the multinational enterprises are involved in this category.

3.3 The global technological collaborations

Technological collaborations occur when the different firms establish a joint venture which aims of developing products or knowledge. These collaborations have provided a technological advance which promoted various mechanisms for the cost divisions and the result exploitation. Thus this has created new organizations forms and structures which are expanding apart from the simple technological sphere (Archibugi, 2002).

4. Science and its growing relevance to contemporary world

Science has a broad definition and meaning. It can be considered as both as outcome as well as process, it can be regarded as the process of getting the knowledge and the knowledge which is being obtained. In science everything is interconnected, as it is a chain of series of events as well as models. Thomas Kuhn who is a physicist as well as historian of science states that science is a constellation of theories, methods a well as facts which are collected in the texts being current, whereas he further defines scientists as the men and women who have successfully contributed in history which is science by their accomplishments as well as failures and they have added their element in the science. He further explains that science is more or less the way of thinking towards nature, life and mankind.

Science as well as technology is essential if a nation aims for providing health, security and prosperity to its citizens. Science is also important for a striving economy, keeping in view the problems which are globally related with the climatic change (Owen, 2012). Science is believed to be the truth and new knowledge by the scientists who are deeply engrossed in this field. The truth in science may be incorporated in a proper system and models, experiments as well as replication and revision of the models. The goal of science is to understand the world in a better way and make it a better place to live for our future generations. Science in broad terms is value free, there are no judgments in science, every opinion as well as fact is greatly accepted and welcomed by scientists (McMillan, 2000).

For a scientific experiment and innovation to be successful it is very important at government level to be engaged and involved. The stakeholders, government officials etc. need to be engaged for a successful application of scientific way, for achieving the Sustainable Development Goals by 2030, in this way no one is left behind and the development is upgraded from sustainable development to inclusive development which leads to peace as well as prosperity of the planet Earth. As per the Organization for Economic Cooperation and Development (OECD), which is the economic cooperation and development, if the trends in science continues, as the world population increase from 7 billion in 2010 to more than 9 billion in 2050, per capita consumption will more than triple, from roughly USD 6600 to USD 19,700 per year, and global GDP will nearly quadruple, requiring 80% more energy. Hence for sustaining the growth at such a massive level, the science advices us to adopt such business models, products and production means which may lead and contribute a role in the innovation and shifting towards such materials and means which lead to the healthy Earth. (Geuna, 2004)

5. Perspective on science, technology and innovation policy

In 1950s the advanced countries Governments focused on the Science and Technology share in the GDP, as it was an essential content of National Science Policy 1960s theories of Science Push and Demand Pull theories. The world economic environment deteriorated which force a shift in the policy emphasis in the early 1970s and early 1980s. in these periods significant change has been observed in understanding the process of innovation, hence the term Science, technology and innovation.

As per Lopez Martinez (2006), with the addition of innovation to science and technology, the whole atmosphere changed and it give rise to a new dimension and attitude. Thus it focused not only on the diffusion and understanding of knowledge but it also focused on the understanding of economic, social as well as institutional factors which later on influence the generation and absorption of knowledge which is technological. Thus in other words the technology policy is not much different from the science policy, although it does represent a shift to increased level at the economic sector (Edquist C. , 2010).

6. Diffusion of Innovation Theory

In a social system, the adoption of a new product or idea doesn't happen simultaneously. However, it is a procedure where some scientists are more open for adopting the innovation then others which are rigid; however science advices people to think from an open mind and clear perspective, every fact is welcomed and understood properly. People who are adopting new ideas and process early are more prone for improvement then those who are rigid and stubborn and don't accept any change or new idea in their facts and theories. In a target population, it is important to understand the mentality of the people to whom the innovation is provided. These are generally 5 categories. When innovation is promoted there are different strategies which are different for each kind of category. These are 1) Innovators: who want to try the new innovation and take the risk. 2) Early adopters: they adopt change easily and are amongst the leaders etc. 3) Early Majority: these people aren't the leaders and they are different from the other two categories. They need evidence to convince them for a new innovation. 4) Late Majority: these people are skeptical and sarcastic and don't change no matter what, they would always see what the others have to say regarding a new idea, rather than using their own minds. 5) Laggards: these are conservative people who are bound by cultural extreme. They fear change and they are under lot of pressure what others might say if they change. (Magro, 2013)

There are total five factors which influence the innovation adoption, and they play an extremely important role.

- Relative Advantage: the new innovation seems better than the replaced idea or product.
- Compatibility: the consistency of the innovation with the values etc.
- Complexity: the level of difficulty of the innovation.
- Triability: the extent to which the new innovation can be tested and experimented.

- Observability: the extent towards which the innovation results the tangible. There are however many limitations of the diffusion of the theory of innovation (Molas-Gallart, 2006).

6.1 History and origin of STI

Until 1980s, there were many reflections academically on science technology as well as innovation. There were however many ideas on orderliness, differentiation as well as relations being contractual amongst the society as well as science. However, the scholars who mastered in STI, came to an understanding being common there existed a contract which is being social in the sense of institutional arrangements and the studies being intellectual which dominated the policy of science from the end of World War 2 to roughly the early 1980s. After the great World War, the idea of social contract and policy for science became increasingly important. As after this the innovation and science rapidly increased and it gained extreme pace. The ideas for the transfer of knowledge and ideas scientific into the common citizens became extremely important

These early concepts of technology were functional in maintain a protected space for the scientists. (Rip, 2011). The knowledge wasn't questioned however the means of spread and transfer of innovative ideas were questioned and put into practice. This the scientists named as the linear model of innovation (Godin, 2006). From 1950s, the linear model advocated the idea that innovation can be spread and transfer via a series of actions and habits. This model highly challenged the STI policy makers and the economists as the complexity was increasing. The importance of the linear model of innovation can't be denied by the STI policy makers, as it made STI discourses worldwide, and portrayed rather as an idea then a model in the eyes of a technical scientist (Godin, 2017).

In the early years of 1950-1980, the alignment of science, innovation and technology was done quite successfully, and some problems and issues were tackled easily. These problems were discussed in debates as basic research and applied research (Pielke, 2012; Schauz 2014; Kaldewey and Schauz, 2018). Due to their interpretive flexibility some concepts function as boundary objects, as they can fuel consensus and evoke contestation. The most important thing to be noted is that the scholars and policy makers needed one language to defend their problems and define them properly. Generally speaking, the technology transfer as well as innovation models were strategies which were adopted by the scientists and policy makers to define the

boundary work (Gieryn, 1983). This tailoring is more strategic, as it provides actors in settings with a sense of imagined innovation in their mind (Calvert, 2006; Kaldewey, 2013, 2017; Steinmetz and Freeden, 2017, p. 2).

Using the actual concepts of STI policy communication, the conceptual history has been complemented with cognitive linguistics. In 1990s the STI policy makers weren't based on the familiar and popular metaphors which would easily convey the idea and images within the contexts. However, there were some innovations which were beyond the understanding of normal citizens, although they bought huge breakthrough in the field of science and opened new doors for science and new experimentation. Such models include the post normal science, the triple helix model of the Deoxyribonucleic Acid (DNA). These studies and discoveries were a breakthrough and they reflect the search for a new contract amongst the society as well as science (Funtowicz and Ravetz, 1993; Gibbons et al., 1994; Etzkowitz and Leydesdorff, 2000; Pavitt, 2005).

6.2 STI in the 21st century

The STI policy and advancements in the 21st century is being observed in the following section. First, we analyze a discourse that materialized in the European Research Council and evolved around the metaphorical notion of "frontier research," which was introduced by an expert group explicitly as a substitute for the old concept of "basic research." Second, we reconstruct a discourse that focuses on the idea that science and society have to cooperate to tackle the "grand challenges" of our time. Finally, we interpret the framework of "responsible research and innovation" (RRI) as a new STI policy discourse, which is more formalized than the other two and more intentionally introduced by influential actors in the field of European research and innovation policy. These three cases were taken into account as these differ in different aspects and they highlight various issues and parts of the STI policy. They are diverse and thus carry a diverse historical background. The models are however in accordance to the policy that the concept matters in the STI policy.

6.2.1 Frontier Research

The European Commission, in April 2005, proposed the European Research Council, as an integral component of the Seventh Research Framework Program. Earlier to this the Commission had differed the idea of the basic funding for the research. Hence in the heated

argument that took place at the policy meeting a new term was put forward as Frontier Research instead of the basic research. Thus it was pressured by the committee on the scientists to come up with a European Research Council (ERC), hence Frontier Research came up (Flink, 2016, p. 159). This was portrayed as the word frontier portrayed the process of exploiting and exploring the Americans (Ceccarelli, 2013).

6.2.2 Grand Challenges

The innovation of frontier research was the most novelties of the Framework Programme 7 (FP7). In Framework Programme 8 (FP8), another innovation was introduced which included the societal challenges rational (European Commission, 2011a, 2011b). This reflects the changing of priorities of the policy. The term challenges of the societal is synonymously with the grand challenges, which were introduced earlier as a rationale for the justification of comprehensive coordination means of European Research Area (European Commission, 2007, 2008).

A grand challenge can be defined as the fundamental issue in engineering or science with applications which are extremely broad, whose solution includes high performances resources which would be available in the future (OSTP, 1987, p. 3). The grand challenges include the changes in the climate, energy security, etc. in short the grand challenges can be termed as the global challenges, as these aren't not just the concern of one nation but in fact it is the concern of the whole world. It is a global issue. This also includes the failure and success of many challenges. Thus these grand challenges ask all authors, innovators and actors to join hands and answer the problem and find a solution to them using the STI policies and means.

6.2.3 Responsible Research and Innovation

Responsible Research and Innovation (RRI) is of the recent origin. This was coined in 2007 in Netherlands (Robinson, 2009; De Saille, 2015). This includes the science with the aid for the society (von Schomberg, 2011a, 2011b; Sutcliffe, 2011; see also Owen et al., 2012, 2013a; Stilgoe et al., 2013). This model explains how the actors and innovators are working for the field of science. This RRI was an adoption to the old STI policies. If the scientists and the organizations were only to talk about the RRI, the concept doesn't affect the identity work deeply. However, it aims the scientists and researchers to aim strategically and work according the STI policy. This may also include the issues at hand of the space and galaxy. Therefore, the

question is whether in a long term perspective RRI can become more than a footnote in a conceptual history of responsibility (Larédo, 2015).

7. STI and capacity building

STI stresses on the importance of science and technology merged into one agenda. Currently speaking the knowledge and the access of technology is rather uneven and unmatched as compared to the people who are educated. It is the role of government to work in such a way that everyone is well aware of the innovative ideas. The access of technology is rather uneven and not equally distributed. For example, 74% of the population in the countries which are developed are facilitated with the service of internet, whereas this ratio is rather less in the developing countries where only 26% of people are using this internet facility. Least developed countries and the developing countries spend significantly way less in the research and development as compared to the developed countries, hence the difference can be seen in the economic development and other everyday problems. However, despite these empty spaces, it is highly misleading thing that people say that technology is developed and produced and innovated in the north and it is transmitted to the South. Innovation is widespread in many developing nations, and the firms which are working in these countries are equally important and play a role in the growing share of global research and development expenditure.

Low income countries have also started to develop the technological capacities domestically. These experiments as well as experience have made the importance of the learning interactive, information exchange as well as the coordination amongst the firms, universities, research centers, governments in building an innovative economy. There are various factors on which the capabilities of STI of a country depend. The capabilities of a STI country depends not only on the increased scientific research and technology, but it also depends upon the healthy interactions of the actors of the innovators in a systemized way which is called as the innovation system. This is one of the biggest challenges in the promotion of the innovation technological events. The lack of innovation system for the ease of interaction amongst the innovative actors, I way more complex then it seems to be. Because of the involvement of the all kinds of sector into one system is very complex, as it involves the involvement of formal sector which includes the enterprises, research institutes, government etc. Along with the non-governmental organizations which include the innovators at small level, and knowledge at local and indigenous level.

The bridging of the informal sector with the formal sector is extremely difficult at such a large level. The characteristic of a good innovative system should encourage and promote the superior involvements and active participation of all the sectors together. Such a system which includes the involvement of all the sectors is basically more effective and in the long run it is able to provide more benefit to the companies as well as the nation collectively. Thus this may foster the needs of the poor and merge and promote technology for the greater cause of the mankind (Watkins, 2008).

8. STI and economic growth:

For a social change to take place it is extremely important for all the instruments to work together. The efforts and effects of STI are understood by the modernization of systems as well as technologies, which are able to change the lives at all level, from nations to the societies. STI will help in the improvement of the competitiveness, it would help in the productivity of the nation, and it would upgrade the structures of the industry and moreover address the challenges at a global level (Wong, 2005).

The increase awareness of global value chain and its rise coupled with the role of the entrepreneurship, along with the search for the new resources of growth and moreover the challenges which are raised by the social as well as the environmental issues have demarcated and incorporated new aims as well as objectives for the intervention of policy. It is the role of government for committing to put the STI at the center for the policy of the economics. When innovative centric economy is kept in mind, it is referring to the ecosystem which is considered to be vibrant, inclusive as well as supportive. It is the surrounding ecosystem which gives strength and resilience to every woman and man nearby to break through all the boundaries and think superior than the past. Thus by pushing their limits and boundaries of an individual, this would help in the advancement of the economic socio development of the extended immediate community of the surroundings (Corrado, 2009).

STI are the drivers which drive the socio-economic development. From the success stories of the developing countries, it shows that the policies of the STI are well managed and well integrated into the national strategies which are useful in the development of the nation. Thus these STI policies when combined with the organizational as well as institutional changes

can help raise the bar of productivity, faster economic growth, create jobs for all, more over improve firm competitiveness.

To achieve such a situation where the STI is of use and help to the common man on streets, the policies need to address the specific innovation techniques as well as strategies. The examples can include the traditional sectors of the economy, the incremental and adaptive innovation importance, the importance and the urge for identifying, acquiring and adoption of the innovations which are foreign to the nations. The particular enhanced direct investment foreign for the nation, the access of firms to the workers who are skilled and to capital the weak infrastructure which is not so technology dependent and the intellectual property rights which can be inadequate at times.

The key element of economic growth and competitiveness of a nation is the innovation. The increased sustained economic growth can only be achieved when the exploitation of innovation and mastering of innovation is done at national level. The high value power can only be generated by the incorporation of innovation. The advantages being comparative like increased population, richness of a natural resource, these cannot become sustainable source of competitiveness. It is because the comparative advantage which can only add low value. However, in many cases the comparative advantage is being used by many nations wisely which lack some resources for driving their economic growth in the development of the industry. Innovative process, technologies as well as activities is being created by the high added value. Principally it can be said that the sustainable economic growth can be attained just by the innovation process and the merge of the STI.

The question then arises that why all nations cannot reach the sustainable economic growth? For the enhancement of country competitiveness can innovative practices be used for the development in other countries for the sake of increasing competitiveness? There is different level of economic competitiveness as well as economic growth which might be experienced by various nations which is a result of the innovation capacity and capability of the nation. However, it can be said that the development practices of a respected country can be adopted and learned only; they cannot be copied because every country has its own culture tradition and mind set depending upon the STI policy. However principally speaking one thing is for sure common

in all the nations whether developed, developing or low income nations that are the importance of the STI and innovation policy. This STI policy as well as innovation enhances the national capacity of a nation likewise increasing its competitiveness.

The mere success and increment of the economic growth it is extremely important to learn from a country who had adopted an innovative policy or idea, as these policies and ideas can only be adopted and learned. With this approach, a country can be able to design its own policy of STI and improve and upgrade its own innovative ideas, keeping in mind its own circumstances and characteristics of the country as well as the political climate and the ecosystem of the nation.

The complex economic, developmental, societal, and environmental as well as challenges related to the cultural identity requires the help of science, innovation as well as technology to weave the society together into one unified society. Such a society is required by the nation which is co designed as well as co-produced by the STI policy processes which connect and allow the exchange being fertile amongst the three terms. Thus it requires the nations to invest actively and openly in the education system of the young in the science field, technology, math and engineering. Thus educating the youth would empower the citizens in the usage of the information which can be useful in the decision making as well as evidence making.

With strong connections amongst the policy, society and science can the societies can prevail which are knowledgeable, well groomed. Such societies be created where the citizens as well as the decision makers have the power as well as capacity to pave the future they want for the beautiful planet they live in. The nexus of the science- society – policy requires to take a perspective which is broad and it accepts the relationship amongst the democracy as well as science. The philosophies of the societies which are democratic impact STI and it is helpful in transforming and reshaping the lives of the communities as well as the individuals, where the citizens are active participants in reshaping the transformations (Jalava, 2002).

STI policies should support economic growth, because economic growth is very important for most countries development strategies. According to Drucker (1993), innovation and knowledge should be essence for economies for being competitive on the market. For

Fagerberg and Srholec (2009), interlinking the idea between STI and development gained importance in the 1960s, when scientists started to postulate dissimilarities in worldwide development linked in technological differences, and these technological capacities required to be developed to close technological gap to stop countries from 'lagging behind'. Röling (2009) states that many developing countries track economic innovation considering as a 'standard recipe' of growth based on the free market economy idea and on a top down policy promotion for technology production with focusing on competitive technological change as a director of development. Most knowledge society models focus on the economic aspects but meanwhile they underline the key role of communication and information technologies to diffuse and disturb knowledge (Hornidge, 2011). Practically with assuming outcome of technological developments closely related to science and technology-based innovation is the perception of knowledge society.

8.1 International organizations

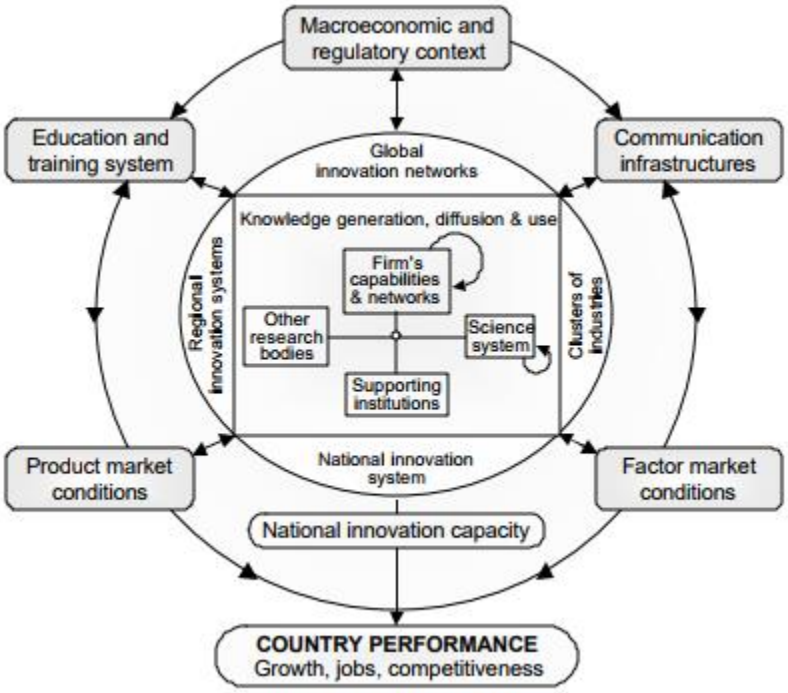
8.1.1 OECD

The OECD is one of the leading international organizations spreading both innovation systems concepts and science policy for economic development (Lundvall and Borrás, 2005; Henriques and Larédo, 2012). OECD defines the organization describes its mandate as follows:

> "The OECD Directorate for Science, Technology and Industry (STI) develops evidence based policy advice on the contribution of science, technology and industry to wellbeing and economic growth" (OECD, 2013a).

In Figure 1 below we can see an example of the OECD conceptualization of the innovation system. Figure one says all components like interaction of firms with research organizations and supporting institutions supports economic growth in one way or another with increasing competitiveness and job opportunities. The concept figures on the differences among countries in several scopes like industrial specialization, population, knowledge base, between others which captured in statistics as manner to comparisons among OECD members and measure the notional differences (OECD, 1999).

Figure 1: Actors and linkages in the innovation system.



Source: OECD (1999)

OECD explains innovation in 2010 as a key driver of growth performance and its positive effect on economic growth to increase (OECD, 2010, p. 25). The publication talked about OECDs positive effect to solve the tasks in the European crisis and they define this effect as a silver bullet. They identified five pillars to support innovation in their report. First one is about training and education development to diffuse more entrepreneurial skills and consumers in

innovation process and more participation of users to empower people for innovation. Second one is about states job to procure financial and framework conditions required for innovation to improve, like taking risks, promoting innovation to small and medium sized firms and remote finance for innovation. Third one is emphasizing knowledge creation and usage, its usage in public sectors and stating the importance of having an effective system of intellectual property rights protection. Fourth one is about international research cooperation and their effect on global challenges and technology transfer to lower income countries. Last one is mentioning about importance of including innovation policies at all level of government for measuring it and evaluation and applying evidence-based policy making.

8.1.2 World Bank

World Bank describes its tasks in view of ST&I policies as: "The mission of the Science, Technology and Innovation (STI) team is to help identify, design, and implement science, technology and innovation capacity building policies and programs, based on global experience, which are essential to generate wealth in today's increasingly competitive global economy and which are tailored to each country's social and economic development challenges" (World Bank, 2013).

In 1996, the World Bank President, James Wolfensohn, rebranded the bank from a 'lending bank' into 'the knowledge bank' (King & McGrath, 2004; Hornidge, 2012). So we can say they recognized the importance of knowledge for development early. Also Global Information Society meeting in Brussels in 1995, Information Society and Development conference in South Africa in 1996, the Global Knowledge Partnership, the first Global Knowledge Conference in Toronto, Canada (Global Knowledge Partnership, 1997a) shows World Bank place importance on knowledge. The Global Knowledge Partnership conference 1997 took both donor community and the global development, planning and government officials from developing countries, private sector and non-governmental organizations for discussing the role of information revolution in the development process (Global Knowledge Partnership, 1997b).

In the publication of the World Bank report entitled 'Knowledge for Development' 1999 it is head lighted that the idea of 'knowledge' being a crucial factor of successful development

cooperation and poverty alleviation. The report states: “Knowledge is like light. Weightless and intangible, it can easily travel the world, enlighten the lives of people everywhere” (World Bank 1999: 1). According to Hornidge (2012) via this report, the idea of ‘knowledge’ as driver of development and subject of argument since centuries reached the summit of global (donor-driven) development discourse. World Bank publications like World Bank support of science and technology development (Goel et al., 2004), promoting innovation in developing countries: a conceptual framework (Aubert, 2005) or Building knowledge economies: advanced strategies for development (World Bank, 2007) shows World Bank’s attention on economic innovation and economic innovation system thinking.

> ‘’Innovation policy requires action in many different policy areas— education, trade, investment, finances, and decentralization, among others—and it is the right combination of interventions in these diverse domains that creates a fruitful innovation climate” (World Bank 2010b: 9).

Differently from OECD, World Bank highlight the role of government in innovation is more explicit, in the sense that besides the importance of firms. The World Bank identifies complexity of innovation policies and they use peculiar metaphor of the government as a gardener. In essence, such a gardener is said to be in charge of: fostering entrepreneurs by giving the needed resources (“watering”); removing barriers (“controlling weeds and pests”); supporting research (“fertilizing”) and education (“preparing the ground”) (World Bank, 2010b: 2). In the report they highlight the government role to remove the barriers in contradiction of innovative projects. The World Bank highlights the importance of effectual institutions for innovation systems to work.

8.1.3 UNESCO

United Nations Educational, Scientific, and Cultural Organization (UNESCO) highlights the high importance of knowledge in the development for economic growth and applied technological research in the UNESCO’s country studies, its regional reports, its science reports, initiatives such as on National Science, Technology and Innovation Systems in Latin America and the Caribbean or the African Science, Technology and Innovation Policy Initiative (UNESCO, 2008; Brito & Schneegans, 2010; Lemarchand, 2010). In the UNESCO’s last report

in 2010, alongside with applied science, 'science' includes natural sciences like engineering, clinical medicine. It contains country chapters and regional sections which describe national and regional ST&I landscape – including statistical data such as investments in R&D, number of patents etc. Also it emphasizes the role of STI for economic development with the section "the growing role of knowledge in the global economy "and give recommendations for STI policies.

Regarding the role of developing countries in the global ST&I context, the report states that "the old notion of a technological gap can today be considered a blessing for those economies possessing sufficient absorptive capacity and efficiency to enable them to exploit their 'advantage of relative backwardness'.

In addition to the science reports, UNESCO advise on ST&I policies and ST&I systems in national country studies for member countries (UNESCO, 2013b). For example, in the country report for Brunei (UNESCO, 2005) they underlie a strategy of ST&I and ST&I policies targeted purely at economic aspects of development. In the report, UNESCO explicitly draws upon the OECD's concepts of innovation "as the key to long-term competitiveness", thus as a motor of growth (2005: 7).

9. STI and International trade

Post war period was extremely important for the international trade to flourish and its importance in this period couldn't be denied. In the absence of international trade, nations might not be able to maintain the standards of living. With the availability of natural resources only, nations couldn't be able to produce and fulfill the requirements of the citizens, as the natural resources are limited of a country.

The importance of international trade can be seen as it allows the advancement as well as involvement of many resources which are gathered from many nations and countries. This term also improves and facilitates the distribution as well as supply of many goods, services as well as products which are produced in different parts of the globe. The innovation at technological level are the basis of the growth let it be economic or social (Burinskiene, 2013). There is a short disagreement of various scientists and researchers who claim that technology is only driven by science, and however it is independent of incentives at economic level. However, it would not be wrong to say that innovation technology as well as scientific innovation requires many economic

incentives. However, the innovations at a greater level which include new scientific technologies always require many heavy investments.

Only that scientific innovation has commercial value which have good commercial value, in the eyes of firms which are private. However, some companies only invest in some new innovative technology when they see their own benefit of earning profit. As the innovations have increased higher capacity, for tis support international trade has to be introduced. This trade may help keeping in line the technological disseminations. However, the exporters who are foreign suggest and advice the manner in which the scientific innovation needs to be used, it might become an even more interesting concept for the citizens of the nation who are going to adopt a technology (Lanteigne, 2015).

The role of facilitating transactions has been played extensively by the Information Technology in the international trade and business to operate at a faster pace. This thing might be extremely important as the finalization is done by the client only upon the delivery of the package, hence now due to IT no need to wait for weeks and months in long distances (Yeung, 2014). The innovation technologies have basically changed the way products, services etc. are traded and they have given the product a mere transportation means. The way a given product moves between the organization and how it replaces the routines of the organizational routines with the new behaviors. The economic growth or development can be achieved by the horizontal innovations as well as the innovations being vertical. Hence because of this, there is an increased number of researches where authors and researchers are linking the international trade with the innovation technologies (Whittaker, 2010).

10. Concept of Innovation

The innovation is a process which is distributed amongst many entities starting from companies, actor's organizations and it is greatly influenced and impacted by the policy, social pressure as well as regulation. Principally, in a broad state of mind, innovation is taken as a part of a system which is extremely broad and wide. Secondly innovation shouldn't just be considered as a process or a product but it is the process, the way amongst these two. For example, the decrease in price of light bulb in the year 1880-1896, this fall in price was taken as an innovation for the increased usage amongst the citizens. The innovations which however is very expensive and it fails and lacks the spark to meet the demands and supply of the citizens is

generally not considered and accepted widely. The production of services or products, which isn't needed by the market, or designing of the processes which won't meet the needs of the user or it would get some resistance while its acceptance (Park, 2010).

Technology push and pull is considered important when the innovations are kept in mind. If the technology or innovation is attracted to the market, it is widely accepted in the market, then it is known as the technology push. However, if the market signaled the need of a certain innovation and it may be called the mother of all the innovations the that is known as the technology pull. At times, push or pull would be dominated however it is ideal that in a market both push and pull be present. Innovations of technology are the most extremely important factor of the economic future. Based on the experiences of the past, it is extremely difficult to predict the changes and innovations which are going to take place at any time. Hence there is a possibility of a paradigm shift which innvolve the convergence of many trends, in which the older or previous innovation is generally replaced by the new one (Breznitz, 2011). Innovations take place within a set of regulations which involve the actors who adopt the innovations by talking about the product etc. however with the passage of time, the actors of innovation will continue with the brand new innovation, which may be better and easy to adopt then the previous old technology (Aghion, 2005).

11. International trade and innovation

The invention of technology increases the international trade in all the nations, the countries which are the mothers of innovations obviously would be able to trade more than the countries who don't produce new innovations. The countries which develop an innovation would be more successful than the other countries. Thus this would be used in the formulation of the international trade and public policy. However, a few innovations may be taken as important, as they cause some gains in the trade (Schneider, 2005). There are countries where they use technology for economic growth and development, which shows high level of commitment with the innovative technology. In the developed countries, they provide incentive to their workers for the innovation technology and production of some policies. There are countries where the countries have diffused technology, and the innovation is widespread and easily accepted. The advances in the technological advances raise the export for countries which are advanced and they gain the progress abroad for the countries which are less advanced (Freeman, 1989).

12. STI and Social Development

According to Stamm-2009 innovation as a guide of pro-poor economic growth would require integration of innovation policies and social objectives. On the other hand, Altenburg (2009) states that most scholars in the system of economic innovation do not consider the specificities of developing countries, like social inclusion via innovation or needs for poverty reduction. This has led to alternative research that focuses on both the economic and non-economic innovation perspectives, emphasizing on the implementation of knowledge for inclusive aims that incorporate resource scarce sectors for the benefits of innovation. As a result, several concepts have developed to support a different perspective; these concepts include 'pro-poor innovation', 'social innovation', 'inclusive innovation', and 'grassroots innovation'. Further differentiation can be based on economic and non-economic perspectives.

12.1 International organizations

12.1.1 OECD

There had not been much discussion on economic growth and its impact on lower income groups; however, lately they have focused on this issue as of their reports published back in 2012. An OECD (2012) report discusses the implications of inclusive innovation on the policies of developing and emerging economies. The concepts were further echoed in a working paper on Innovation and Inclusive Development (Paunov, 2013). Both the report and working paper discuss the inequalities that arise as a result of innovation, which may in fact ""reduce opportunities for the poor and thus their contribution to the economy; they then hinder the development process" (Paunov 2013: 6). The OECD sees the relation between innovation and inequality as bi-fold, on one hand inequality being a hindrance for innovation and on the other innovation leading to a reduction in inequality.

Inclusive innovation consists of two elements that define how lower income groups can benefit from innovation. First, inclusive innovation refers to innovations that facilitate the needs of lower income groups, these may include economical innovation, products for the poor income groups that have fewer features and can be sold in resource scarce markets. As OCED states (Paunov 2013, p. 7) that entrepreneurs use innovative financial and business approaches to serve the low-income markets profitably. Entrepreneurs are able to create solutions that will serve these low-income groups while at the same time earning their profits. Second, OECD also

embraces innovations that are created by lower-income groups in so called grassroots innovations that are conceptualized based on local or local market knowledge or that adapt external technologies. In this sense, inclusive innovations are not necessarily high-tech, but rather they fit the needs of the local market and the conditions of the consumers (which in this case would be lower-income groups). The dimensions stated by OECD are in fact the economic dimensions of innovation and relate to economic benefits. STI for social problems are related to existing business opportunities i.e. irrigation techniques, water management systems, new farming techniques, etc. However, it should be stated that OECD in its initial reports have not provided any policy recommendations for inclusive innovation. Therefore, although OECD talks about inclusive innovation and the need to include lower-income groups, it doesn't provide a specific path that can be utilized to achieve this inclusive innovation.

12.1.2 World Bank

The World Bank has discussed different aspects of inclusive innovation in different publications prior to 2010, and also within their Handbook on Innovation Policy for Developing Countries (World Bank, 2010b). The report mainly focuses on the economic benefits of innovation while also containing a section on pro-poor innovation. However, pro-poor innovation as part of the report seems a bit out of place as the rest of the handbook focuses on policies that promote innovation for economic growth. There are no specific sections of the report that focus on improvements or the overall direction in which the ST&I policies are headed. Although, mentioning pro-poor innovation in the report, this aspect is not an integral part and plays a minor role in the innovation system. The World Bank defines pro-poor innovation as:

> "a pro-poor innovation system can be defined as a multi stakeholder social learning process that generates new knowledge, puts it to use, and expands the capabilities and opportunities of the poor" (World Bank 2010b: 336).

According to the World Bank (2008), innovations in fields that are related to people at the 'bottom of the pyramid' and aimed at the Millennium Development goals, i.e. agricultural research, public health, alternative energies, or drinking water supply, are considered within inclusive development through innovation. The World Bank proposes strengthening all elements and connections within the ST&I system in order to reach this objective. The World Bank

stresses importance of capacity development in all social segments disregarding discrimination among the poor in order to adapt technologies to local conditions (World Bank, 2010b). World Bank also emphasizes the participation of developing countries in pursuing inclusive innovation solutions rather than having to conform to solutions that are put forth by the OECD institutions. Furthermore, the World Bank recommends that in order to increase STI based innovations, universities from developing countries should contribute to more research to social problems. In addition, stronger funding must be provided to these universities to pursue these research goals. Therefore, funding should not only be provided for research activities but should also focus on wider dissemination of the research especially those that are assisting the public good as well as commercial products or technologies for the poor (World Bank, 2010b).

The World Bank also emphasizes the importance of the 'products for the poor', stating that:

> "The objective of inclusive innovation is to harness sophisticated science and technology know-how to invent, design, produce, and distribute, primarily via private sector Small Medium Enterprises (SME), high performance technologies at prices that can be afforded by the billions of people at the [bottom of the pyramid]" (World Bank 2010a: 9).

The World Bank also recognizes the market share of the 'bottom of the pyramid' as having significant overall purchasing power hence it should be targeted by the private sector through,

> "developing affordable products and services tailored to the needs of low-income consumers, by creating job opportunities and increasing the productivity of the poor." (World Bank 2010b: 368).

The bank also encourages governments within developing countries to remove legal barriers and provide incentives in order to motivate the private sector to develop products for the poor segment of the market. World Bank also promotes inclusive innovation with the inclusion of the poor in the innovations, i.e. grass root innovations or innovation within the informal sector. There are two ways that these innovations can contribute to inclusiveness; first, they function as income generators, second, they provide adapted solutions (World Bank 2010b). İn addition, the World Bank in regards to supply-drive initiatives states that,

> "[t]op-down, supply-driven initiatives have often proved ineffective for addressing the needs of the poor. Inclusive innovation policy presupposes a change in institutional culture and mandates the involvement of the poor in identifying their development priorities and in providing incentives for various actors to serve their needs more effectively" (World Bank 2010b: 362).

Hence, it is important that developing countries be involved in seeking and formulating solutions for the poor segments of their populations. They understand the problems better and research through their higher educational institutes is more important in creating long-term solutions that can assist the poor in their daily lives and in improving their situation over time.

12.1.3 UNESCO

UNESCO has not published any document that exclusively focuses on ST&I. They have however, mentioned ST&I in different publications such as the UNESCO Science Report (Brito and Schneegans, 2010) and the World Social Science Reports (UNESCO and ISSC, 2010; ISSC and UNESCO, 2013). Whereas, Science and Technology regional publications by UNESCO have discussed the ST&I in different dimensions. A report on the National Science, Technology, and Innovation Systems in Latin American and the Caribbean, mentions that ST&I be utilized to contribute to reaching Millennium Development goals. The report suggests the integration of social and innovation policies, which may improve the economic development in the long-run through,

> "the generation of a 'virtuous circle' as the social legitimacy of these policies could prove to be an important path towards strengthening capacities in favor of actions towards building a Knowledge Society" (Gorfinkiel, 2010).

Similarly, a report on Science, Technology & Innovation Initiative. Responding to the Needs of Africa (UNESCO, 2008), summarizes UNESCO's actions in the field of ST&I as,

> "key contributors to poverty reduction, disease prevention and environmental conservation. Strengthening capacity in science for sustainable development, and harnessing the fruits of scientific discoveries, can only be achieved within a comprehensive framework of science and technology" (UNESCO, 2008: 3).

Likewise, another recent initiative by UNESCO on ST&I in developing countries, 'Project for strengthening science and technology policy capacities in the Republic of Congo', conceptualizes ST&I beyond economic thinking and focusing on social and economic development. The document on the project states the following,

> "in the social and economic development strategies of developing countries in order to ensure growth and sustainable development" (UNESCO, 2010b).

UNESCO, as observed through various reports and initiatives, focuses not only the economic benefits of ST&I but also the social benefits. It emphasizes both the social and economic development as a result of ST&I.

13. National Innovation System

At the present day science and technology policies are one of the most important factors that affect country's economic performance but on the other hand it is not enough to implement science and technology policies merely to have a success on economic frame in a quick changing economic environment. Structures like national innovation systems helps countries to have a better economic performance with science and technology policies. Countries constitute their own national innovation systems and integrate their national innovation system with science and technology politics has successful outcomes. Rapid change in today's knowledge based economies and technological competition increased countries attentions on structures like National Innovation System (NIS).

13.1 Definitions of National Innovation System

A national system of innovation has been defined as follows:

> " .. the network of institutions in the public and private sectors whose activities and interactions initiate, import, modify and diffuse new technologies." (Freeman, 1987)

> " .. the elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge ... and are either located within or rooted inside the borders of a nation state." (Lundvall, 1992)

> "... a set of institutions whose interactions determine the innovative performance ... of national firms." (Nelson, 1993)

" .. the national institutions, their incentive structures and their competencies, that determine the rate and direction of technological learning (or the volume and composition of change generating activities) in a country." (Patel and Pavitt, 1994)

".. that set of distinct institutions which jointly and individually contribute to the development and diffusion of new technologies and which provides the framework within which governments form and implement policies to influence the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artifacts which define new technologies." (Metcalfe, 1995)

The smooth operation of innovation systems depends on the fluidity of knowledge flows – amongst enterprises, universities and research institutions (OECD, 1997: 3). Both implicit knowledge and expertise exchanged over informal networks, and codified knowledge, or information codified in publications, patents and other sources, are vital. The instruments for knowledge flows comprise of joint industry research, public/private sector partnerships, technology diffusion and movement of personnel (OECD, 1997:3).

According to OECD (1997) there are three factors that the national innovation system approach has taken on increased analytical importance in the technology field:

1. The recognition of the economic importance of knowledge;
2. The increasing use of systems approaches;
3. The growing number of institutions involved in knowledge generation.

National Innovation System States in general (DPT, 2000, p. 9);

- Obtaining new technologies containing product or product management, assimilating them, providing diffusion these technologies to the whole operations of the economy
- Product development, designing new products
- With the new product designing developing new production process, designing new method
- Designing new production machines needs by the new or developed production method
- Maintaining research and development activities feeding design and production process, producing required technology with scientific findings

- Systems which occurred from national institutions which have ability to organize research development, design, production, marketing process both inside and between themselves and developing new organization methods that reproduce again at the higher hub and relationships between these institutions.

13.2 Institutions Constitutes National Innovation System

According to Taymaz and OECD we can evaluate institutions that generates national innovation system under six group concerning; producing, diffusing, safekeeping and using of scientific and technological knowledge. (Taymaz, 2001, p. 26-27, OECD, 1999, p. 29).

- Public and private concerns that located in technological innovation and network configuration that these firms constitute: At the present time firms are in sight primary resource of economic growth. Behind of this view, reality is firm's technological possession of competence on big changings on market, product or sources as a result of learning and accumulation on the process of productive activity.
- Research agencies: Public or private research agencies which are nonprofit organizations, produce/spread technology has very important role on national innovation system. We can categorize public labs, patent offices, and institutions provide technological transfer under this segment.
- Science system: In science systems universities have tasks like producing scientific knowledge, making an invention and training researchers
- Support bridges and organizations: Support bridges and organizations which involved in an activity like extending new technologies, defining standards of support services; offers support services to intuitions which make innovation activity for their technological substructure.
- Financial institutions: Financing of technological innovation activity has different characteristics from other investing activities. So technological innovation activities have been supported by some tools like research and development donations, loans, tax deductions. In addition to these, advanced technology oriented venture firms need fund, has a high potential to grow has to be supported.
- Institutions that develop, implement evaluate policy: Institutions that develop, implement evaluate policy have an important function in the system for establishing and functioning

actively national innovation system, coordination of activities, protecting system from indirect problems.

13.3 Main Techniques Used in National Innovation Surveys

The OECD have used four techniques in national innovation surveys (OECD, 1997).

1. Joint research activities – These include technical activities and research done jointly by universities, research institutes, and firms using data available by government funding agencies, organizations, universities, etc. These joint research activities include both projects funded by civil society organizations, financing by university for its research, and any other type of contract research.

2. Co-patents and co-publications – These are measured through collecting patent records and analyzing publication indices. In general, the number of co-patents and publications developed with the collaboration of enterprises and universities must be included in this category.

3. Citation analysis – Users generally cite their sources hence a citation analysis can be utilized to assess the extent to which an enterprise has used information that was originally generated by universities or research institutions.

4. Firm surveys – Surveys can assist in realizing the degree to which a university or a public research institute is regarded as useful in terms of knowledge for innovative activities. These surveys also allow us to capture the informal links between industry and public research sector. Therefore, these surveys reveal the extent to which public knowledge differs according to the industry.

Table 1: Core Knowledge Flows in National Innovation Systems

Core knowledge flows in national innovation systems	
Type of knowledge flow	**Main indicator**
Industry alliances	
Inter-firm research co-operation	Firm surveys Literature-based counting
Industry/university interactions	
Co-operative industry/University R&D	University annual reports
Industry/University co-patents	Patent record analysis
Industry/University co-publications	Publications analysis
Industry use of university patents	Citation analysis
Industry/University information-sharing	Firm surveys
Industry/research institute interactions	
Co-operative industry/Institute R&D	Government reports
Industry/Institute co-patents	Patent record analysis
Industry/Institute co-publications	Publications analysis Citation analysis
Industry use of research institute patents	Firm surveys
Industry/Institute information-sharing	
Technology diffusion	
Technology use by industry	Firm surveys
Embodied technology diffusion	Input-output analysis
Personnel mobility	
Movement of technical personnel among industry, universities and research institutes	Labor market statistics University/Institute reports

Source: OECD (1997)

National innovation systems involve firstly research and development activities, education system, industrialization policy and science and technology policy of countries according to countries own conditions (Saçlı, n.a). On the other hand, including economy policies all national innovation systems that determined by the governments should count

environmental problems. Because nonrenewable natural resources of world run short, water weather land pollution and scarcity increasing. So national innovation systems that determined with observing and implementing environmental values are very important for providing and implementing development.

14. History of Research and Development in Turkey

- OECD, Pilot Teams' Project on Science and Economic Development [Turkey], DAS/SPR/67.8, Paris, 1967.

In the preparatory work of first five-year development plan and the time period 1963-67 that this Project was implemented, OECD performed a project under patronage of scientific research committee which Turkey attended too named 'The Pilot Teams' Project on Science and Economic Development'. Project began at 1962 and aim of the project was examining how to associate optimized relationship, scientific research and technology pursuant to plans and politics that encourage and maintain proper economic growth rate between production and social welfare problems at the national level. Reason to brought project into force by Directorate for Scientific Affairs was the important role of scientific activities on economic growth so the necessity of these activities in policy at the national level.

Project run with working groups at seven countries named Pilot Teams. The first participant was Greece at 1962-Dec than second one was Italy. Turkey, Spain and Ireland join at 1963. Portugal join at 1965 and at least in 1966 Yugoslavia join. At 1967 the report of Turkey was published. The main topics in hand at the report were:

- Relationship between science & society, science & economy
- The results can be get from science policy at less developed countries
- Planning development and science policy
- Mechanisms of executing a science policy and continuous improvement & necessary components
- Constraints of Turkish economic development and science policy

With above subjects a formula of Turkish science policy general frame formed. After that from Turkish economy history progress, general structural and main industry specific analysis, goals for economic development and social welfare was identified and strategies formulated. At least a foreseen science policy that can be help to reach economic and social aims, revealed.

This science policy shows widely the topics of industrial research and development that Turkey should turn towards, the policies, actions and industrial arrangements should be done especially at agriculture, energy and some industry sector like textile, metallurgy, chemistry, machine manufacturing, electric machinery, agricultural machinery and electronic industry for developing production.

Project prepared by, Dr. Attila Karaosmanoğlu, Dr. Necat Erder, Dr. A. Sönmez, Dr. Demir (Yorgi) Demirgil, Refet Erim, Cevdet Kösemen, Selçuk Özgediz ve Dr. Ergun Türkcan and head of the project was Prof. Erdal İnönü. But following projects suggestions about science technology, production was shelved by state planning organization experts with the reason of no demand to science and technology at industry.

- 1967 Study of Dr Atilla Karaosmanoğlu 'Contribution of Science and Technology to rapid development '

Dr Atilla Karaosmanoğlu has an important contribution to OECD's Pilot Teams Project Turkey under topic 'Science and Economic Development 'and he did a study titled Karaosmanoğlu 'Contribution of Science and Technology to rapid development 'at that term for state planning organization. But his views like taking science, technology, production and development issues with systematic cohesion which parallel to mentioned 'Science and Economic Development 'Pilot Teams Project Turkey did not reflect to the documentary on Pilot Teams Project Turkey.

- 1971 Consultant Report: Proposals for a study about science policy from Turkish Science and Technology institution:

Scientific and Technological Research Council of Turkey (TUBITAK) submitted research project proposal to OECD to 'Program of Technical Assistance to Turkey' for science policy works. According to Charles Cooper consultant report 'Turkey is a country which has an inborn practice to technological inertia at its traditional sectors of economy and has a weakness of economic and social demands for scientific activities. Fundamentally role of scientific activities is limited and it is just for learning purpose' Also he added that 'It is just a hypothesis about development of science at Turkey and this determination presently just recognition about structure and role of science at Turkey so it is not a base and not a way to Turkey to show how science should be developed'. In other words, Cooper says Turkey really weak in terms of

economic and social demands to scientific activity but it does not mean not to do anything about science.

- 1983 Turkish Science Policy (1983-2003): Prof. Dr. Nimet Özdaş's study titled 'Turkish Science Policy 1983-2003' was presented to the Turkish prime minister at 27/10/1983.

According to this study for the first time in Turkey

- Capacity of Turkey on research and development, labor force and spending determined proper to international norms.
- Long term scientific goals determined.
- Turkey's priorities on research areas based on Turkeys economic and social targets were revealed.
- To reach targets on science area at the same time optimization of existing system, the supreme council for technology with delegated legislation and necessary mechanisms was constituted.

Although it named AS 'Science Policy' in real this study was science and technology policy projection. This policy shelved almost at the time presented to the Turkish prime minister, only thing from this study rest to today is the supreme council for Science and technology which established to implement this policy.

Founding father of science policy projection Prof.Dr.M.Nimet Özdaş, was the first secretary of TUBITAK (1964-66), he was member of TUBITAK science supreme council(1968-72), president on establishment committee of Marmara Research Institute (1968-72) and then he was institute manager of Marmara Research Institute (1972-73). Briefly he was establisher of institute, he was close viewer of OECD's studies of science policy, when he was working for North Atlantic Treaty Organization (NATO) as science committee president (1973-79) he put into place Science for Stability program, in the line of this duty he found an opportunity to examine other countries science policy. He was a big chance for Turkey at 1980s with his knowledge and experience he has qualification and prestigious science environment to help him for leaping forward on science and technology. But unfortunately opposite to his presume military coupe of Generals on 12 September 1980 not for making Turkey a country which independent as science technology and industry power.

After many years he expresses lost time with shelved policy of he suggested as 'South Korea may be a good example for us on 1981-7983 when we were preparing Turkish Science Policy. But in those years because of South Korea not prove itself we had no idea about South Korea's science and technology policy. On the other hand, in terms of publishing at 1982 Turkey was 43. South Korea was 47. It was only known that South Korea did big investments on research and development. Japan cannot be an example for us because of scope difference. Even before 2ND Word War Japan has strong industry base and USA give a big aid and support to Japan. Therefore, we started off having conscience about developed countries science politics but without taking as a model fully for making our own way. After few years Turkish science policy publish (1983) we had documentary of South Korea and saw that there are big similarities. We had only one important difference that they implemented politics which adapted from Japan distinctly. On the other hand, we did not implement and wasted time which is the most important source of the world at least 10 years.'

- 1985 Turkey Advanced Technology Incentive Project Preliminarily report

Report prepared at 1985 by commission occurred Istanbul Technical University at the request of government. Although it prepared by the request of government it failed on stony ground.

- 1987 Ministry of state study document: Science and technology policy:

In the second half of 1980S a study document published titled 'Science and Technology document policy' which its preface was written by M.Tınaz Titiz who is government minister of current year. Some remarkable points from his preface are 'After policies, targets, principles and tools presented on this documentary argued they will submit to approval of the supreme council for science and technology, by this way technology document will be guideline for decision makers'. 'Innovations are one of the most important development instruments of a country. Turkish science policy will encourage innovations '. When document examined there are lots of instruments to implement both science / technology policy and innovation policy but although this policy documents established 1983 first meeting done at 9 Sept 1989 by the supreme council for science and technology and it does not negotiate at the meeting; they just some political tools from document and the supreme council for science and technology did not meet until 3 Feb 1993.

- 1990 First Science and Technology Council Decision:

To define circumspections about science and technology at May 1990 Turkish Science and Technology Council made several decisions under the presidency of M.Tınaz Titiz government minister of current year. The council meets up under the tutelage of Turgut Özal prime minister of current year, Korean Advanced Science and Technology Institute president Proff.Dr.S.S.Lee, Director of UNESCO Science and Technology K.H. Standke; European Commission Science and Technology administrative Prof Dr.P.M.Fasella and European Commission Telecommunication and Information administrative J.LCruzate attended to meeting. After council at the book by TUBITAK its written that 'Decisions of First Science and Technology council will bring light to the relevant person and institutions and especially will be a base for the next studies' This decision remain as foreword.

- 1991 Chamber of mechanical engineer's defense industry sector report & electronic industry sector report.

Two report prepared by chamber or mechanical engineers venture named Defense industry sector report and Electronic industry sector report on November 1991 and both of them sheltered.

- 1992 Electronic Industrialists Association, Turkey report in face of information society and future technology.

Report titled 'Turkey in face of information society and future technology' issued on 7 Jan 1992 by Electronic Industrialists Association and sheltered.

- 1993 Turkish Science and Technology policy (1993-2003):

The supreme council for science and technology defined a 10 year plan planned named 'Turkish Science and Technology policy 1993-2003' at meeting on 3 Feb 1993. 1993 was the last year of first ten-year Turkish Science and Technology policy 1983-1993. The supreme council for science and technology just had one meeting after six years of its establishment at 1993 after 10 years they found an opportunity to complete their missions, it is an adequately indicator to see Turkeys view science and technology issues at 10-year period.

According to document prepared by TUBITAK which submitted for the approval of The supreme council for science and technology named 'Turkish Science and Technology policy'; ''

Main purpose making Turkey advanced country in terms of science and technology, in other terms catching the word technology'. Councils predictions for the end of ten years:

- Increasing 7 full time researcher as 15 for per 10.000 Economically active population
- Increasing research and development expenses percentage from 0, to % 1 in gross domestic products.
- Increasing rank of Turkey from 40. To 30. In terms of contribution to universal science.
- Increasing research and development expenditure margin of private sector from %18 to %30

It is highlighted on the document that to catch world technology as national target and they especially highlighted the importance of catching information technology, biotechnology, advanced technology goods, space technology and nuclear technology improvements. For catching these technologies process defined as below:

- Transferring mentioned technologies
- Learning and assimilating transferred technologies
- Diffusing learned and assimilated technologies
- Reproducing diffused technologies, improving design and technology
- Maturation on scientific field that will help skill-building.

Their explanations about strategy: 'When we look back issue from historical perspective after British Industrial Revolution, all countries under development procedure follow same strategy and via this way they can continue to develop. At the second half of X/X. century Germany, USA catch British Empire; after 2nd word war Japan catches USA and western Europe with the help of same strategy. Today developing countries like South Korea, Taiwan follows same strategy'.

According to Taymaz Turkey should improve its technologic ability, increase productiveness with technological innovation, and transform manufacture and export structure to intensive technology product for maintaining economic development in the long term. Because of this to improve manufacturing industry Turkey need, extensive industry, technology, innovation policies and efficient national innovation system. He says 'Establishing National Innovation system was added to agenda at 1990 s from TUBITAK in this direction The supreme

council for science and technology build policy recommendations and some of them transferred into practice. One important implementation from them research and development credits and donations for research and development activities from TUBITAK (scientific and technological research council of turkey) and Turkish Foundation for Development of Technology (TTGV).'

- Studies of TUBITAK about Science Technology and Policy (1993-2000):

Department named Center and Institutions Department for Planning and coordination established at the beginnings of 1993 than changed name as Department of Scientific and technological policy (BTP); has lots of study to make defining science and technology politics as a basis. One of the main aims of these studies was assimilating and developing basic concepts of science and technology policies. Results of these studies published as TUBITAK Science and Technology Strategy and Policy Working Series. These studies prepared by the scientists and experts from inside and outside of TUBITAK. Publications by these groups which inside and outside of TUBITAK listed as below. Except some limited distributions most of them distributed (1000-2000 copy) to related, responsible persons, universities and academicians' technocrat and expert persons from industry according to contents of publications by the head of the TUBITAK.

Publication List:

- Research before Competition: TUBITAK BTP 94/01 MARCH 1994.
- Turkey University-Industry cooperation first council (Arranged by Istanbul Technical University 4-5 November 1994): Improving industry-university cooperation, executing strategy design and practice model. TUBITAK BTP 94/02, June 1994.
- Methods of evaluating Research and Development Activity and projects, TUBITAK BTP 95/01, March 1995.
- Science and Technology enterprise project Report and appendixes within Main structural evolution projects which should be handled first in the term of VII. Five-year plan by High Planning Council (24 Feb 1995): TUBITAK's remarks about 5-year development plan and education and training reform, TUBITAK BTP 95/02, First edition: April 1995, Second edition: April 1996.
- Science-Technology-Industry Policies at Aviation: Suggestions for Turkey, TUBITAK BTP 95/03, October 1995

- Science and Technology Management System: Turkey as a country example, TUBITAK BTP 96/01, May 1996.
- New approach on Science and Technology policy: Developments at Turkey and needed to restructure, TUBITAK BTP 96/02, July 1996 (Limited Distribution)
- Flexible Production/ Flexible Automation Systems and Technologies: TUBITAK BTP 96/03, First edition: September 1994, Second edition: October 1996.
- TUBITAK Project Support and Incentives head of department, Science and Technology Centers/Museums, TUBITAK BTP 96/04 November 1996.
- High Speed Trains: System and Technologies, TUBITAK BTP 96/05, November 1996.
- Science and Technology areas: Standard classification and coding, TUBITAK BTP 97/01 February 1997.
- Public Research Development institutions in Turkey: TUBITAK BTP 97/02, April 1997.
- Turkish Science and Technology Policy and TUBITAKs mission, TUBITAK BTP 97/03, May 1997
- Turkish Science and Technology Policy, TUBITAK BTP 97/04, August 1997
- Defense industry and procurement (Ziylan, Aytekin and Şemsi Batmaca, Raşit Por, İnci Uysal, Mehmet Zaim, Yücel Tatar, Ünal Er) TUBITAK BTP 98/01 January 1998
- Science and Technology High Council 2 June 1998 Assessments and decisions about developments TUBITAK BTP 98/02, July 1998 (Limited Distribution)
- Energy Technologies of 21. Century: Technologies role for reduction on emission of energy based greenhouse gas. TUBITAK BTP 99/01, May 1999
- Özdaş, M. Nimet, Science and Technology policy and Turkey TUBITAK BTP 00/01 December 2000.
- 1994 Turkey University – Industry Collaborations First Council: Report and implementation model prepared for developing Turkey university-industry collaboration by Istanbul technical university. (4-5 November 1994). Unfortunately, it will have no function beyond being resource for political studies about university industry collaboration.
- 1995 Science and Technology enterprise project working Report and appendixes within Main structural evolution projects which should be handled first in the term of VII. Five-

year plan by High Planning Council (24 Feb 1995): TUBITAK's remarks about 5-year development plan and education and training reform, TUBITAK BTP 95/02, April 1995.

It is targeted in the report 'Science and Technology enterprise project' that to form a basis for investments on different areas for leaping forward on science and technology especially technologies mentioned on 1993 documentary. Targeted areas as below:

- Establishing national innovation network that will carry Turkey to future informatics community and telematics services networks.
- Adapting Turkish industry to the flexible production/flexible automation technologies which is sine qua non for providing competitive advantage at international area.
- Renewing railway system at the base of high-speed train and developing rail system on inter-city transportation.
- Following an industrial investment and development strategy on aeronautics and space industry and defense industry depended on field and product selection.
- Focusing on research and development on Biotechnology and Genetic engineering.
- Focusing on eco-friendly technologies, energy saver technologies and eco-friendly energy technologies and developing implementation areas rapidly countrywide.
- Industrial investments and research and development on advanced material technologies.

As is seen some of the projected investments areas are infrastructural investments others are research and development investments. Preparer of the report predicted relationship between infrastructure investments and development on science and technology like if they began high infrastructure investments like high-speed train system it will need improvement on engineering, design, technology so need for science and technology improvement will increase. Because of these when they choose these infrastructure investment areas they took into consideration both Turkey's emergent needs and gaining generic technologies of time. There should be a demand for catching technologies of time and resource sciences of these technologies for creating research and development capacity at the country. Investments should be creating this demand and institutions that will make investments will give a guarantee initially for buying inside the country for new or advanced goods, production managements and technologies. Investments on

aeronautics and space industry may create a powerful research and development demand and intelligent supply policy will follow may modernize country in terms of technology.

It is thought that when selecting investment areas rather as research and development investment: Flexible production line, applying flexible automation technics and robotic practices began to be essential for providing a competitive advantage. Hard rules were getting hard at issue about clear product, clear products on international level. Genetic engineering or advanced material technologies began to have a generic character and their implementation areas were growing rapidly so Turkey's industry should keep pace to these improvements. To implement these practices on time necessary technologic inputs should improve inside the country. For procurement of these technological inputs creating a demand and capacity for research and development was only way.

From this year we may say even it's delayed some of these investments done. But in real except defense industry investments there were no enterprise or competence on other investments areas about science and technology at country level. Also we will see in time the results of policy of Under Secretariat of Defense Industries on which defense technology Turkey had competence.

- 1995 Science Technology Industry Policies in Aviation: Suggestions for Turkey

Prepared by military, civil part of community and all stakeholders from universities related aviation and space under the leadership of TUBITAK. (TUBITAK, BTP 95/03, October 1995).

- 1995-2202 Turkish Academy of Science (TUBA)-TUBITAK-TTGV Science Technology Industry Discussion Platform. Policy and strategy proposals prepared and published Science Technology Industry Discussion Platform.

Established by Prof. Dr. Metin Ger [ODTÜ/TTGV], Prof. Dr. Metin Durgut [ODTÜ], Doç. Dr. Nesim Erkip [ODTÜ], Kaya Yazgan [Roketsan], İsmet Rıza Çebi [TÜBİTAK] and Aykut Göker [TÜBİTAK] late in 1992. (Academic titles and corporations during those dates). In September 1992 platform started with edition prepared by Cemil Arıkan, Metin Durgut, Nesim Erkip, Metin Ger, Aykut Göker, Kaya Yazgan and Semih Yücemen [Prof. Dr., ODTÜ] named

‘Forum: Society -Science- Technology’. At 1992 TUBA, TUBITAK and TTGV supported platform. In 1997 May member of platform was 620. Distribution of members as below:

- 315 members from universities and research institutions
- 160 members from private sector (26 of them are senior managers from associations like TUBITAK- Turkish Electronics Industry Association (TESID)- Association of Automotive Industry (OSD), Association of Automotive Parts and Components Manufacturers (TAYSAD)
- 145 members from political parties, professional organizations like Union of Chambers of Turkish Engineers and Architects (TMMOB), media institutions and bureaucrats.

Platform’s working group send strategy and policy proposals that they prepared to government officials and released to the public. Publications like below:

- Platform of Science Technology Industry Discussions (BTSTP), Science and Technology Working group directed Informatics area, Group Report, October 1995.
- BTSTP, Science and Technology Working group directed Informatics area, New policies and Regulatory Agencies at Informatics area, October 1995
- BTSTP Science and Technology Working group directed Advanced Material Area, Strategy and Policy Suggestions for Turkey, September 1995.
- BTSTP Working group directed genetic engineering and biotechnology, Policy suggestions for Turkey about molecular biology, genetic engineering and biotechnology, October 1995.
- BTSTP Working group directed encouragement of Research-Development and University-Industry collaboration. Structure and frame of research and development, March 1996.
- BTSTP Working group about accreditation rule and institutions of European Union related science-technology-engineering. Subgroup report about quality management at higher education, February 1996.
- BTSTP Working group directed eco-friendly Technologies area: Group Report, March 1996.
- BTSTP Evaluation Meeting of Platform for the year of 1996. February 1997.

- BTSTP Working group report about energy technologies Policy, May 1998.
- BTSTP Clear Production-Clear Product: Industry Sector Report by eco-friendly Technologies working group, October 1999.
- BTSTP Clear Production-Clear Product: Transportation Sector report by eco-friendly Technologies working group, July 2002.
- BTSTP Working group reports about Benefiting Technologies from Marine and Submarine resources:

By General Coordinator administrative of Prof. Dr. Demir Altıner (TUBITAK- Ground Sea Atmosphere Sciences Research Group Executive Secretary) and general spokesman ship of Prof. Dr. Emin Özsoy (Middle East Technical University (ODTÜ) Marine Science Institute) seven sub report prepared and published:

- Marine geology and geophysics Research and Seismicity Subgroup Report (Coordinator: Prof. Dr. Aral Okay (Istanbul Technical University (ITU) Eurasia Geology Institute)), May 2001;
- Subgroup Repot about repression of Marine Pollution (Coordinator: Prof. Dr. Orhan Uslu; Reporter: Assoc. Prof. Dr. Filiz Küçüksezgin [Both of Them from Dokuz Eylül University (DEÜ) Marine Sciences and Technology Institute]), July, 2001;
- Marine Living Resources Sub Group Report (Coordinator: Prof. Dr. Ferit Bingel Reporter: Assoc. Prof. Dr Ali Cemal Gücü [Both of Them from ODTÜ DEÜ Marine Sciences Institute]), September, 2001;
- Navigation and Navigation Safety Sub Group Report **(**Coordinator: Tuğamiral Nazım Çubukçu [Head of Navigation, Oceanography and Hydraulic Institute of the Navy department]; Reporter: Dz. Alb. Zeki Menge [Department Manager of Navigation, Oceanography and Hydraulic Institute of the Navy department.]), February,2002.
- Subgroup Report of Marine and Ground Sea Atmosphere Energy Sciences, Mineral and Industrial Raw material. (Coordinator: Prof. Dr. Namık Çağatay; Reporter: Assoc. Prof. Dr.Nilgün Okay [Both of Them from İTÜ Geology Engineering Department]), March, 2002;

- Subgroup report of Ecosystem and Climatic Change (Coordinator: Prof. Dr. Emin Özsoy; Reporter: Prof. Dr. Temel Oğuz [Both of them from ODTÜ Marine Sciences Institude]), March, 2002;
- Subgroup report of integrated waterside management (Coordinator: Prof. Dr. Erdal Özhan [ODTÜ Civil Engineering Department]; Reporters Dr. Hayri Deniz [Ministry of agriculture and rural affairs] and Assoc. Prof. Dr. Tuncay Kuleli [Çukurova University (ÇÜ) Faculty of aquaculture]), May, 2002.

Workings of platform TUBA-TUBITAK-TTGV Science-Technology-Industry discussions will stay as collection piece of Turkey that should be on the archive of Turkey's science and technology policy workings. Also these publishing conducted by the supports public institutions like TUBA and TUBITAK and bridge institution between public and private sector like TTGV, did not create reactions in the presence of government and state.

- 1996-2004 Four informatics Report:
    - Turkey Informatics Strategy Working report by the Turkey Informatics Strategy Cell of Turkey Informatics Foundation (1996);
    - Turkey Informatics Strategies General Balance Model (1998) made by Turkey Informatics Foundation for supporting and improving Turkey Informatics Report published at 1996 with scientific approach.
    - Turkey Informatics Council (10-12 May 2002, Ankara) Come under motto of 'Progress to information society'. Research and Development Working report at Informatics.
    - 2nd Turkey Informatics Council (10-11 May 2004, Ankara) Come under same motto of 'Progress to information society'. Research and Development Working report at Informatics.

Four report related informatics strategies did not take in consideration by governments also third report represented by under secretariat of prime ministry at regulatory authority, fourth report executed by delegates of TUBITAK, State Planning Organization (DPT), Turkish Telecom and Education Technologies General Directorate.

- 1996-1999 Turkey National Information Infrastructure Main Plan (TUENA)

Plan named Turkey National Information Infrastructure Main Plan (TUENA) prepared by TUBITAK by the directive of prime ministry at 05 February 1996, under the coordinator ship of Ministry of Transport and council under the presidency of same ministry. Council named executive council occurred from representatives of Turkish General Staff, General Secretariat of the National Security Council, DPT, Higher Education Council (YOK), TTGV, Turkish Electronics Industry Association (TESID), Turkish Informatics Industry Association (TUBISAD) and Turkish Telecom. Plan approved by Ministry of Transport at 1999 July and released to the public by Süleyman Demirel prime minister of Turkey that time at Çankaya on 11 January 2000. That mean government adopted TUENA.

The main difference of this plan is related private sector institutions supported this plan financially and entered into the process of preparation with experts. The most important target of the main plan was, creating ability of product development on information and telecommunication area at the process of investment on information substructure. Although this plan found voice in Prime Ministry that it will transfer into practice without any explanation failed of the agenda of the Supreme Council for Science and Technology and all government agencies. Parallelism between fail of TUENA from the agenda and privatization process of Turkish Telecom is remarkable. Privatization workings of Turkish Telecom began with the go in effect of the law number 4161 dated 01 August 1996. Preparatory work of TUENA was with the prime ministry's directive on 05 Feb 1996, (six month ago). After eighteen days, TUENA released to the public by Süleyman Demirel prime minister of Turkey that time at Çankaya on 11 January 2000; the law numbered 4502 named 'Reorganizing place of Turkish telecommunication sector and Turkish Telecom' go in effect on 29 January 2000.

In addition, enterprises for sale of shares of Turkish Telecom began at 13 June 2000 but because of the legal struggle to selling process and related arrangements finished at 2005. %55 share of Turkish telecom sold to Oger Telecoms with the cost of 6,550,000,000 US dollars. (Composed of Telecom Italia and Saudi Oger). It is very clear that if the main plan could be implemented, Turkish Telecom would have important role to reach projected targets. Turkish telecom would make new investments too beside renewing on its substructure; especially it would give a chance to obtain finance to the projects related telecommunication and information

sectors to reach research and development ability. Turkish Telecom had an enough financial power to implement this duty.

But making investment seriously not permitted after privatization process of Turkish Telecom despite its huge financial power.

- 1997 Science and Technology Policy of Turkey

The document titled' Science and Technology Policy of Turkey' which was approved by Meeting of the Tupreme Council for Science and Technology (BTYK) on 25 August 1997; contained execution agenda as immediate action plan. This agenda essentially occurred from science, technology and establishing national innovation system decisions. These decisions contained lots of policy area from education policies to tax policies, from research and development policies to infrastructure investment policies and the only for success was handling these topics systematically with the adoption of political power.

Below agenda topics may give clues about policies wanted to be track:

- Preparing Main Plan of National Informatics Substructure
- Establishing National Academic Network and Information Centre.
- Setting up technological, physical, legal infrastructure to establish Electronic Commerce Network in Turkey
- Legislating for Technology development zones.
- Making legislative arrangement about management of Brainpower
- A university attained a universal quality (Preparing academic staff legislation, encouraging research scientist, developing scholarship systems for doctorate and after, supporting and giving incentives social and human sciences field.)
- Enacting Turkey Accreditation Council Law
- Regulations about Reconstruction of Research institutions
- Setting a budget for national research and development
- New regulations about government aid decision to research and development.
- Extending Venture Capital Investment participations
- Innovation and Technology support to SMEs
- Establishing University-Industry joint research center

- Regulations About Public medium and long term purchase process
- Building Occasional Satellite earth station
- Turkish General Staff's opinion and staffs about developing, supporting, leading up Turkish defense industry
- Establishing National Aeronautics and Space council
- Subsidizing fund and developing supplement mechanisms to find a place on International Collective research projects for Turkey
- Determining regulatory rules on workings about Biotechnology/Genetic Engineering
- Defining Policy Research and National policies directed to rational use of energy and nature friendly renewable energy resource.
- Policy researches towards Eco Friendly Technologies and Environmental management technologies. Defining national policy research.
- Marine sciences, Policy researches towards marine and submarine treasures utilization technologies. Defining national policy research.
- Researches towards industry-specific innovation policies/Workings introductive Innovation Term; Diffusing Technology-Management, Innovation-Management, Quality- Management and Certification system.
- Developing technology on Industry sector; ''Technology development Project II' within the context of Word Bank's aid strategy to the Countries.
- Supporting spending for Industrial design registration and Utility Model document
- Establishing National natural history museums.
- Establishing Science and Technology centers. (Centers for attracting attention of children, youth and public to science and technology; supporting them to learn with experience/search)
- Supporting internet access centers
- Evaluating proposals about new member participation to The Supreme Council for Science and Technology

In the two meeting of BTYK some decisions took about this agenda as below: (Supplementary agenda articles that approved by BTYK on 02 June 1998)

- Benefiting from Off-Set to increase technological ability of the Turkey
- Appropriation of donations needed assignment by BTYK to establish National Innovation System
- Defining a national policy to pursue Mega science

(Supplementary agenda articles that approved by BTYK on 20 December 1999)

- Extending scope of research and development subsidize
- Defining critical technologies for Turkey
- Determination of preventions on Brain drain to empower reversing flow.
- Defining national policies on Molecular Biology, Biotechnology, Genetic Engineering
- Structuring on researching and supporting earthquake issues and disaster management
- Establishing seismological data bank
- Evaluating and improving established structures in terms of earthquake resistance
- Examining faults on Marmara Sea and investigating seismicity of region

Some of below agenda items was implemented on time, some of them implemented with delay fully or partly. But some of them shelved despite its critical importance. Obviously we can say political stability, sustainability and implementation with systematic integrity principle which must to reach competence on science, technology and innovation, not implemented. As it seen some of the agenda topics was predicted to define policies vital for Turkey on science and technology areas detailed below:

- Technologies for rational use of energy and nature friendly renewable energy resource.
- Eco Friendly Technologies (To make clear production, produce clear product)
- Marine sciences, policies for benefiting from marine and submarine treasures
- Biotechnology, Genetic Engineering, Molecular Biology
- Mega Science

Policy studies done for none of these areas to bring light for decision makers. The topic of ‘Defining Sectoral Innovation Policies’ which essential for Turkey’s industry sector wholly

failed of the agenda in time. As a viewpoint of persons working with science and technology policies academically, 1990s was taken off years for policy works. Lots of policy documents produced but little part of them actualized.

- 2004 Turkey Economy Congress: Science and Technology working group report

Science and Technology working group report approved on 7 May 2004 at session of 2004 Turkey Economy congress with cooperation of TUBITAK, TTGV and participation public sector, industry and universities. Working group prepared this report with the fixation from 'Take the place of Turkey at developing word and benefiting from science and technology as a strategic tool. (By the perspective of full membership of the European union, reaching Turkey at the cutting edge of economic and social developments and transforming society to knowledge society). First results of TUBITAKs Vision 2023 Panel Reports was taken into consideration majorly on the suggestions for technology politics and policy implementation tools of Science and Technology working group report. Unfortunately, report stayed as Congress document only.

- 2002-2004 TUBITAK's and TUBA's Prediction studies on Science and Technology. Vision 2023 Technology Prediction Study

TUBA's Prediction studies on Science and Technology constitutes the backbone of Vision 2023. Technology prediction study;

- Oriented by the supreme board occurred from 65 people from state institutions and organizations, non-governmental organizations, trade assassinations, umbrella organizations of private sector, associations and foundations on sectorial bases, universities and financial support institutions which directly related with science and technology.
- Managed by executive committee from delegates of TUBITAK, DPT, TTGV and under secretariat of defense industry
- Executed by project team attended consultants apart from TUBITAK too.

Panel workings underlined Technology prediction study. 250 expert members from public, private sector, universities attended 12 panels. Panels get started at 2002 June, in one year made 228 panel meeting. Technology prediction study, be subjected to the well-attended expert inquiry (Two-Stage Delphi Method), panels predictions reason out from these experts. Via

Delphi Method with e-mail 7000 experts was reached and reply was 2400 (%34), it was world class turnaround. Definitive panel reports prepared with taking account of the result of this implementation, presented to TUBITAK president ship on 24 July 2003. After that strategic technology groups began to work on 2004 May (group number established was 8, total member was about 140), strategy and policies to reach targets to have a strategic importance for Turkey defined.

Also strategy group composed from 21-member prepared forecasting report about education and human researches in terms of importance of the topic. In conclusion, a strategy team with the participation of experts outside TUBITAK too, evaluated all studies done and submitted their predictions about strategy would be followed on technology until 2023 to TUBITAK president ship (2003-2023 Strategy document).

National Science and Technology Policies: 2003-2023 Strategy Document accepted on 11. Meeting of the supreme council for science and technology (BTYK) dated March 2005, and this decision was brought into force with other decisions of BTYK by the notice of prime ministry numbered 2005/9 on 12 April 2005. Strategy document accepted by BTYK but unfortunately it had been made invalid with decisions on the same meeting. New management team of TUBITAK came with Justice and Development Party (AKP) may though that regretting strategy prepared before them with broad participation, but as a result strategy document is on the shelve. None of the strategies targeted 2023 included term of 2006-2008 did not take in consideration. Similarly, strategies on 9^{th} development plan contain 2007-2013 term did not take in consideration. These examples are proof of document shelved.

Panel reports as a result of Vision 2023 Prediction work and Technology policies based on this report: 2003-2023 Strategy document was not representing gospel in terms of socioeconomic targets, priorities, strategies and policies will be followed associated with science, technology, and innovation areas for Turkey. As a result, document was based on prediction study so it may have missing, adjusting parts. Also science and technology are info clusters that rapidly changing and reproducing so predictions should renew periodically according to changing country and world change. The way of making it right, correcting deficiencies and renewing predictions according to changing conditions; maintaining these studies in its own logic.

If a country began to make technology prediction studies which this works done by approval of the government and expenses done by capital budget same in Turkey, that means government will take in consideration these studies; will make effort to actualize the suggestions with evaluating by their political objectives; will watch results of implementations and review prediction studies abide by results. It seems that none of these works done by the government for Vision 2023. It is a hard evidence that Project team which perform such wide Technology Prediction study and with this practice learn via searching-doing, reinforce learned things via sharing experiences with experts in the same topics from European Union; dispended after completion of study. National Science and Technology policies: 2003-2023 Strategy document (version 19(2 November 2004)) is on the electronic shelf of TUBITAK. It just works for discourse of TUBITAK components on the international meetings with foreign colleagues to say that they have a long term strategy.

- 2002-2004 TUBA Science Prediction Studies:
    - Fundamental Sciences Prediction Study (Turkish Academy of sciences reports Number 9,2005)
    - Molecular Biology and Technology Prediction Study: 2003-2023 (Turkish Academy of sciences reports Number 11,2005)

Unfortunately, both prediction studies within the approval of DPT just printed as TUBA publication, not evaluated in it's entirely and long term perspective.

15. Turkey Vision 2023

Science and technology are one of the most important factors for a long term economic and social development, as for science and technology policies are one of the tools to affect speed and direction of this development. All developed countries in regard to economic and social like Japan, ABD, European Union member countries developed science and technology vision compatible long term social, economic, political goals and when they update this vision they used technology forecast studies as an efficient tool.

According to TUBITAK in Turkey at 1960s workings to build science and technology policies especially with documents 'Science and technology policy 1982-2003' and 'Science and technology policy 1982-2003' took on important dimension. But also documents have universal

consents and important institutional and legal changes; not implemented with regard to objects. As a reason we can say a science and technology vision not presented and recommended policies not adopted commonly by universities, political power, public sector and private sector. From the process of this determination to benefit from science and technology effectively, in the meeting at 13 December 2000, the supreme council for science and technology decided to prepare Turkeys Science and Technology Document for the years 2003-2023(2001/1 numbered judgment). After one-year work, likewise many other developed and developing countries, a national Technology Foresight Program was carried out in Turkey under the name of Vision 2023.

15.1 Drivers of Institutional Foresight

According to O. Saritaş (2006) foresight essentially implies some form of 'participative vision-based planning process'. Institutional Foresight has been implemented commonly widely in the last couple of decades especially at the national level by public policy-making.
The activity is extensively hailed in national academy of sciences, government councils, research councils, government advisory boards or other government department have managed to organize and carry out Institutional Foresight exercises at length and assigned limited resources based on the result of those exercises.

Below drivers of rapid diffusion of Technology Foresight from different authorities: From Martin and Johnston's framework foresight is a beneficial activity for "wiring-up" and empowering National Systems of Innovation.

- Escalation in industrial and economic competition. Due to the competition in the global economy, innovation and development of new technologies are becoming more crucial for industrialized and industrializing countries. This is where the primary role of Foresight arises as to identify emerging technologies, which are likely to have significant impact on industry, the economy, society and the environment over coming decades, at an early stage. (B. Martin, R. Johnston-1999)
- Increasing pressure on government spending. Because of limited government resources, like other areas of public spending, research and technology cannot be fully funded by the government. Foresight is presented as a process to help in the identification of funding priorities. (B. Martin, R. Johnston-1999)

- Changing nature of knowledge production. The identification of emerging technologies and the prioritization of research and technology areas point to the increasing need for communication, networks, partnerships and collaboration among researchers and between researchers, industry as the performers and users of the research, government and other relevant stakeholders. Foresight offers a means for developing and strengthening those linkages. (B. Martin, R. Johnston-1999)

Keenan comments two further drivers to the wide penetration of activities around the globe:

- Bandwagon effects. To a considerable extent the diffusion of institutional Foresight is due to the competition between countries. As one country has undertaken a Foresight exercise, 'competitor' countries feel the need to follow this trend. (M.Keenan-2001)
- Millennium effect. Governments all over the world initiated exercise to appear to be prepared for the new opportunities and challenges in the twenty-first century. (M.Keenan-2001)

With the activities at the corporate sectorial level in 1950s, US can be considered as the precursor of institutional Foresight. In the early 1970S Japan started macro-scale activities at the national level. After that European governments followed by the practices. Starting from 1980S Netherlands (A. van Dijk, R. van Esch, M. Hilders-1996), Germany (K. Cuhls, H. Grupp,-2000), the United Kingdom (UK) (L. Georghiou-1996) and France (B. Martin-2001) initiated institutional Foresight exercises and they have exercised it more than once since than 1980s. During the second half of 1990S diffusion of Foresight activities from developed to developing countries began especially on the area of Science and Technology (STI) issues because of realizing the need of long-term research planning in the era of increasing competition at the global level. Due to deliberations given on technology-push and market-pull exercises focused on industrial and service sectors and generally done by industry and government representatives from scientific body of government in the identified sectors and experts from academia by the combination of methods like expert panels, Delphi survey, scenarios and brain storming. Because of the rising importance of social concerns, later practices have indicated a shift from exercises of research priorities and strategic goals concerning the different aspects of STI to the scope of Foresight exercises

Saritas (2006) and Miles (2002) listed some of the reasons for this shift as follows:

- Increase of the importance on technological innovation and organizational innovation
- Development on service economies
- Understanding the close relationship between STI and society
- Changes on environmental affairs, cultural practices, demographic structures
- Developments on globalization

Between 1992-200, technology, social and market dimensions integrated into Foresight activities to create sustainable development. The activities done by the actors from industry, academia, government and social stakeholders such as voluntary organizations; like land use, demography environmental attitudes and problems, transport and living standards was the main topics in Foresight activities.

In 1980s and 1990s creative and advisory methods like practices in UK (e.g. the second and third cycle of the UK Foresight Program 2003-2005), Germany (e.g. FUTUR-2004) and France (FutuRIS-2004), has been used. In the late 1990s and 2000s, the common activities like full scale national exercises among the new members of the EU and Candidate Countries done. For example, the UK Technology Foresight Program used as a base when actors prepare foresight programs of Hungary (A. Havas-2003), Czech Republic (K. Klusacek-2004) and Turkey. Malta, Cyprus, Bulgaria and Estonia has a capacity buildings efforts mainly aimed to restructure national research systems and set priorities in preparation to join Turkey applied a national level Foresight exercise, titled 'Vision 2023 Turkish National Technology Foresight Program' with three more sub-projects (called "R&D Manpower", "Technological Capabilities Inventory" and "National R&D Infrastructure") with an aim to collect data on current technology, science and innovation capacity of the country, as one of the Candidate Countries for the EU.

15.2 Progress to National Technology Foresight Program in Turkey

History of Turkish National Science and Technology Policy-Making

The first enterprises for formulating STI policies started with the First Five Year National Development Plan in 1963 which was the planned economic period (N.K. Pak, T. Tankut, T. Tumer, T. Gurkan-2004). The Scientific and Technological Council of Turkey (TUBITAK) was established in the same year for the purpose of:

- To coordinate, organize and promote basic and applied research

- To direct research activities with the target of the national development plan
- To set research priorities

1. Organizing, coordinating and promoting basic and applied research
2. Directing research activities to the targets of the national development plan
3. Setting research priorities (TUBITAK-2004)

In the 1960s and 1970s Turkish STI policy was mostly based on the 'promotion of basic and applied research in natural sciences' and STI policies were formulated by TUBITAK with regardless of policy document by a tacit compromise with the government so there was a lack of participatory policy-making culture (N.K. Pak, T. Tankut, T. Tumer, T. Gurkan-2004). Decisions by the government and government agencies generally had been based on the fragmentary policies and short-term necessities.

With the Fourth Five Year National Development Plan 1973-1977 technology policy concept and its integration with the investment policies and industrial employment had been practiced. "Turkish Science Policy: 1983 – 2003" which is the first detailed STI policy document in Turkey was prepared in 1983 under contribution of over 300 experts with the coordination of the Ministry of State. It was to first time the important role of technology for the development of the country recognized openly.

Later on the Supreme Council for Science and Technology (SCST) was established as the highest STI policy-making body, with the designing STI policies via participation of the actors from management of economic and social life in Turkey (TUBIRAK, ANKARA-2004). The first operational meeting of SCST was only in 1989. SCST started to play an active role to formulate the national STI policy as the main factor of the National Innovation System in the mid-1990s. In 1993 the document titled "Turkish Science and Technology Policy: 1993 – 2003" which set up a substructure for the new policy initiatives like R&D support programs in the 1990s; approved İn 1993 by SCST. Via this way turning point of STI policy-making in Turkey and paradigm of shift from "building a modern R&D infrastructure" to "innovation oriented national STI policies" began.

At 1995 in the STI chapter of the Seventh Five Year National Development Plan for the period of 1996 – 2000, with "A Project for Impetus in Science and Technology" the policies in the document titled "Turkish Science and Technology Policy: 1993 – 2003" expanded. SCST highlighted the high importance in STI as the determining factor for repositioning of world's

resources and for increasing the welfare of the society on 13 December 2000 in SCST's sixth meeting. After that SCST decided to set priority areas for the time period covering 2002 – 2023 and formulate new STI policies. Also the year 2023 marks the 100th Anniversary of the foundation of the Turkish Republic. TUBITAK prepared a project named "Vision 2023: Science and Technology Strategies" as a general secretariat of the SCST and project approved by SCST on 24 December 2001. The implementation of Vision 2023 started in January 2002.

15.3 Reasons for Using Technology Foresight in Vision 2023

From 1960S TUBITAK started to prepare long-term STI policy documents with the desk-based methods but all documents from this work used limitedly. Documents prepared for the long term policy but success in realizing concerned action was too less.

M.A. Oner, O. Saritas (2005) explains fail of development plants to meet their targets in Turkey via extract the sectoral policies and strategies and analyzing them with their "Integrated Development Management Model". Limitation on the implementation of the STI policies in Turkey explained ad below by A. Goker (2002) and Saritas (2006):

1. The lack of long-term and strategic approach to STI issues
2. The lack of ownership of the R&D agenda by stakeholders and society
3. The lack of political support
4. A low level of dissemination
5. Isolated STI policies
6. The fragmentation of researchers and resources

TUBITAK brought an idea to initiate an institutional Foresight exercise as a solution and SCST submitted that Foresight would be a useful tool to deal with the problems like lack of isolation, participation and fragmentation in the formulation and implementation of the STI policies. The only way for implementation was ownership that provided by the extensive involvement of the society otherwise if society involvement is wider it could bring political support together. Also integration of STI policies and other sectoral policies is possible with the participation of sectors in the economy as an inventor and implementer of these policies in a Foresight exercise. So as per explanation of TUBITAK on its webpage-2004 Vision 2023 Technology Foresight Program started in order to:

1. Build an STI vision for Turkey
2. Determine strategic technologies and priority areas of R&D

3. Formulate STI policies of Turkey for the next 20-year period
4. Get a wide spectrum of stakeholders involved in the process, thus to gain their support
5. Create public awareness on the importance of STI for socio-economic development

15.4 Background and Rationalities of Vision 2023

Main aim of the exercise is to identify the areas to improve STI systems for the future like the economic sectors. The chosen area should be useful to focus on some social themes related with economic systems and STI. When STI and economic systems with considerations given on the social system counted as exterior context of the exercise, internal context was TUBITAK which is the host and main sponsor, organizer and client of the exercise. Not only monetary resources but also human resources and expertise were provided by TUBITAK which is a national public institution submitted a Foresight program with its own resources to develop its own policies.

The project office which is responsible for the implementation of project was constituted within the STI Policy Department of TUBITAK, also a management team created in TUBITAK involving people. These people had a professional competence in project management, communication skills, policy-making and research. Highest ruling body of program was The Steering Committee. The Steering Committee consisted from 65 members which 29 from Non-Governmental Organizations (NGO) and industrial organizations, 9 from universities, 27 from governmental institutions. The Committee directed project by approving reports and policy recommendations and taking the strategic decisions, budgetary and operational decisions was taken by the Executive Committee. Not only internal but also external expertise was mobilized in the Program.

All-important sectors in the economy were covered in the Program. They focused on the economic sectors because of their distinct and clearly defined structures for learning demands from STI in the policy formulation process with the other words it was though those successful STI policies should consider sectorial demands. The Steering Committee's first aim was selecting focused sectors in the first meeting in April 2002. The members of the Steering Committee first made a broad list of sectors after that they applied a cluster analysis for aggregating of sectors which are considered to be 'related' for the purpose of the Program. After that they draw up to prioritize the sectors in the list. It was considered to cover:

1. Sectors in which Turkey had competitive advantages and would likely to have competitive advantages in the next 20 years.
2. Sectors which were technology and policy relevant. For example, the sector which the success of it was not dependent on STI policies, but to other policies like financial policies, it was considered to be outside the list.

According to The Steering Committee number of selected sectors should be around 8–10 that would be a manageable size for the exercise. In voting session, the Steering Committee members prioritized and selected ten technology and policy relevant sectors that underpinned the competitiveness and economic development in the Country including:

1. Information and Communication
2. Energy and Natural Resources
3. Health and Pharmaceuticals
4. Defense, Aeronautics and Space Industries
5. Agriculture and Food
6. Manufacturing and Materials
7. Transportation and Tourism
8. Chemicals
9. Textiles
10. Construction and Infrastructure

Besides ten economic sectors, two cross-cutting thematic areas were covered in the Program including:

1. Education and Human Resources
2. Environment and Sustainable Development

Table 2: Scientific Research Areas

Information and Communication Technologies	Design and Production of all Integrated Circuit Technologies Display Production Technologies Broadband Technologies Display Sensor Technologies
Bio Technology and Gene technology	Large Scale Platform Technologies: Structural and Functional Genomics, Transcriptomic, Proteomics, Metabolomics Recombinant DNA technologies System cell therapy and Cell therapy Drug Screening and Design Technologies Therapeutics Protein Production Technologies and Controlled Release System

	Bioinformatics
Nanotechnology	Nano photonics, Nano electronic, Nano magnetism Nano material Nano characterization Nano fabrication Nano Quantum Data Processing Nano biotechnology
Mechatronics	Micro/Nano Electromagnetic Systems and Sensors Robotics and Automation Technologies Basic Inspection Technologies, Generic Areas
Production Processes and Technologies	Flexible and Agile Production Technologies Rapid Prototyping Technologies Face/Interface, Thin Film an Vacuum Technologies Metal Forming Technologies Plastic Part Production Technologies Welding Technologies Machining Technologies
Material Technologies	Boron Technologies Composite Material Technologies Polymer Technologies Smart Material Technologies Magnetic, Electronic and Optoelectronic Material Technologies High and Low Resistance Material Technology
Energy and Environmental Technologies	Hydrogen Technologies and Hydrogen Powered Fuel Cells Renewable Energy Technologies Energy Storage Technologies Nuclear Energy Technologies Environmental Friendly and Highly Productive Fuel and Firing Technologies Water Treatment Technologies Waste Assessment Technologies
Design Technologies	Virtual Reality Software and Virtual Prototyping Simulation and Modeling Software Grid Technologies and Parallel and Distributed Calculation Software

Source: TUBITAK

It was the first time for Turkey to run a Foresight exercise at the national level. Staff members went international courses of United Nations Industrial Development Organization (UNIDO), to learn about Foresight than in SCST meeting TUBITAK proposed the use of Foresight for STI policy-making. Foresight was considered to be a useful policy-making tool for Turkey same as many EU and Candidate countries although problems on implementation and formulation of STI policies. In the beginning of process design, TUBITAK examined the Foresight programs of other countries like, Hungarian, Korean, British, German, Czech, Japanese, Dutch national programs and forthcoming work in the US. They noticed that there are

too many ways to make national Foresight exercises like expert panels, scenarios and most common one Delphi at the analysis. After consultations about methods they decided to use combination of expert panels and the Delphi method. A two round Delphi Survey was implemented with coordination of expert panels and a prioritization scheme.

The panels become a target of building their own visions and defining socio-economic targets and representing these targets and visions with the society and determining underpinning technologies and giving a primacy to them. The Delphi process targeted to achieve technological developments and testing them in contraction of a set of criteria stated by the Steering Committee too and prioritization criteria defined. Task definition document was sent all the Panels to explain them how to implement project tasks. Below main tasks listed in the document (O. Saritas, Vision 2023-2005):

1. Vision building
2. Dissemination
3. Delphi survey
4. Policy proposals

The tasks were same for all of the Panels. By the guide of task definition document, all panels participated in (O. Saritas, Vision 2023-2005):

- To assess current situation of their sectors by using the analysis of trends and drivers via Strenghts, Weakness, Opportunities and Threats (SWOT) analysis and desk-based research.
- Using brainstorming sessions to create a vision.
- For reaching determined socio economic targets organizing technology activity
- Prioritize technology activity areas by the voting way.
- Negotiating with an extensive expert group by a Delphi survey for their opinions on prioritization
- To suggest policies about prioritized areas by evaluating previous work.

All these tasks assigned, also they had an opportunity to carry out their tasks. They had a chance and it was allowed to work in diversified ways and they may use their own methods to reach aimed outputs.

15.5 Vision 2023 Practice

Around 200 panel meetings and enlarged workshops occurred began with the first panel meeting on 3 July 2002 to 24 January 2003 with the purpose of building vision and listing underpinning technologies. Tis stage ended via competition of preliminary reports. In 28 January 2003, at a press conference The Deputy Prime Minister by virtue of STI issues announced the completion of the reports. Below points of interest areas by preliminary reports of the panels:

- Trends and issues which will probably influence world and Turkey
- 2023 vision of Turkey for each sector
- Socio-economic objectives should be achieved in order to realize those visions
- Evaluation current standing of Turkey (SWOT analysis)
- STI competencies and underpinning technologies should be achieved the socio-economic objectives

Delphi process started right after publication of the preliminary reports by aiming to achieve the envisaged technological development and testing them against a set of criteria determined by the Steering Committee.* (The identified variables in the Delphi survey were asked in the following order: the level of expertise, Turkey's current position, the scientific/technological stage to start with, policy tools to be used, expected realization time, and expected impact on competitiveness, scientific and technological capacity, environment, national value added, and the quality of life. The ‘realization time’ here refers to the expected realization of each Delphi statement in Turkey conditional on the implementation of appropriate policies.) The technological developments calculated by the view of effects:

- Competitive strength
- STI innovation capability
- Environment and energy efficiency
- Creation of national value added by using domestic resources
- Quality of life

Apart from the Education and Human Resources Panel, all panels prepared more than 1200 statements which may to play an important role for realize their visions for 2023 and The Project Office examined all the statements to elucidating of expression, policy and technology relevance, and double posting. The first round of the Delphi process began on 12 May 2003 and finished on mid-June 2003. The Delphi survey forms which occurred from 413 unique

statements, were posted to more than 7000 people who are expertise and from different professional standings. The questionnaire was filled online or from printed version by the respondents via using the username and password provided by the Project Office. To encourage participation to the survey, one-year subscription "Bilim veTeknik" (Science and Technique) and "Bilim Cocuk" (Science and the Kid) which are popular journals of TUBITAK were offered. Individualized Delphi survey developed for the on-line version for the respondents to create their own individual surveys because it was quite difficult to classify Delphi statements into different categories with the reason of the increasingly important role played by multidisciplinary research in R&D activities. This individualized Delphi survey led respondents to identify the explanations which closely related with their expertise area by not going through all statements. Delphi process's first round response rate was %32, for all 413 statements total of around 45000 responses received; these results were provided to panels for their evaluation and consideration. At a later stage all process, results and analysis published in the report form, submitted the first versions of their reports to the Project Office on 24 July 2003. The Panels came up with 94 Technological Activity Areas (TAAs) in their reports. TAA is a group of technological developments which generally based on a Delphi statements and leads to new or improved product and/or service with a vision to support socio-economic objectives. The project office prepared roadmap which included the list of technologies needed to be established to reach the TAA goals, for each TAA in a format. After submission of the final reports the Project Office examined them and formed a synthesis report. This report included the assessment of the process, a summary of each panel report in a clear format, besides the analysis of findings and recommendations of the panels. Project office combined 94 TAAs proposed by the panels and classified the under four categories:

- "Competitive Advantage"
- "Quality of Life"
- "Sustainable Development"
- "Information Society"

As a result, a workshop ("Strategic Technology Fields) was held that supporting four categories of TAAs. The strategic technology fields classified by The Project office as:

- "Information and Communication Technologies"

- “Biotechnology and Genetic Engineering”
- “Nanotechnology”
- “Mechatronics”
- “Production Processes and Technologies”
- “Materials Technologies”
- “Energy and Environmental Technologies”
- “Design and Development Tools”

Between May-July 2004, “Strategic Technology Groups” which occur from experts, realized a detailed technical study to define strategies in the form of a 20-year road map use for each strategic technology field. In the process of the project several changes and deviations emerged in despite of the common systematic process designed for all panels in the Program. Consequence of VISION 2023.

The Vision 2023 Project contained the first national Foresight Program of Turkey which focused mainly on defining the priority areas of technology with an estimated cost 200,000 Euro which TUBITAK will supply %100 of this amount from its own resources. The solid outputs of project occurred from 24 reports, specifically, 12 panel reports, 1 Delphi report, 3 synthesis reports, and the reports of the 8 Strategic Technology Groups. These reports and other tree sub projects of Vision 2023, done with aiming to be utilized at the academic, public and corporate levels in developing STI policies of the academia, companies, NGOs, governmental bodies, research institutions. From this point of view there have been two developments;

1. The resolutions of the “2004 Turkish Economy Congress” with the organization of the State Planning Organization* (State Planning Organization (SPO) is an undersecretary reporting directly to the Prime Minister and responsible for five-year development plans of Turkey.) have implemented the STI Policies Working Group Report fully based on the recommendations and findings drawn in the in the synthesis reports.
2. The vision 2023 Project was introduced by the aim of preparing a Science and Technology strategy document for 20-year period, TUBITAK designed a strategy group via instruction to prepare a document based on the recommendations and findings of the reports.

The Strategy group tendered a draft titled "National Science and Technology Policies: 2003–2023 Strategy Document" in August 2004 which had three main elements:

1. To focus on strategic (priority) areas of technology (in this regard, three generic and emerging areas of technology, and 42 specific technology fields were proposed based on the two-year long consultation period of the Foresight exercise)
2. To increase R&D expenditure (with specific targets for both public and private sector share)
3. To develop of R&D manpower (with specific targets)

The strategy document offered a "National R&D Fund" which could be managed and established and to lead to the establishment of Turkish Research Area some mechanisms may be implemented. These priority areas identified as:

1. National Programs
2. Public Procurement
3. Targeted Projects (for public bodies and sector organizations).

The importance of public awareness and loyalty of Governments to Science and Technology issues highlighted in the document, and beginning of five national programs in selected priority areas projected in 2005 also the importance of systematic monitoring and evaluation of program and need for continuity of the Foresight activities highlighted. On 8 September 2004 the draft of the strategy document was carried to the agenda of the 10th meeting of SCST and the SCST conclude that TUBITAK should be prepare a five-year action plan and a final strategy document grounded on the assessments of the SCST member organizations on the draft document. The SCST confirmed14 TAAs and 8 strategic Technology Fields (TFs) as "priority" areas as recommended by the Vision 2023 Strategy Document, which was formed by TUBITAK, in March 2005 in its 11th meeting. The SCST requested all public institutions like public universities to take these technological areas into consideration in their graduate education and research programs, R&D activities and R&D funding. TUBITAK declared that these TAAs and TFs are in is priority as a research topic, both officially and in a meeting with the European Commission throughout during the accession screening process.

On the other hand, "National Defense Research Program" and the "National Space Research Program" (announced in the 11th SCST meeting in March 2005), also "Public Research Programs" on Agriculture, Health and Energy (announced in the 12th SCST meeting in

September 2005) oppositely with the basic idea of Vision 2023 project. Interestingly at the 11th SCST meeting, the "Science and Technology Policy Action Plan" was accepted and it was negotiated that Science and Technology decisions were taken on STI priorities. Vision 2023 process draw an attention of mass media and public bodies, academia and too many numbers of people from industry had been included to the Vision 2023 process. However, the momentum from the past was not sustainable therefore, the attitude of stakeholders towards STI issues is the same as was in the past.

It has no doubt that Turkey has been a technology user much than technology producer because of that the process sensitive to changing priorities and behavior of decision makers. Also the process was influential for the fund of knowledge and abilities like Delphi software and list of technology fields; related regarding STI policymaking in Turkey. As a result of the project two online databases prepared (These databases are available at http://arabis.tubitak.gov.tr and http://tarabis.tubitak.gov.tr.) which provide information necessary for coming studies on STI policy. Also TUBITAK was attended the organization of UNIDO-led Foresight training programs spryly.

Overall the Vision 2023 project and partly the Technology Foresight program, has an important role on the way of harmonization of Turkish STI system with that of the European Union. With this project Turkey first time has responded to calls of Foresight as a strategy to contribute to the development of the country and contribute to European knowledge-based development. Also, Turkey has actively played a role in the joint of enterprise 15 countries. (11 EU Member States, 3 Candidate Countries and one associated country) for coordinating their own national programs with the aim of increasing their national and European impact and perform join programs. It is too early for evaluating whole impact of process, it will be more clear if decision makers explain their long-term STI vision and objectives, as well as their policy on the future of Foresight activities in Turkey.

Foresight was believed as essential for Turkey because of exclusive needs of the country, because of disintegration of researchers and resources, insufficiency of political support for the STI policies and segregation from other industrial policies. Because of this a Foresight exercise and systematic prioritization process intended, the methodology composed as an exercise via experimentation from other countries for the usage of expert panels and the Delphi method; also different practices occurred from different sectorial panels.

III. METHODOLOGY AND DATA ANALYSIS

1. Data Collection and Methodology

In this study, data from five countries is collected based on their closeness in terms of economic development. Emerging economies of Brazil, India, Russia, South Africa, and Turkey are used in this analysis. Data on their research and development expenditure is collected from World Bank Data Bank from years 1996 to 2015. All of the data was collected from the World Bank Data Bank. Separately, data on exports of different products is used to analyze the amount of technological advances that have been made by these countries. Low technology, medium technology, and high technology product exports are to be evaluated as a part of this study. Similarly, the data for these products is analyzed from 1996 to 2015. All of the data has been collected from World Bank Data Bank. Descriptive analysis has been used the main mode of data analysis. Descriptive analysis has been preferred because it assists in making reliable analysis of the given data.

2. Data Analysis

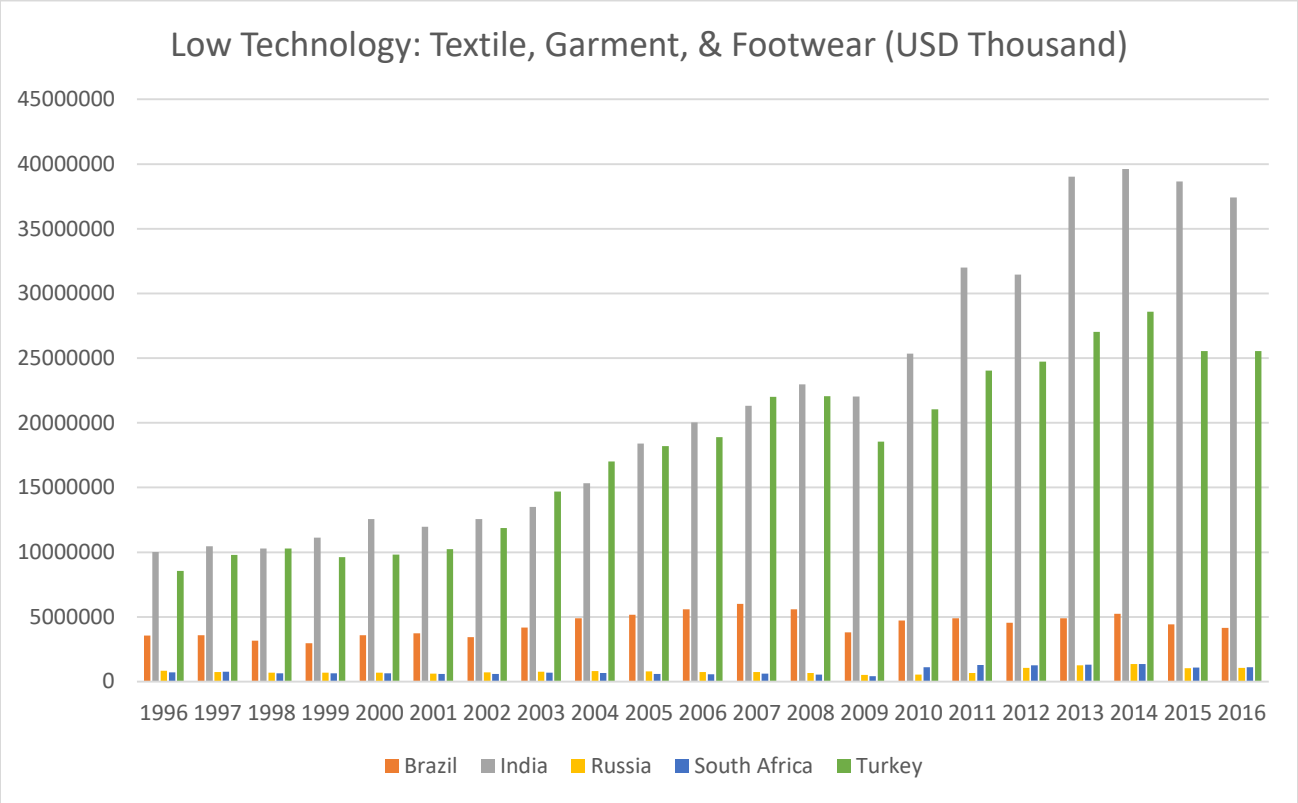
Table 3: R&D Expenditure as a percentage of GDP

R&D Expenditure as a percentage of GDP					
	Brazil	India	Russia	South Africa	Turkey
1996	..	0.62772	0.96487	..	0.45159
1997	..	0.67588	1.04486	0.58364	0.49169
1998	..	0.69295	0.95369	..	0.37095
1999	..	0.71275	0.9969	..	0.46587
2000	1.00084	0.74306	1.04921	..	0.47811
2001	1.02879	0.72196	1.17741	0.71315	0.53829
2002	0.97667	0.71213	1.25004	..	0.52665
2003	0.9982	0.70727	1.28684	0.75809	0.48288
2004	0.96233	0.74436	1.15318	0.81149	0.51834
2005	1.00273	0.81118	1.06845	0.86276	0.59098
2006	0.98784	0.7981	1.07363	0.89786	0.58046
2007	1.08149	0.81483	1.11771	0.88266	0.72256
2008	1.12896	0.86728	1.04376	0.88781	0.72482
2009	1.11968	0.84461	1.25215	0.83485	0.84863
2010	1.15869	0.8219	1.1304	0.7365	0.84251
2011	1.14132	0.8309	1.02249	0.7354	0.85801
2012	1.12795	..	1.04614	0.7345	0.91988
2013	1.19828	..	1.05605	0.72283	0.94314
2014	1.16755	..	1.08797	..	1.00561
2015	..	0.6274	1.13202	..	..

Source: World Bank Data Bank

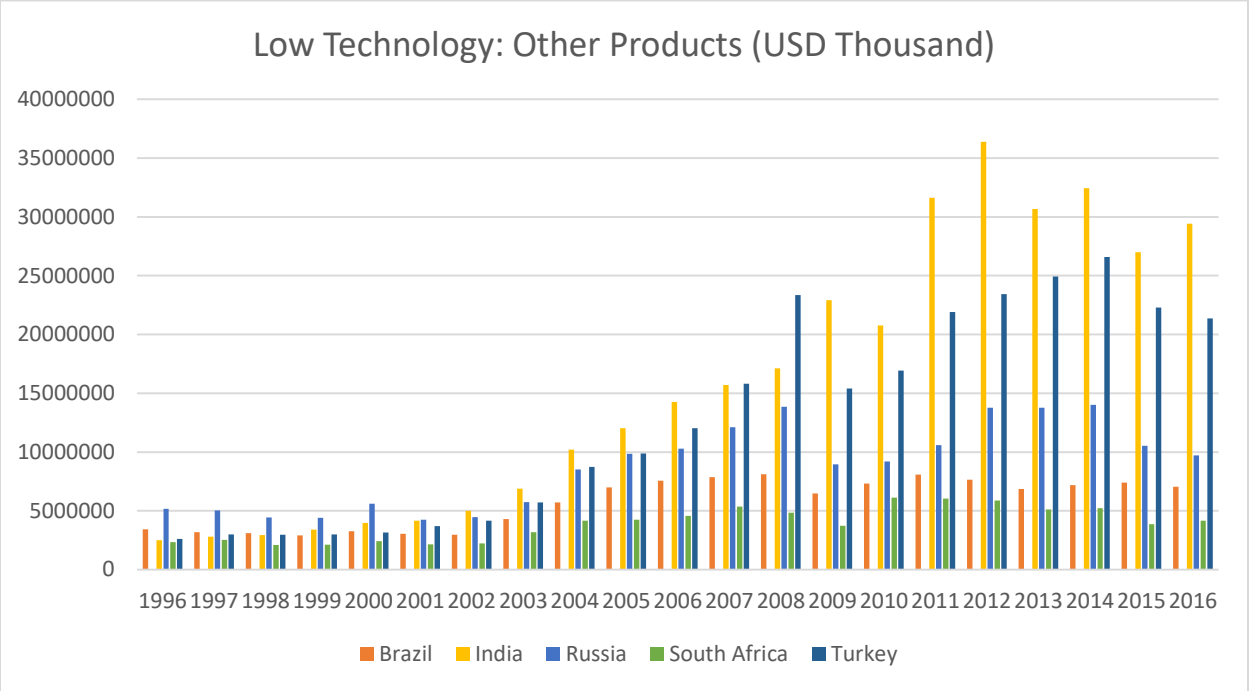
The research and development figures are assessed in order to see if these figures have an impact on the export composition of the countries. The research and development figures are shown in the table as a proportion of the total gross domestic product. The data shows that the R&D expenditure as a percentage of the GDP has stayed quite consistent for all countries over the years. However, it must be noted that the GDP of these countries has been increasing so in fact the total R&D expenditure in USD has increased and has increased exponentially. For example, the GDP of India in 1996 was around $400 billion (0.62% of which was R&D expenditure, more than $2.5 billion), however, the GDP in 2015 was $2.112 trillion in 2015 (again 0.62% of which was R&D expenditure, more than $12 billion). This shows the exponential increase in R&D expenditure that has taken place over the years. The countries are spending much more on research and development leading to technological advances and a change in the structure of production in the countries. Turkey on the other hand has not only increased the amount of spending on R&D but, they have also increased the percentage of spending in relation to the GDP. The R&D spending as a percentage of GDP was 0.45% in 1996 which increased to 1% of GDP up until 2014. Turkey has been trying to improve the technology and industry within the country. Their spending on R&D has increased but it is still lower than that of India since the GDP of Turkey is much lower than India.

Figure 2: Low Technology Product Exports: Textiles, Garment, and Footwear



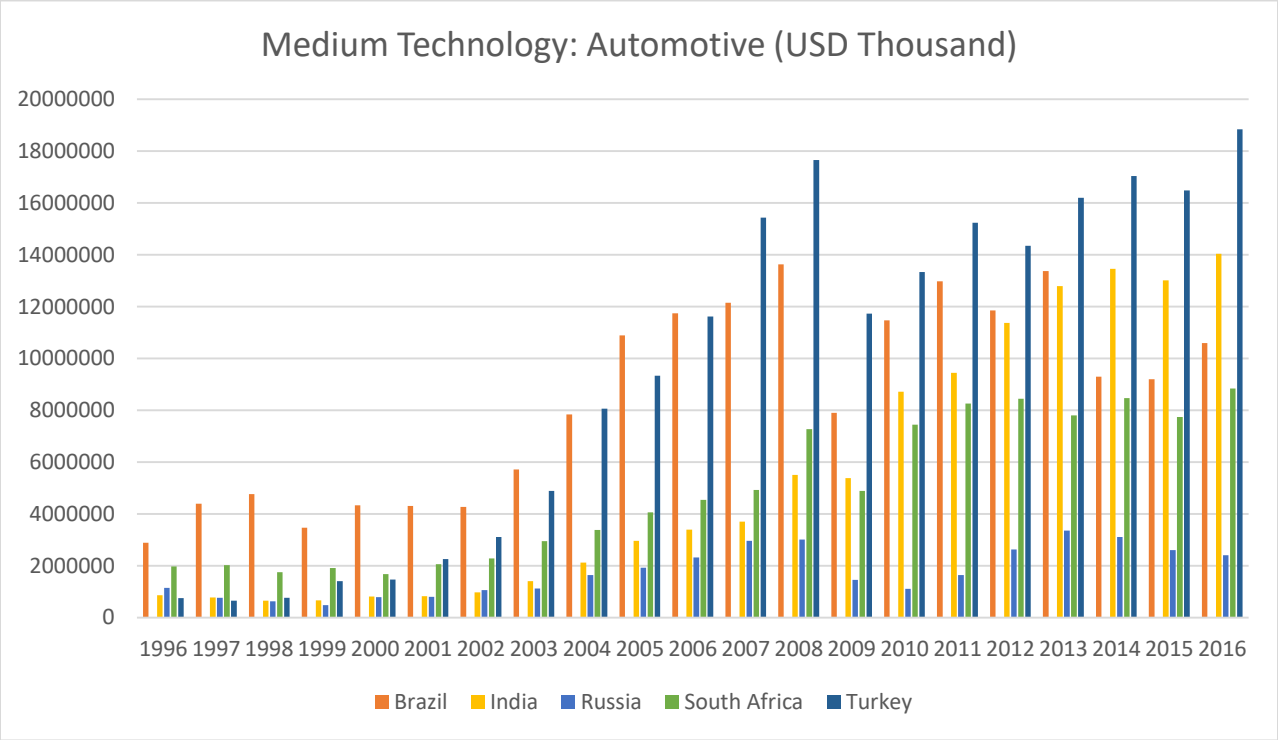
The low technology products that are classified within the category of *'textile, garment, and footwear'* include all types of textile products including clothes, fabric, and everything that comes under apparel. In addition, it includes leather and leather products. Among the countries that are examined as a part of this research, India exports the highest amount of low technology products and this has been the case for most of the years since 1996. Turkey led in this category for some years in the late 1990s and early 2000s, however India has since increased their production and exports and are ahead of all other countries in this sample. Since the financial crisis of 2008, there has been sort of a boom in the exports from all countries but especially from India. This shows the high production capacity of India as well as their labor intensive industry.

Figure 3: Low Technology Product Exports: Other Products



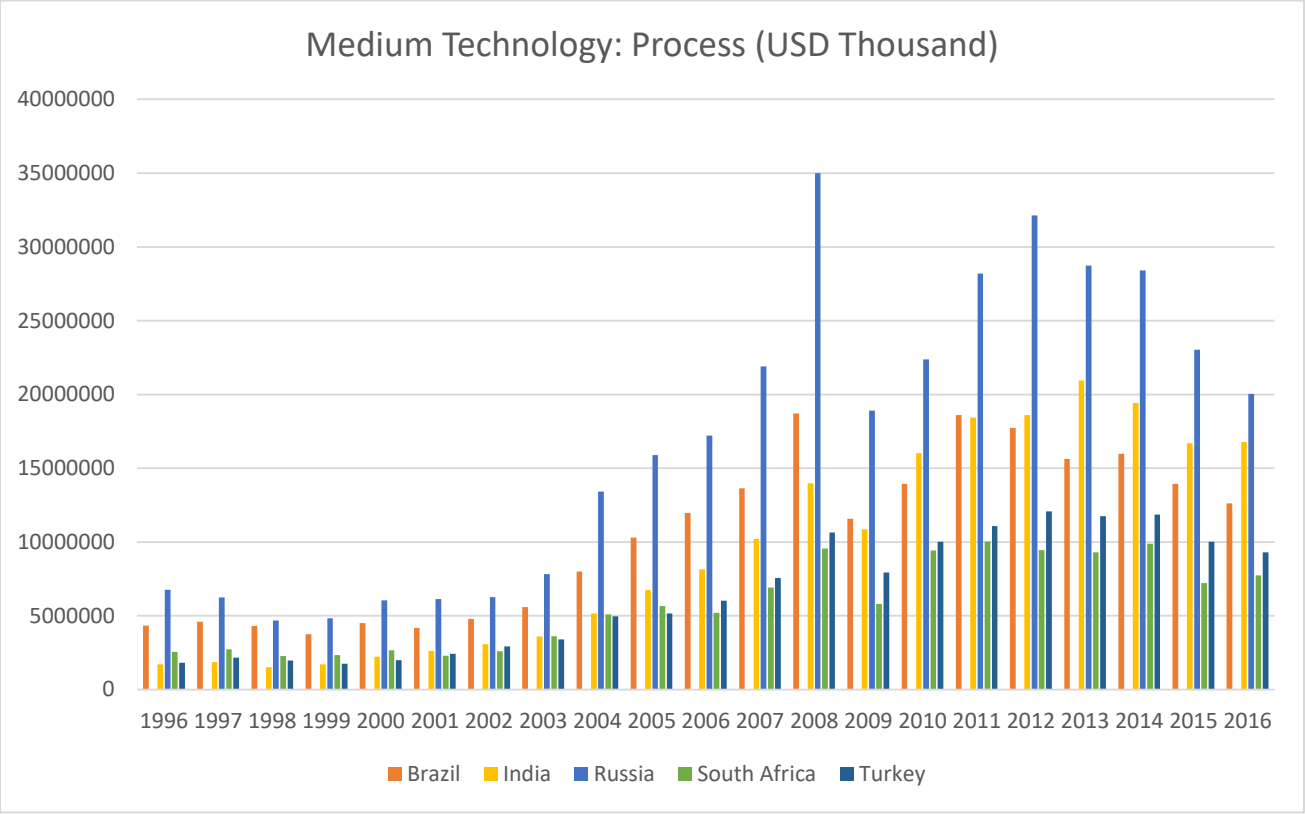
There are many products that are included within this category some of the more prominent ones are paper, pottery, glassware, iron and steel bars, wire products, cutlery, tools for use in the hand, furniture and parts, office and stationery supplies, jewelry, etc. Similar to the last graph, India is leading all the countries in the sample with the highest exports in low technology category of other products. Turkey also has high product exports in this category, especially as the leather products from Turkey are popular. Other countries in the sample are far behind Indian and Turkey.

Figure 4: Medium Technology Manufactures Product Exports: Automotive



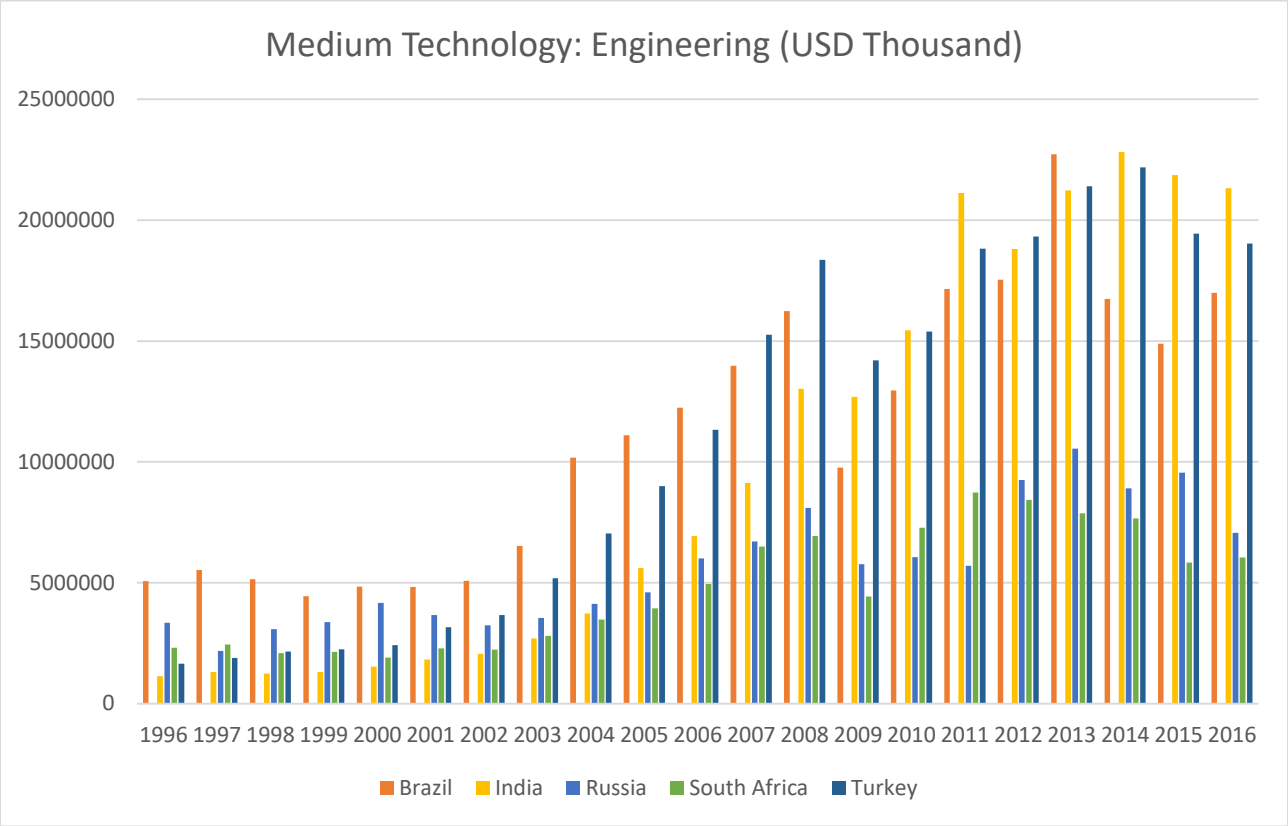
In the medium technology, there are automotive which includes all motor vehicles and their parts. In the late 90s, Brazil led the sample countries in exports of automotive. It is also important to note that the Customs Union was signed between EU and Turkey in 1996 therefore the exports are low at the time but with the passing of time Turkey becomes the highest exporter of automotive among the sample countries. This is indeed due to the fact that almost 50% of all exports from Turkey are to the EU and the automotive industry in the country produces a very high amount as depicted by the graph. Other countries are not far behind; they do still have a high number of automotive exports. The exports of automotive fell after 2008 and only recently in 2016 Turkey was able to get to the same level of exports as in 2008. On the other hand, India's exports been increasing since the financial crisis whereas, the automotive exports of Brazil have been decreasing since 2013 and may be a cause of worry.

Figure 5: Medium Technology Manufactures Product Exports: Process



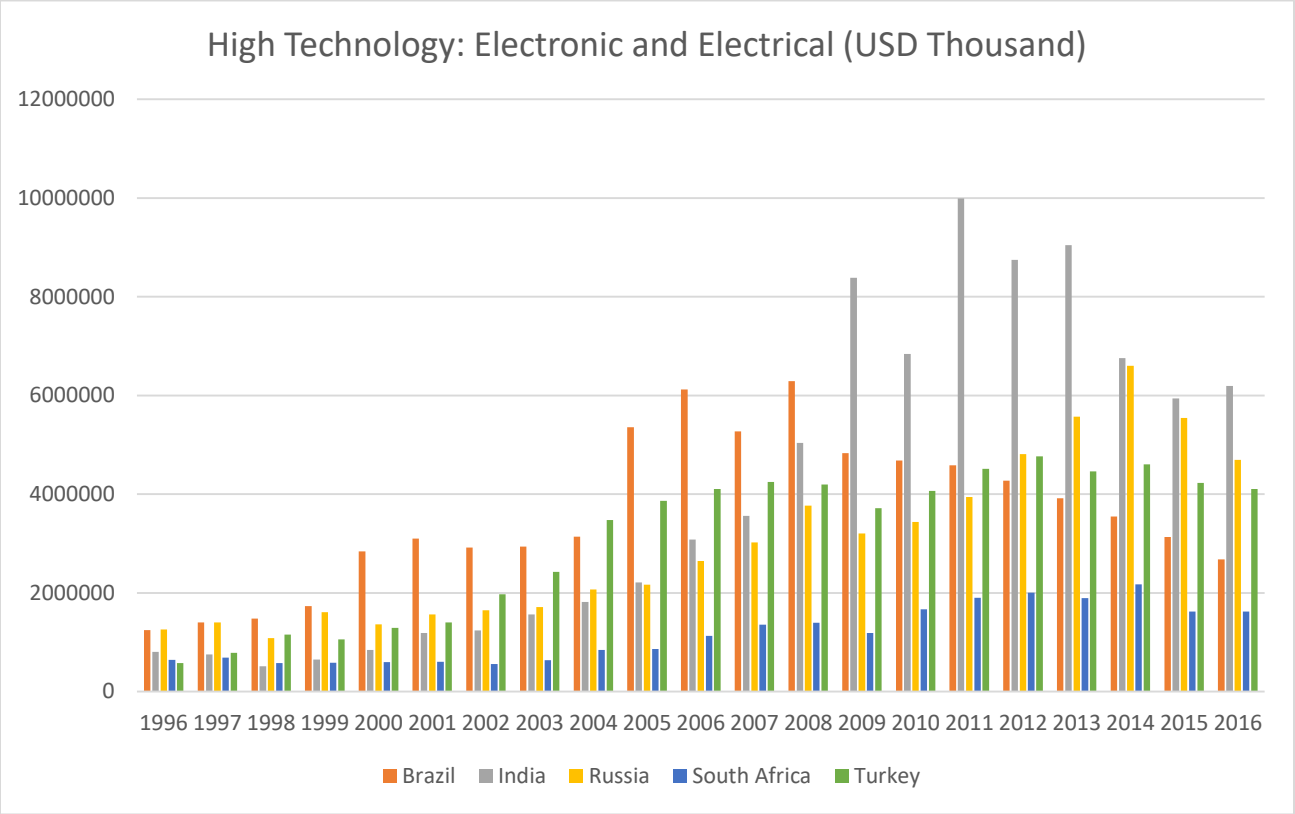
Medium technology products that fall under the process category include alcohols, carboxylic acids, pigments, paints, polymers, fertilizers, tubes, pipes, cinematographic supplies, etc. Within these medium technology products, Russia has always been the leader in this sample of countries. They have always been exporting higher than any other country in this sample and have continued to do so throughout the years. Turkey's exports begin to increase after the year 2000 and continued to increase until the financial crisis after which the exports decreased exponentially. However, they began to increase again till 2012 when they became stable and decline once again after 2014. In general, there is an increase among all countries in exports of products in the process category.

Figure 6: Medium Technology Manufactures Product Exports: Engineering



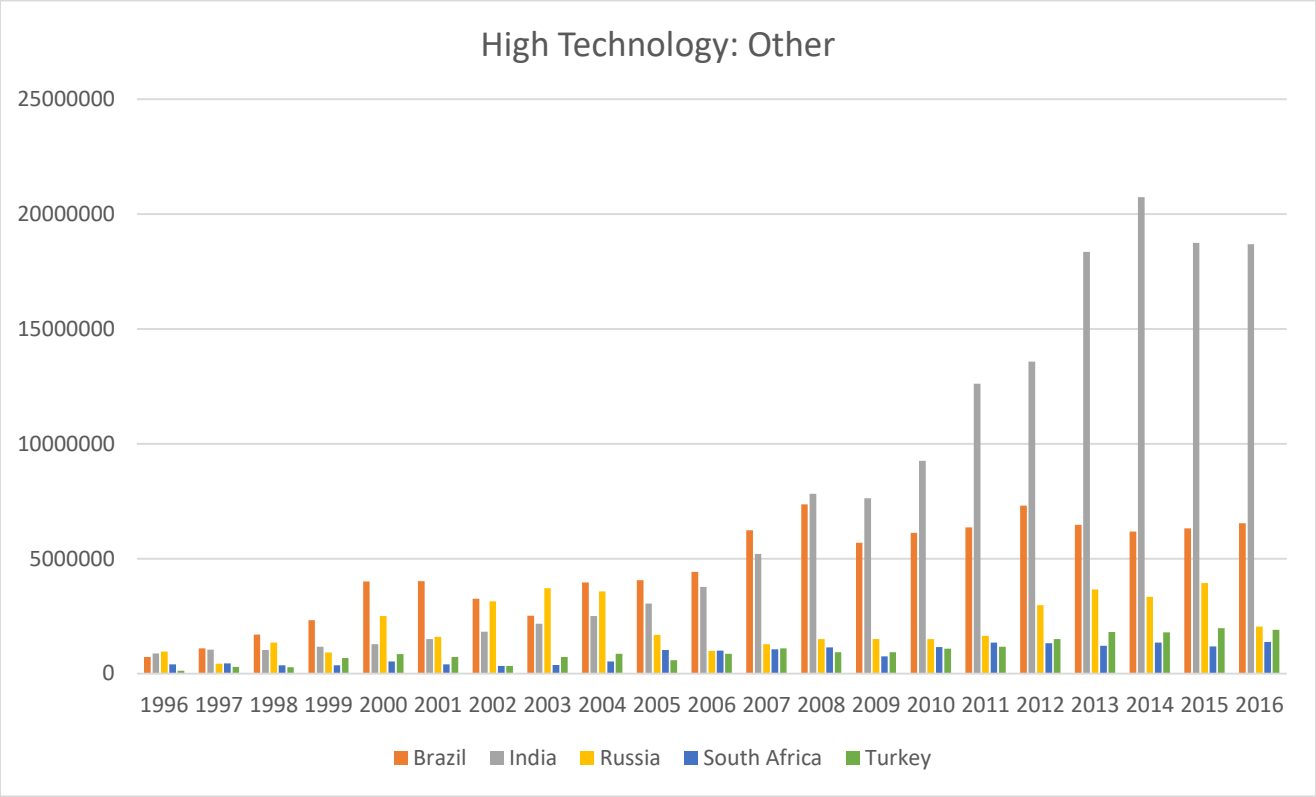
The medium technology engineering category contains a number of products, some of these include agricultural machinery, textile and leather machinery, printing machinery, heating and cooling equipment, arms and ammunition, etc. A boom can be observed after 2002, exports within this category increased for each country during this time so much so that Turkey surpassed all others in 2008 whereas, it was below all other countries except India in 1996. Since the crisis, India has been able to increase their exports in this medium technology category and have become the leader of the group of countries selected for this research. The consistence increase in the exports of these products from these emerging economics may be an indicator for the developments in the industry of these countries.

Figure 7: High Technology Manufactures Product Exports: Electronic and Electrical



Finally, the high technology manufactures within the electronic and electrical category include various products some of which include office machines, telecommunication equipment, electric power machinery, electrical machinery, etc. Until the 2008 financial crisis, Brazil led the sample countries in the exports of high technology manufactures within this category, however since the crisis they have fallen off. India's exports have boosted and more than doubled from 2008 to 2011. Turkey has yet to reach the level of exports it had in 2008, the exports of high technology from Turkey have decreased a little over the years since 2008 but remain around a consistent level. It should also be noted that the overall exports in USD of high technology from these economies are much lower than the middle and low technology exports.

Figure 8: High Technology Manufactures Product Exports: Other



The *'other'* category of high technology products includes products such as medicinal and pharmaceutical products, aircraft and associated equipment, optical instruments, etc. India among this group of countries has been the highest exporter since 2008 before which Brazil was the lead exporter. Russia, South Africa, and Turkey have had very limited exports in this category and do not seem to be improving. Russia's exports were increasing since the 2008 crisis but have decreased immensely in 2016. Turkey on the other hand seems to be consistent in their exports within this category, the same holds true for South Africa. Again, it should be noted that the amount of exports in USD are much lower than the other categories especially those of medium and low technology.

IV. DISCUSSION AND CONCLUSION

1. Discussion

The exports of the sample countries have been increasing over the years which compliments the fact that these economies have also been appreciating throughout these years. Similarly, these economies have been increasing their spending on R&D hence the increase in the exports of high technological products. Over the years these emerging economies have improved their economies with increasing exports and higher production that has also led to the increase in GDP per capita. The developments in these countries can also be witnessed in the fact that they have become large economies and indeed powerful over the years. Some of them have joined the G20 economies in the world that represent the 20 largest economies in the world.

Turkey has also witnessed an improvement in the trade market since signing the Customs Union with the European Union in 1996. That can be seen as a historical moment in terms of economic ties since it led to a rapid increase in the trade between EU and Turkey. It helped Turkey in improving their production levels and reach to a much large and developed market. Furthermore, the development after the market crash in 2002 have been key for Turkey in terms of economy. Turkey has grown rapidly since 2002, the graphs of exports also shows this as Turkeys exports have increase immensely leading to higher economic growth in the country. Turkey's exports in 2002 amount to a little over $58 billion while this number has increased to over $211 billion in 2017. This is a four-fold increase in just 15 years, it shows the rapid growth of the economy and the country as a whole. It is important that Turkey continues to invest in R&D activities in order to further grow and compete in the market. Turkey will have to innovate and introduce more technologically advanced industrial practices that will lead to the production and exports of high technology products.

2. Conclusion

Majority of the countries are promoting the transformation of sectors and the STI as well as economy. A policy of STI which is optimal overlap on the question for promoting the technological learning and building of competence. The STI policy might lead to the creation of jobs in the economy by the process of industrialization which is efficient. (Atkeson, 2010) There are different modes of transfer of innovation in the different countries like UK, USA, Canada,

China, Japan etc. except UK all the governments of the countries play an extremely important role in the promotion of STI and its policy. The policy of STI need to address the following questions and issues:

1.Identifying the most critical areas of coordination,

2. How the policy of innovation does would fit into the broader context of development strategies of the countries which are in practice.

3. What results it can give at the level of macro, micro for the improvement of firms, which can be understood and which can be applicable to the other foreign countries.

It is the role of the governments to provide the incentives which are adequate for the innovation, which should be specific for a specific country (Dosi, 1990). Therefore, the role of governments is enhanced in funding research and development so more innovative projects can be undertaken and more technologically advanced industries can be funded.

This study focused on five countries in assessing the impact of STI policies on trade. STI policies determine the amount of R&D expenditure by a country, the countries assessed have increased their expenditure over the years. However, for the most part the R&D expenditure as a percentage of the GDP has remained consistent over the years. Turkey has increased the R&D expenditure as a percentage of GDP over the years, this has also meant that their export composition in middle and high technology products have increased. This is also the case in the other countries that were a part of this study, Brazil, India, Russia, and South Africa. These emerging economies are improving their economy through trade and higher production. The rapid economic growth over the past 20 years has meant that these economies have developed very quickly within this time period. In order to improve further it is imperative that these countries continue to invest in R&D activities and continue to move up the trade ladder through exports of high technological products.

Future research should focus on analyzing the STI policies of other developed and developing countries in order to make comparisons between the two. Studies on developed countries may help researchers better understand the path that those countries have taken in order to become advanced and the STI policies that go along with it. Furthermore, comparisons

between different types of countries could help in analyzing the differences that are arising in STI policies among the different countries leading to better policies in the future.

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