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ECONOMY COMPETITIVENESS: IS TECHNOLOGY INNOVATION THE GATEWAY TO DEVELOPMENT?

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LIST OF ABBREVIATIONS

NIS: National Innovation System

OECD: Organization for Economic Cooperation and Development

GCR: Global Competitiveness Report

BP: British Petroleum

EBI: Energy Biosciences Institutes

R&D: Research and Development

GDP: Gross Domestic Product

ICT: Information and Communications Technology

FDI: Foreign Direct Investment

GII: Global Innovation Index

EU: European Union

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ABSTRACT

The purpose of this paper is to analyze the underlying transformational strategy and impact of innovation that stimulates growth and development of the economy for global competitiveness. Competitiveness varies among economies as a result of the different transformational strategies implemented. This paper further compares the competitiveness of different economies, the correlation and the impact of technology on the economy. Literature review was conducted on academic journals and international organizational reports that focused on the development stages and the concepts of innovation. Data collection and analysis were done to collect statistical data and information from government, academics and world organizations' surveys, and report data. Based on the outcome of the research, it could be stated that the core goal of most effective strategies toward growth and development of an economy is directly linked to the effectiveness of technology innovation and strategies. The paper concludes by reiterating the role of technology innovation and economic technology capacities towards development.

Keywords: Economic Development, Technology Innovation, Economic Competitiveness, Technology Adoption, National Innovation Systems, Stages of Development

1 INTRODUCTION

1.1 Background

The current trend of globalization in the world called "global village" calls for competitiveness in the market place for the economies to survive. Economies that have competitively positioned themselves are moving forward while the others drag behind. This subject has drawn lots of interests from researchers, organizations and individuals: noted among these, are the concurrent publications by the World Economic Forum. The interests are widespread among many researchers looking into the fundamental theories of the economic developments (Schumpeter, Lundvall, Freeman, Cooke and Nelson among others). For centuries, cities grow and thrive with resounding fame across globe for their efficient acquisitions of technology that spur growth and development. There were powerful rush from the country side to the cities to explore and enjoy the beauty accolated with cities thriving under the light of technology advancement of their periods. Economies became richer and stronger relative to other economies as they quickly adapted to the latest developments of their era. Economic growth and developments experienced over the ages were usually associated with specific instruments of growth. What has been the driving force of strong economies? How have they been able to rise over the edge of the cliff while the rest of the world watches with grace?

Economies do not just appear like magic, they are consciously developed. The development of these economies is associated with their level of technology diffusions. Migration from villages and rural economies are largely caused by the enticing infrastructures and possibilities booming in the main cities. The inventions of iconic technologies that led to the industrialization and extensive complexities of economies in the West were an icebreaker. With the inventions of internal combustion engines, turbines, steam engines, telegraph, printing press, papers, automobiles, personal computers, internet and electricity among many others, there was no limitations in the level of economic attainments by the first adopters of these technologies. The rates at which these technologies are invented and diffused, corroborates the rates at which the

economies experienced major shifts in developments. It is unambiguous to say that economic developments are strongly hinged on the potential power of the technology that are absorbed and used in that economy. Though not conclusively penned but could be factly stated that as economies hinged on technology advancements, this stares on the interactive social institutional policies embraced by the societies.

What could have been the systemic analysis of the costs of technology advancements to economic developments? Would negating economies drown into the seas of obscenity? A cross-reference study shows the impact of technologies on the economy. The airplane, an effective and impactful technology from the past century, represents the average effects of technology on the society at large. The aviation industry that embodies the use of this technology elaborates the major impacts. It is a major game changer; drives domestic business activities, opens up and boosts the growth of tourism across the globe, opens up new geographical locations to the world economy, revitalises the developments of communities they are located, provides direct and indirect employment opportunities, contributes to the national GDP and drives agile supply chain networks across the globe. In 2014, the aviation industry supported 3.4% of the global GDP which amounted to US$2.4 trillion, and 58.1 million jobs worldwide. Figure 1 below summarises the impact of aviation sector as regard GDP and employment rate. 'If aviation were a country, it would rank 21st in the size of GDP.' (ATAG 2014:4)

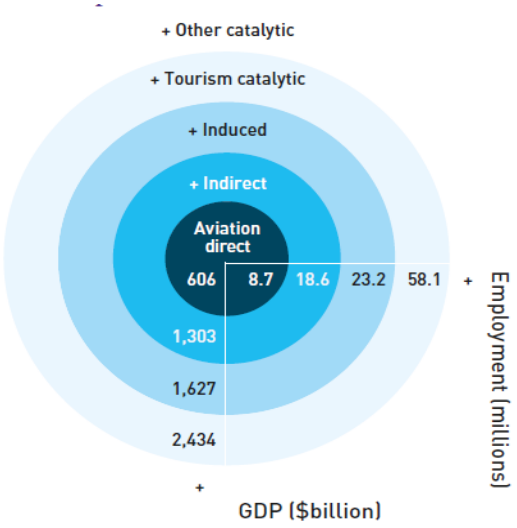


Figure 1 Aviation global employment and GDP impact (ATAG 2014).

1.2 Research Question

This report is intended to overview the importance of technology innovation on the performance of economies. The competitiveness of economies are linked to the performances of the technology industries. The research questions below are to serve as a guard in ensuring conformance to the goal. The questions are also guides that pinpoint the necessary spots to be evaluated during the course of the research. They provide the insight into the importance of the technology. They spur the inquisitiveness as to the emotions driving the completion of this report.

Q1.What is the role of technology in the development of an economy?

Q2. How does technology capacity of an economy influence its rate of growth and development in relation to other economies?

Q3. What are the transformational strategies and structures that make an economy more competitive in comparison with others?

Q4. Why is there a large income disparity between the developed and developing economies?

The research questions were the consolidation of different questions to ensure that the accurate information are embedded. These questions are directly interwoven with the objectives of the report.

1.3 Objectives

The objectives listed below gives the basis for pursuing the topic and the propulsion force driving the engines of the thesis completion. It images the expected results and knowledge intended to be covered by the end of the research work. The objectives are

* To explore how economic competitiveness relate with stages of development.
* To explore and analyse the role of technology innovation in economic development.
* To show that economies can be successfully developed and sustained by developing its knowledge capacity.
* To analyse if there is any correlation between innovation inputs and outputs.
* To analyse how economies develop their technological capabilities.

* To discover if different economies can be directly compared with each other.
* To understand the importance of economics' knowledge to non-economics students.

1.4 Thesis Structure

The thesis is structured into three different parts. The different parts focus on related concepts and the approach to these concepts are different. The main concepts that are to be treated are economic competitiveness, the stages of development, pillars of competitiveness, innovations as related to national innovation systems, industry-institute collaboration, impacts of technology on the economy and research questions.

The first part is the literature review. The literature review comprised of the economic competitiveness, stages of development, pillars of competitiveness and innovation concepts. This part of the thesis deals with the comprehensive description of the concepts. This chapter explore the different perspectives of these concepts. It is followed by the methodology section. This covers the description and presentation of the data used for analysis in the result sections. Also the sources of the data could be found from this chapter.

The second part is the result presentation. The results chapter graphically demonstrates the correlation between the economic competitiveness level and the different parameters including technology usage. The final part of the thesis is the research questions. This section answers the proposed guiding questions. This is done by analysing with instances from the results with examples. The four questions are to be fully dissolved to ensure clarity in the answers.

2 LITERATURE REVIEW

The focus of this review is to determine how technology innovation plays a major role as part of the underlying transformational strategies that determines the development of these economies. The pivotal role of technology innovation is critical to the economic development as clearly defined and described in the World Economic Forum yearly reports. The review is to be conducted by analysing different yearly reports and the stages of the economic development of an economy. By doing this, the technological transition is noted and its impacts on the economy. The review continues by analysing the two strategies of implementing technological innovation in the economy. The first strategy deals with the national innovation system approach. The channels, process and actors involved in implementing the system are also included. The second strategy is to briefly analyse an overview of innovation creation and development. Though there are many approaches to this, industry-institute approach will be analysed.

2.1 Global Economic Competitiveness

Figure 2 Global Competitiveness Model (GCR 2015-2016).

An established fact from the recent Global Competitiveness Report (GCR 2015–16) is that competitiveness is based on the effectiveness and productivity of the economies involved. The development path of the economies defined the niche of each one as shown in Figure 2 above. The three stages of development namely; least, moderately and highly competitive, could be related to the developed and developing economies. The developing economies were differentiated into the least competitive and moderately competitive. Figure 2 above describes the least economies to be factor-driven. They belong to the least technology adoption group. These merely rely on importing technologies and relatively invent none. The moderately competitive are the efficiency-driven economies. They are termed 'technology balancers' because they import high-tech products and locally make the low to average technologies, thereby belong to both adoption and innovation group in relative term. The stages of development also have transition stages for economies transiting from one niche into the next phase. These economies were classified separately into their niche (more description to follow later in the following sections). This model extends the description of the competitiveness by their technology consumptions. By including technology consumptions, the influence and impact of innovation in the growth and development of the economies could be exposed. The analysis of the competitiveness, as defined in the annual reports of the World Economic Forum, is based on 12 pillars of competitiveness. These pillars (12) were categorised into the order of importance and economic influence to define the specific stage of each economy. As these are the fundamental factors for defining the competitiveness of each economy, below is Figure 3 elaborating on how each pillar integrates into the model defined above.

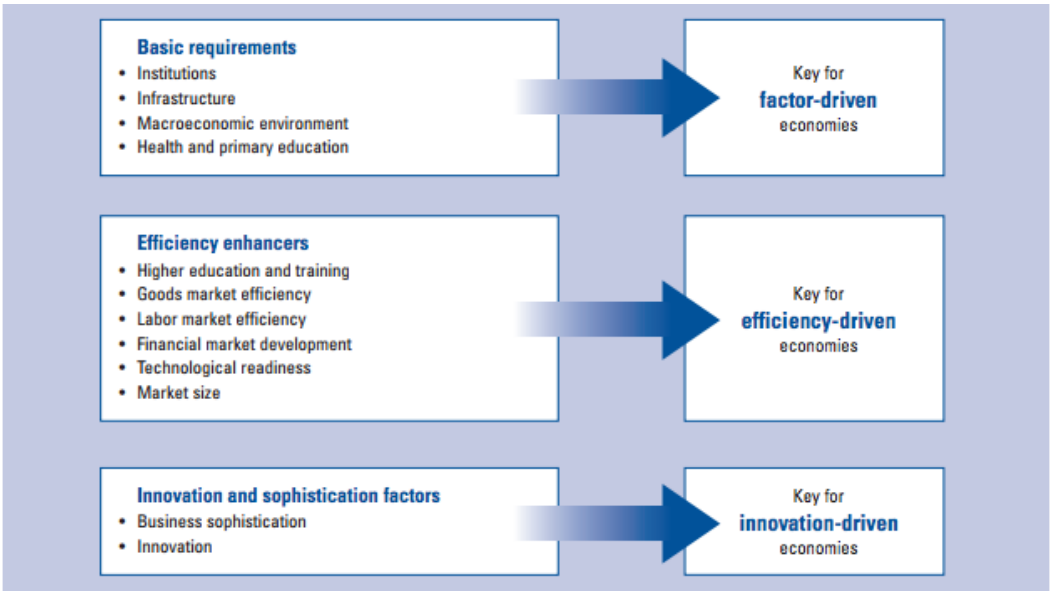


Figure 3 The 12 pillars of competitiveness (GCR 2011 – 12: 9).

As shown in Figure 3 above, economies are differentiated into their individual niche which in turn defines the stage of development it falls. The least competitive economies defined as being factor-driven require four pillars (institutions, infrastructure, macroeconomic environment, health and primary education) serving as the basic requirements for such economies to improve their competitiveness. The moderately competitive economies require 6 pillars (higher education and training, goods market efficiency, technological readiness etc.) to consolidate their readiness for the next phase. While the highly developed economies, being at the highest level of competitiveness, require steady innovation and business sophistication to remain on top of the ladder.

Least Competitive Economies: The level of competitiveness of an economy relies on its agility and ability to consolidate the different pillars of competitiveness to its advantage. The least competitive economies are also the low productive economies. The low productivity drawbacks of these economies are tied to their struggles with the basic requirements for growth and development. Overtime, researchers have shown that inadequacies in these four pillars of competitiveness (institutions, infrastructure, macroeconomic environment, health and primary education) have adverse effects on the growth and development of the economy. Arab springs, terrorist attacks in Mali among

others practically represent a misfortune that could envelope an economy. Most of the economies in this category fall short of adequate security and property right protection, for example Lao PDR ranked 115/140, Madagascar 129/140 in property right (GCR 2015–16). These inadequacies prevent economic growth by repelling investors from investing in the economies. Many of the least performing economies are also bewildered with the uncertainty of property right protection. Ineffective institutions to protect and serve the public rightly lead to increased cost of doing business, reducing perceived profits and endangering further investments possibility. Moreover undue influence and corruption, ineffective judicial system and government bureaucracy affects the economic growth and development. (GCR 2015-16)

Historically, fast growing economies are those that are well connected. '*From the ancient cities of Mesopotamia to the Phoenician and Greek harbours around the Mediterranean, from the Roman paved roads to the Silk Road that connected China to Europe, and from the railroad systems built in Europe and North America in the 19th century to the interstate highway system of the 1950s in the United States and to the current global Internet network, human progress has been associated with the infrastructures that facilitate the exchange of products and ideas*. (GCR 2015-16: 6). '

Lack of efficient infrastructure to include forms of transportation (air, water and road), communications, internet connections and energy among others are epidemics facing such economies and reducing their capabilities to effectively compete with others. Epileptic power supply raises cost of production, hampers effective infrastructural development like ICT, technological adoption and utilization, health and education competitive developments. Malfunctioning infrastructure crumbles productivity rates, reduces market size and acts as barrier to globalization effect necessary for economy growth and development. Myanmar ranking 133/140 in global competitiveness index showed poor competitiveness in health and primary education, higher education and training, technological readiness, and innovation (GCR 2015-16:271). The lack of infrastructural supply affects negatively other aspects of the economy.

Least competitive economies are characterized by low productivity due to bad health system. According to GCR (2015-16), a better health leads to high income, vice versa, high income leads to better health, for example by enabling a country to afford better nutrition, sanitation and health care services. Otherwise, bad health leads to low productivity, which leads to impoverishness and low competitiveness. Experiences teach that bad health condition translates to low productivity. An unhealthy worker

tends to skip work for his/her health. While unhealthiness in a population means lower man-labour, lower output and less productivity. Low-grade health system is worsened by lack of infrastructure; electricity, water supply, good transportation and low standard education. Hence, lack of these basic requirements limits the chances of growth and development of an economy in the face of fierce competition for competitiveness. Moreover, instability of macroeconomic environment contributes more negatively to the woes. Economies operating in deficit budget could be characterised by several destabilising factors; inability to fund recurring expenses and capital projects, inflation and high interest rates. Every other economy that are either advanced or developing have come to terms with these shortcomings, of which according to the ratings by the World Economic Forum must have passed the average ratings and keep improving on the fundamental factors. By the generally accepted ratings from WEF reports, the least competitive economies are those struggling with these fundamental requirements and these economies are more competitive than each other. Some have effectively managed many of these factors and are progressing while others are less competitive when compared as shown below.

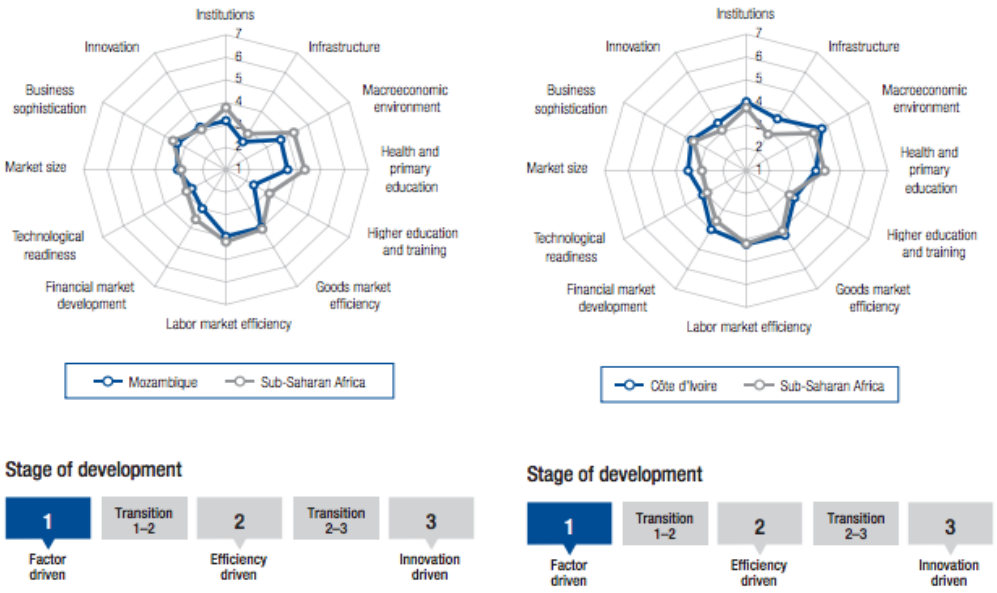


Figure 4 Stage 1 of Economic development. (GCR 2015-2016)

Mozambique (left hand side) and Cote d'Ivoire (right hand side), are both listed in the first stage of development. Figure 4 shows clearly that Cote d'Ivoire is more competitive than its counterpart. Though both economies are in the same group from the same continent, Cote d'Ivoire has been able to meet and surpass the average ratings of the pillars of competitiveness. This, in other words, means that Cote d'Ivoire is probably heading for transition from this stage of development. Mozambique, on the other hand, still has to improve on most of the pillars of competitiveness. Moreover, Figure 4 shows the average problematic factors of competitiveness that plagues the economies in this stage of development. Averagely, these economies face the problem of infrastructure, health and education which are very instrumental to the rate of development and competitiveness. Energy infrastructure has consistently been a worrisome factor in this stage of development. To develop in this aspect of the economy, technology innovation has to play a significant role. Ranging from solar energy, hydropower to wind energy. Basic education, better health system and good institution to drive the development would be needed. These are the potential problems facing these economies, which need to be addressed before concrete growth and development can take place. (GCR 2015-2016)

According to the recent annual report from the World Economic Forum, the most problematic factors for doing business per economy were highlighted. Generally, these problems are inherent in the four pillars of competitiveness analysed earlier. Though the order of influence could slightly be different, but the most frequent were access to financing, inadequate supply of infrastructure, corruption, inadequately educated workforce, and inefficient government bureaucracy among others. Presented below is an example of a member of this group.

The least competitive economy are characterised as being factor-driven. These economies compete based on their natural resources and unskilled labour (GCR 2011-12:9-10). Third world countries mostly classified in this category are gifted with large unskilled labour force and natural resources. These make the economies to compete by trading their natural resources. Literarily, as the resources flow out, basic technology flows in to advance the productivity. The availability of unskilled labour translates into low productivity and low quality products which cannot compete with that of their counterparts. With a better macroeconomic environment and improved infrastructure,

the country can attract technology and skill inflow to boost their productivity. The trend in the global economy shows many manufacturing companies subscribing to manufacturing offshoring to take advantage of cheap labour. This flow of knowledge and skills can improve the productivity of the economy and hence its competitiveness. But given the large potential of returns in utilizing these ample opportunities, investments are being hindered by the state of the institutions and macroeconomic environment as discussed in the OECD (2002) report presented below

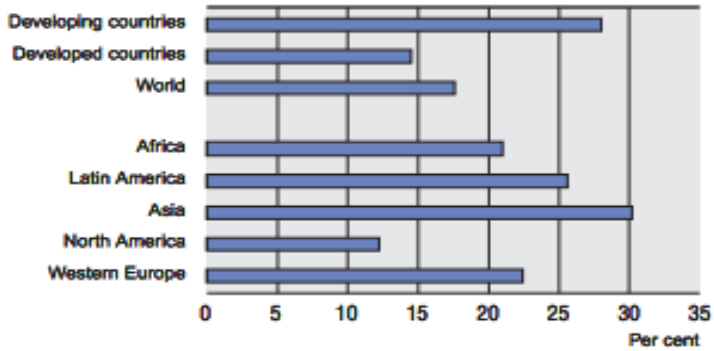


Figure 5 Inward FDI stock, 2000 (share of GDP) (OECD 2002:7).

Figure 5 shows the percentage share of GDP of Foreign Direct Investment by regions. The inflow of FDI is higher in developing economies compared to developed economies. Africa, as an example, has over 20% of its GDP and Asia with around 30% generated from FDI. The inflow of the FDI is originated from the developed economy to the developing economies. *The main factors motivating FDI into Africa in recent decades appear to have been the availability of natural resources in the host countries (e.g. investment in the oil industries of Nigeria and Angola) and, to a lesser extent, the size of the domestic economy (OECD 2002:8).* This reinstates the fact that the least economies are factor-driven economy. In order to develop competitiveness, it would be incumbent to develop their macroeconomic environment, infrastructure and institutions. The attractive possible return on investment in these economies are retracted by high taxes and significant risk of capital losses attributed to macroeconomic instability, loss of assets due to non-enforceability of contracts and physical destruction caused by armed conflicts. (OECD 2002).

Comment: It is quite notable to state that at least 50% of the problems facing the economies in the first stage of development could be resolved by the acquisition and utilization of technology innovation. The problem of energy infrastructure, for example, is a typical pointer to how the economy could be transformed for a better competitiveness. Nigeria has been facing epileptic power supply for decades, of which stability of energy supply in the country would be a major turn-around in the state of the economy. Technology innovations; solar panels, wind turbines, and peat would be of immense contribution. ICT was ranked very low across least developing economy. The automation of processes and computing would open a big functional and efficient processes that leads to higher productivity. The transportation infrastructure could be boosted by modernized ports, aviation systems, road and railway systems.

Studies show that FDI triggers technology spillovers, assists human capital formation, contributes to international trade integration, helps create a more competitive business environment and enhances enterprise development. All of these contribute to higher economic growth, which is the most potent tool for alleviating poverty in developing countries. Moreover, beyond the strictly economic benefits, FDI may help improve environmental and social conditions in the host country by, for example, transferring "cleaner" technologies and leading to more socially responsible corporate policies. OECD (2002:5).

The transformation of these economies requires the use of technology innovation. Though, technology innovation is presented as an almighty formula for alleviating poverty and improving the competitiveness of these economies, it would be infeasible without the right consultation of the other players. There has to be a sound institution that acts in the favour of the business environment. The property rights of corporations and privates' should be protected. Efficient administration and strong corporate governance should be delivered. Undue influence and corruption should be cross-checked to protect the integrity of the state. Policy favouring FDI and innovation has to be adopted to facilitate a better state of the economy.

Moderately Competitive Economy: Some years ago, the Republic of China was ranked in the least competitive economies. By providing tax incentives, cheap labours, better macroeconomic environment among the other improvement pillars, then, big corporations started investing into the economy. It became a suitable candidate for FDI from multinational companies; big corporations one-shot investment as supported in

Figure 7 below. The economy has grown quickly at an alarming rate and it is ranked to be in the second stage of development according to GCR (2015–16). It enjoyed the benefits of FDI and its productivity has improved. In Figure 6 below, moderately competitive economy would be described in the light of China's repositioning from stage1 to stage2 of economic development as indicated in the GCR 2015-16 edition.

Factors	United States		Hong Kong		Japan	
	1992	1993	1992	1993	1992	1993
Abundant labor supply	77.1	70.1	81.9	77.6	78.2	80
Tax incentive programs	60.6	52.6	57.6	52.8	72.7	61.4
Market size	68.9	56.7	50.3	48.9	56.4	65.7
Low land price or rent	18.1	24.7	33.3	31.8	30.9	22.9
Similarity in language or dialect	14.8	9.3	25.2	24	7.3	14.3
Cheap industrial supplies	32.8	26.8	24.2	23.1	23.6	35.7
Customers moved to China	6.6	7.2	9.1	8.2	9.1	10
Industrial peace	1.6	5.2	4.1	4.8	5.5	4.3
Tariff and quota jumping	4.9	3.1	2.1	2.1	1.8	4.3
Low pollution abatement costs	1.6	0	2.5	2.5	0	1.4
Other	6.6	5.2	4.2	3.9	7.3	7.1
Number of cases	61	97	648	896	55	70

Figure 6 Reasons for investing in China, 1992–1993 S (Fung, K. C. et al, 2004:14).

China has successful attracted a large inflow of Foreign Direct Investment into its domain to support its economy growth and development. It turned into an investment-driven economy. China concentrated efforts on building the four pillars of economic competitiveness at first, with its explosive market size, and strengthening its macroeconomic business environments. China had invested heavily into its energy and transport infrastructure, upgraded the primary education and public health. These served as the right foundation to capitalize on in order to entice foreign investment for a better economic buoyancy. According to OECD (2002), 30% of the GDP of the developing Asia was contributed by FDI. This percentage was grossly shared between Singapore and China.

Singapore was an efficient economy (GCR 2001-02); a fast-paced developing economy with most of its economy indices well-adjusted for both inward FDI flow and high competitiveness. Singapore, on the second stage of development, was highly competitive from infrastructure, macroeconomic stability, and institutional development

to competitive education system. According to GCR (2001-02), it was ranked first (1st) in macroeconomic development, 6th in public institution, 18th in technology and 4th in overall economy competitiveness ranking. It boasted of some of the best competitive institution with no or extremely corrupt-free governance. It has some of the best transportation infrastructure e.g. sea ports and regulated public transport. Its bases for attracting FDI were an efficient economy, which far out-compete neighbouring economies.

China, on the other hand, was the upcoming manufacturing investment hub for FDI. It boasts especially of its rising domestic market, natural resources, low cost of labour and robust tax incentive programs for FDI. Fung, K. C. et al (2004) in their book 'US Direct Investment in China' captured the numerous Chinese tax incentives endowed on foreign corporations for direct investment in its domain. Chinese government provided special incentives in the form of reductions or exemptions to any US or foreign companies that contracted investment into its special economic zones, open coastal cities, economy and technology districts, open economic cities and area. As they noted in their examples, *foreign invested firms are taxed at 15% rate instead of the general 33% percent rate. Firms with a contract term of more than ten years pay no taxes in their first two years in which they make a profit (*Fung, K. C. et al, 2004:15-16). In 2002, the survey executed by A.T Kearny disclosed that majority of firms in United States, Britain and Hong Kong preferred to invest in China as compared to other regional economies (Fung, K. C. et al, 2004). Among other surveys, Figure 6 presented the most important reasons for investing in China; preferential tax and import duty treatment to foreign firms, low labour costs and supply, relatively large domestic market, and availability of natural resources. (Fung, K. C. et al, 2004)

Figure 7 Efficiency-driven Economy. (GCI 2011-12:9)

In the stages of development, economies generally develop from the factor-driven economy which relies heavily on the FDI and characterised by low productivity, low skilled labour, lack of advanced technology capabilities and heavy importation of technology. Then, it moves to stage2 of the development after raising its productivity by upgrading its basic requirements to a usable and acceptable level. The stage2 of the economic development is the efficiency-driven zone, also referred to as the investment-driven zone in

Figure 7. The efficiency-driven is basically depended on a number of factors as highlighted in Figure 8; higher education, goods market efficiency, labour market efficiency, financial market development, technological readiness and market size. According to GCR (2015) report, economies in this zone includes but not limited to China, Cape Verde, Armenia, Albania, Ecuador, South Africa, Bulgaria, Colombia, Georgia, Guatemala, Indonesia, Jamaica, Ukraine, Morocco, Thailand, Egypt and Macedonia etc. Efficiency-driven economy, such as China and Armenia, constantly improves on the state of their basic requirements to be more competitive. Those requirements serve as the foundation for any economy growth irrespective of its level in the stages of development. In addition to that, these economies begin to develop the efficiency enhancers. The efficiency enhancers pose new challenges that require a new system of approach. Like China, efficient economies would be focussing on improving these factors.

Higher education and training is an important factor among others. The quality and availability of the educational system is a factor that determines if the economy grows or not. A general trend at this stage is that the economy has a higher percentage of secondary education enrolment to tertiary education enrolment. For example, Egypt (86.3, 30.1), El Salvador (70.2, 25.5), China (89, 26.7), Cape Verde (92.7, 22.8) has secondary enrolment far greater than tertiary enrolment. Some economies, also, have rising vocational education to take advantage of building capabilities in the new technologies flowing in through FDI. *Secondary and tertiary education especially facilitates the transfer of knowledge about new information, products, and technologies created by others* (GCI 2015-16:49). The advantage of this level is that the labour force capabilities are developed enough to operate and make improvements on acquired technologies, serving as the basis for further competitiveness in productivity. Though

according to the statistics noted above, the tertiary education is not fully developed with a lower enrolment, it provides capable labour force to steer the management of the industries. There is also a considerable labour training provided by the firms to their employees. Corporate and other professional trainings improve the rate of transfer of knowledge and know-how in the pool of labour force, which usually reflects in the mobility of labour within the economy.

The competitiveness of the economy is affected by the level of the market competition (goods market efficiency). Domestic competition has to be improved at this level. The effectiveness of the anti-monopoly policy, government bureaucracy on the procedures to start a business, and the tax rate has to be considered with respect to domestic competition. FDI remains a potent force in the development of the economy; therefore, foreign competition has to be considered. China, in order to boost its foreign competition, entered the World Trade Organization in 2001 to ensure that trade flows smoothly, effectively and freely with other nations. This increases its influence on attracting FDI. Incentives on tariffs, custom burdens and other trade barriers would be considered to improve the efficiency of the economy. *Industries where competition is more intense are more efficient and produce more innovation, thus improving productivity* (GCI 2015-16:50). Market competition forces industries to be creative and more productive. Entry of foreign competitors facilitates productivity, driving out least competitors and encourages more innovations which use better technology. As the market competition improves, economy competitiveness improves as well. Competition-favoured policy have to be adopted for the economy to consume more inward investments and improve the domestic industries to a more advanced and competitive level.

Investment-driven economies are classified as manufacturing dependent economies. The growth of such economy is dependent largely on the market size it reaches. Today, national market extends beyond the political borders of the country. The invention and improvement of transportation technology such as ships and aeroplanes have made distances no barrier in the global trade. The global value chains support multi-regional networks that is not confined to one region. As economy grows into more efficient-driven stage, it endorses diverse OEM vendors. This leads to supplies ranging beyond the domestic markets. The market size of individual economy depends on its

population, thus, a basic reason for many firms to choose China as their investment choice. China has a population of more than 1.3billions, hitting the largest single market size for any investment. Efficient economies with small domestic market size rely on foreign markets. Regional markets are important factors that these economies could integrate into. For example, Asian markets have populations of over 2billions, of which Singapore, Taiwan, India Japan compete in. Analysis on Apple supply chain elaborates on how OEMs integrate into the global supply chain. Apple Incl. source components from four different regional markets, manufactures it in China and eventually, supply the product to the global market. (BetaNews 2014)

Figure 8 Economic competitiveness of Bulgaria, China and Georgia (GCR 2014-15).

Figure 8 above presents a comparison and similarities among efficiency-driven economies in stage2 of the development. It is not surprising that the economies have different inclinations to each pillar ranking. The economies chosen are located in three different regions which indicates their rate of growth. Bulgaria, an European economy, shows a moderate growth rate which is relative to an average European economy. The pillars are generally balanced. The basic requirements for development are seen to be moderately developed. Especially the health and primary education sector, which in Europe is well developed. European economies tend to be moderately developed in infrastructure and education which serves a great fundamental force for their development. Technological readiness, market size and higher education and training are expected to be well developed; Bulgaria as a member of European Union is theoretically integrated into a large mobile market as part of its market endowment, the easy flow of knowledge and technology in the market is a potential force driving the technological readiness of European economies. Georgia, included in the

Commonwealth of Independent States, is similar to Bulgaria. They share many similarities but differ in many areas. The economy has a backlash in market size and higher education and training.

Highly Competitive Economies: These are the economies that are on the third stage of economic development. These have been classified as such based on their GDP per capita generated or countries that are 'resource *driven and significantly wealthier than economies at the technological frontier are classified in the innovation-driven stage (GCR 2015–16:37)'*. Highly competitive economies are innovation-driven, highly efficient and macro-economically strong. Advanced economies usually fall into this category including Switzerland, Finland, Denmark, Sweden, Japan, United States of America, among others. A shortlist of these economies could be found in Figure 2. These economies are innovation driven because they have reached such levels that efficient production does not suffice increasing cost from wages, standard of living and investments. Such economies invest significantly in research and development of different sectors but majorly education, health and environment, public and private sectors. Industry/university collaboration is common as it aids funding and it is advantageous to both parties involved. Innovation-wise, they roll out new inventions both in technology and non-technology for commercialization. Innovation-driven economies are usually stacked with increasing exports compared to importation. Due to their high efficiency, complex production and services are intricately well managed and competitive high quality innovative products and services are patented. Complex production and supply networks are handled, examples of such is the complex supplier networks by Apple (IPhone). (GCR 2015–16)

Innovation-driven economies are as strong as the strength of their fundamental basic requirements. The four pillars of basic requirements (institutions, infrastructure, health and primary education and macroeconomic environment are extremely important in maintaining their competitive advantages. The institutions have to be strong to ensure smooth running of activities, corruption reduced drastically and effective policies driving innovations are to made and widely supported. Infrastructure must remain strong and constantly developed especially transportation, energy and internet networks. Energy infrastructure is constantly given attention with goals as vision 2050 developed

by the European Union to ensure not only that energy is sufficient but that energy is been generated and utilized sustainably. German complex interrail networks and ultra-fast 4G telecommunication networks been utilized are other examples of advancing the infrastructure that keep supporting high competitiveness. Most economies grow gradually from the initial stage 1 of development to stage 3 of the development, except recently created countries.

Innovation-driven economies are those with a past; stage 1 basic requirements have to be fulfilled to rank into the second stage of development and then the third stage of development. These economies are also referred to advanced economies based on their level of development. Innovation-driven economies are knowledge dependent economy. There must be a level flow of knowledge in the economy. Knowledge is constantly acquired through different means. The education sector plays a big role in circulating knowledge. There is averagely a high rate of literacy in knowledge economy. Most of these economies have secondary school enrolments over 90% and tertiary institution enrolment to be above 60%. For example, Germany (101.3%, 61.7%) Switzerland (96.3%, 55.6%) Hong Kong SAR (99.3%, 66.8%) Iceland (112%, 81.4%) Japan (101.8%, 61.5%) respectively. Other common means of knowledge sharing include specialized staff training and well-coordinated vocational training services.

Moreover, innovation is given a high priority in both the public and private sectors. There is high concentration in the research development spending, industry-institute collaboration and emphasis on science and technology in the institutions. The capacity to innovate is constantly stretched. Innovation-driven economies consciously and carefully expand their market efficiency through various means to allow access to a large market that may otherwise not be available in their economy. Though these factors are already dealt with in the previous stage, yet they are carefully expanded and improved at the advanced stage for maximum efficiency and return on investment.

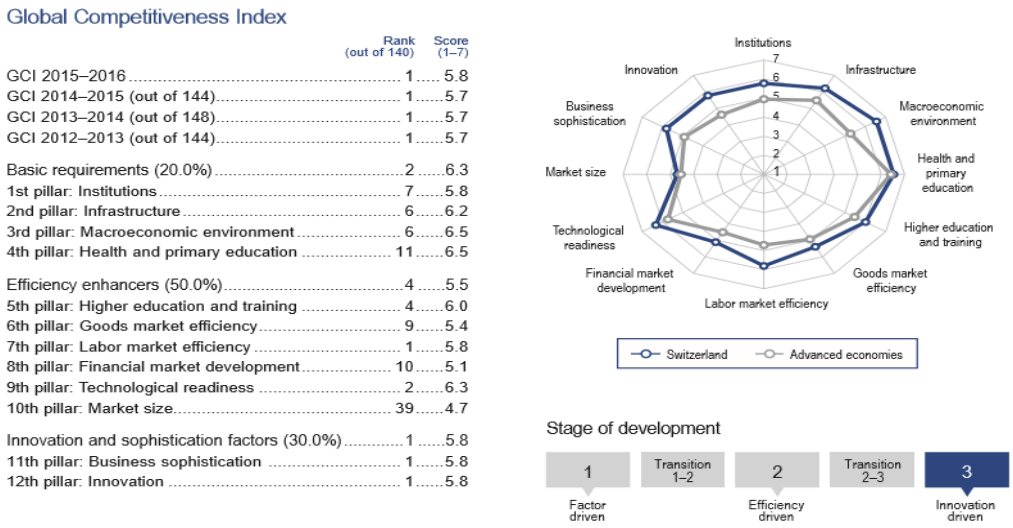


Figure 9 Swiss' global competitiveness index. (GCR 2015-16:336)

Figure 9 above showcase the Swiss' economic competitiveness index. It is at stage 3 of economic development and innovation-driven. The Swiss' competitiveness is ranked the most competitive economy for the seventh year in a row. The Swiss' success is built on many factors though the main factors are highlighted to be based on its '*world-class research institution (1st), high spending on research and development (R&D) by companies (1st), and strong cooperation between the academic world and the private sector (3rd) (OECD 2015-16:23).*' Besides these, Swiss economy is praised for ranking among the top most in other areas to include excellent infrastructure and connectivity, efficient labour market, efficient financial market, effective and transparent institutions and stable macroeconomic environment. Other economies in the top ten ranks include Singapore (2nd), United States (3rd) Germany (4th) Netherlands (5th) Japan (6th) Hong Kong SAR (7th) Finland (8th) Sweden (9th) United Kingdom (10th). (GCR 2015-16)

2.2 Innovation Systems

According to OECD reports, global economies vary longitudinally. It ranges from the rich to the poor, developed to the underdeveloped, and industrialised to the less industrialised economies. This variation could be accounted for on several economic factors, which ranges to the political system, technology and infrastructures. The

underlying nagging question to this variation is 'what is the transformational strategy or factor that differentiates these economies from each other?' Does innovation play a strategic role in defining the classifications?

Then, what is innovation? The concept of innovation is very broad from the perspective of science and technology. As there are many definitions and descriptions of innovation. One definition described technological innovation as technologically new products, processes, and significant technological improvements in products and processes (OECD 1997; Becheikh, N. et al 2006). This definition limits innovation to products and processes and exempted the perspective of services. Service innovation, in the same context as technological innovation, refers to *'innovation taking place in the various context of services, including the introduction of new services or incremental improvements of existing services (Poutanen, P. et al 2013).'* In the context of this literature innovation would be limited to technological innovation. Nowadays, a broader definition of innovation would include the *different sets of activities engaged in the process of technological change, such as the problems of awareness of definition, the development of new ideas and new solutions to solve existing problems, the development of new technological options as new solutions to both new and existing problems, and the rate of diffusion of new technologies in the market systems (Cooke, P. 2001).*

Based on the broad definition of innovation described by Cooke, P. (2001), innovation is generally diffused into the process of technological change. The process of technological change is segmented into three categories; invention, innovation and diffusion. Innovation itself is a part of the process of developing a new technology or technological improvements. The stages are described by Cooke, P. (2001). The first stage, which is the invention, encompasses creating the awareness of the problems requiring solutions, and development of new ideas and solutions to the identified problems. This stage is completely independent of the production of such technology. The second stage, the innovation, is the stage at which the new knowledge is applied in the production for building a technology as an example. This is the 'application of existing knowledge within production.' The final stage, the diffusion, is the 'broad use of the new technologies.' The diffusion stage can be compared to the commercialization and consumption of the new technology in the market. (Cooke, P. 2001)

The scope of this literature would be considering technological innovation as successful new technologies, products and processes and significant improvements in existing products, processes and technologies (OECD 1997). This definition cuts deep into all tangible products, processes and technologies that are economically viable for use. Technology innovations are considered for their tangibility of use and economic impacts on the growth and development of the economy. This invariably implies that innovations are important factors that may influence the competitiveness of any economy (Durand, M. and Giorno, C. 1987). A further view into the impacts of innovation to the economy would be examined later in the literature. It is also important to note that innovation cuts across from the economy, organizations to the societal levels. Therefore, as innovation is a force of process, it can spring up at any level or place and at any time in space without restrictions. Cooke, P. (2001) noted it as a "Ubiquitous Phenomenon" that is present in both major and incremental technology changes. This phenomenon describes innovation to be fluid in the economic context of it.

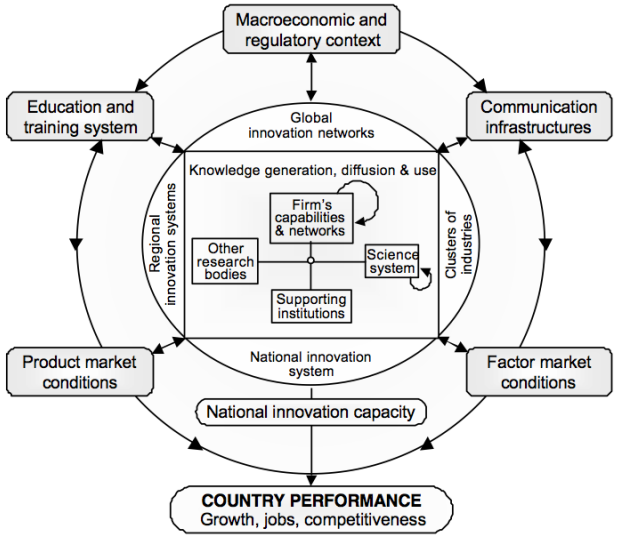
This section focuses on stating the importance of innovation to the development of the economy as captured in the second hypothetical question at the beginning of this chapter. Research evidences show that there are considerable comparable innovation and organizational performance relationship. Though there are lags but there is no concluding tone on specific type of innovations that influence some specific organizational performance, and whether the innovation and organizational performance is a direct influence or influenced by internal and external factors. (Walker, Richard M. 2004). However, research shows that there are considerable impacts of innovation on firm performances; increased corporate performance, improved market position and higher competitive advantage are some of the benefits that accrues from the impact of innovation (Alpkan, L. et al 2011). Several researches have shown positive results of innovation and performance relationship, though with the criticism of the need for more research encompassing the types of innovation against performance (Walker, 2004; Alpkan, L. et al 2011; Damanpour and Evan, 1984; Damanpour et al., 1989; Marcus, 1988; Subramanians and Nilankanta, 1996).

Meanwhile, considering the impacts of innovation on the economy might be a little consuming compared to impacts on an organization. The measurement of innovation on

the economy would encompass the collective impact of the different types of innovation. In other words, the measurement of the economic impact of innovation would encompass the product, process, and technological impacts and the influence of innovation policies and systems. As innovation is a process which is influenced by several factors, it would be of importance to describe how innovation is managed both at the national and regional level. The innovation systems have been researched for over a decade and have been described at different levels. The systems show how innovation has been incorporated and used to enhance the productivity and economic development of different regions and countries based on specific theories and practices. Two of the common innovation systems are the National Innovation System (NIS) and Regional Innovation System. (Lundvall, B. 2004).

According to OECD, innovation concept is a concept that relies heavily on the knowledge flow within and across the boundaries. Studies have shown the breadth and length of the national innovation concept as knowledge flow from individuals like entrepreneurs to firms that have the capacity to reshape and expand them. Knowledge often flow beyond to the government arms, the environments and outside the boundaries of a particular region. The interactions between these different sectors, which includes knowledge flow, leads to innovative outputs. These interactions and network connections are defined in innovation systems as presented in the

Figure 10 below.



Source: OECD, Managing National Innovation Systems, 1999

Figure 10 OECD, Managing National Innovation Systems. (OECD 1999:23)

National Innovation System

Based on the research questions, the influence of innovation in the national economy is of critical importance. This section, therefore, focuses on understanding how innovation is created and diffused in the national system. The national innovation system is an important conceptual framework that encompasses policies and theories that promotes innovation and economic development in developed and developing economies. The system is particularly popular with OECD emphasizing the need for innovation and diffusions as a strategic move for promoting economic development. (Freeman, C., 1995a). A broad-view of this concept in relation to innovations and economy could be found in the throng of the several definitions presented over the years.

The researcher, Metcalfe (1995), defined NIS as a '*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 the innovation process. As such it is a system of interconnected institutions to create, store and transfer the knowledge, skills and artefacts which define new technologies. (Feinson, et al 2003; Niosi, 2001:292)*' The interactions of interconnected institutions give rise to a consolidated networks, which could serve as the backbone of the economy. It is defined as a '*set of institutions whose interactions determine the innovative performance of national firms*' (Feinson, et al 2003:17; Nelson and Rosenberg, 1993). A broader definition was given by Niosi et al (1993) as '*the system of interacting private and public firms (either large or small), universities and government agencies aiming at the production of science and technology within national borders. Interactions between these units may be technical, commercial, legal, social, and financial in as much as the goal of the interaction is the development, protection, financing or regulation of new science and technology.(Feinson, et al 2003:17)*' The definitions distinctly unveiled the broadness of NIS on how it is created and influence the economic policies. Economies could only forge forward by the interactions of the institutions supporting each other. These interactions contribute to consolidating the development and advancement of technologies which directly impacts the economic performance. NIS concept is defined and confined within the national boundary and its systems.

The pioneer work of describing and mapping the boundaries of NIS was carried out by OECD. Its single act of defining and exploring the context of this term opened a gate for the subsequent works of research. The OECD focussed on analysing the interactions and networks of the different sectors involved in building the NIS. OECD describes the NIS to be knowledge-based and an essential commodity to building a reputable and competitive economy as could be seen in the excerpt below.

> *"An understanding of these systems can help policy makers develop approaches for enhancing innovative performance in the knowledge-based economies of today. The smooth operation of innovation systems depends on the fluidity of knowledge flows – among enterprises, universities and research institutions. Both tacit knowledge, or know-how exchanged through informal channels, and codified knowledge, or information codified in publications, patents and other sources, are important. The mechanisms for knowledge flows include joint industry research, public/private sector partnerships, technology diffusion and movement of personnel. (OECD, 1999)"*

National Innovation System is treated with preference in this literature as it is essentially connected to all the key objectives from innovation, policy strategies to the competitiveness of the economies. It is also directly related to the knowledge flow in varying capacities in the economy. Knowledge is practically embedded in human brains as part of the factors of production and it is difficult to transfer without moving people. Considering other important factors (for example, government regulations, institutions and natural resources) that are less mobile, NIS maybe the next available solution.

The strategy used by NIS in promoting economic growth is basically to enhance the nation's innovative and technological capacity. The role it plays in economic development based on the level of development is dynamic. In developed economy, 'NIS serves the role of maintaining or improving an already established level of competitiveness and growth, developing countries are faced with the task of catching-up with the advanced ones. In developing economies, the approach of NIS is dependent on several factors as argued by different researchers like Lundvall (1997), Dahlman and Nelson (1995), Juma et al, (2001) and Viotti (2001). Researchers agreed that based on the technological gap between the developed and developing economies and their absorptive capacities. By absorptive capacities, Dahlman and Nelson (1995) defined it as their *'ability to [acquire,] learn and implement the technologies and associated practices of already developed countries.'*

Profiles of National Innovation System

The profiles of NIS vary for each economy. The variances are dependent on the size of the economy and the robustness of the innovation systems. As the level of development and competitiveness of these economies are relative, their approaches, challenges and capabilities are relative as well. Highly developed economies are tagged to battle with increasing their innovativeness. Their approaches and policies are set to align with optimizing their resources towards this goal. They have an established innovation system, policies and active actors, serving as a basis for further developments. The efficient economies battle to balance their sheets between adoption of foreign technology and translating into innovation-provider. Their innovation systems battles with building a strong science-technology base. As they build onwards in copying and adapting foreign technology, they are expected to work towards affirming their position in technology innovation. (OECD 1999)

National innovation system is a framework that is driven by knowledge flows between the actors through the different routes as indicated in the innovation systems diagram above. The effectiveness of National Innovation System is founded on a smooth connection and interrelationship of the actors. The main actors are the state government, firms, research-based bodies and individuals. The factors that influence policies and decisions are the microeconomic environment, communication infrastructures, factor and product market conditions, and education and training systems. Detailed descriptions of this system can be found in the economic growth models in Uenera, S and Sarido, E (2011).

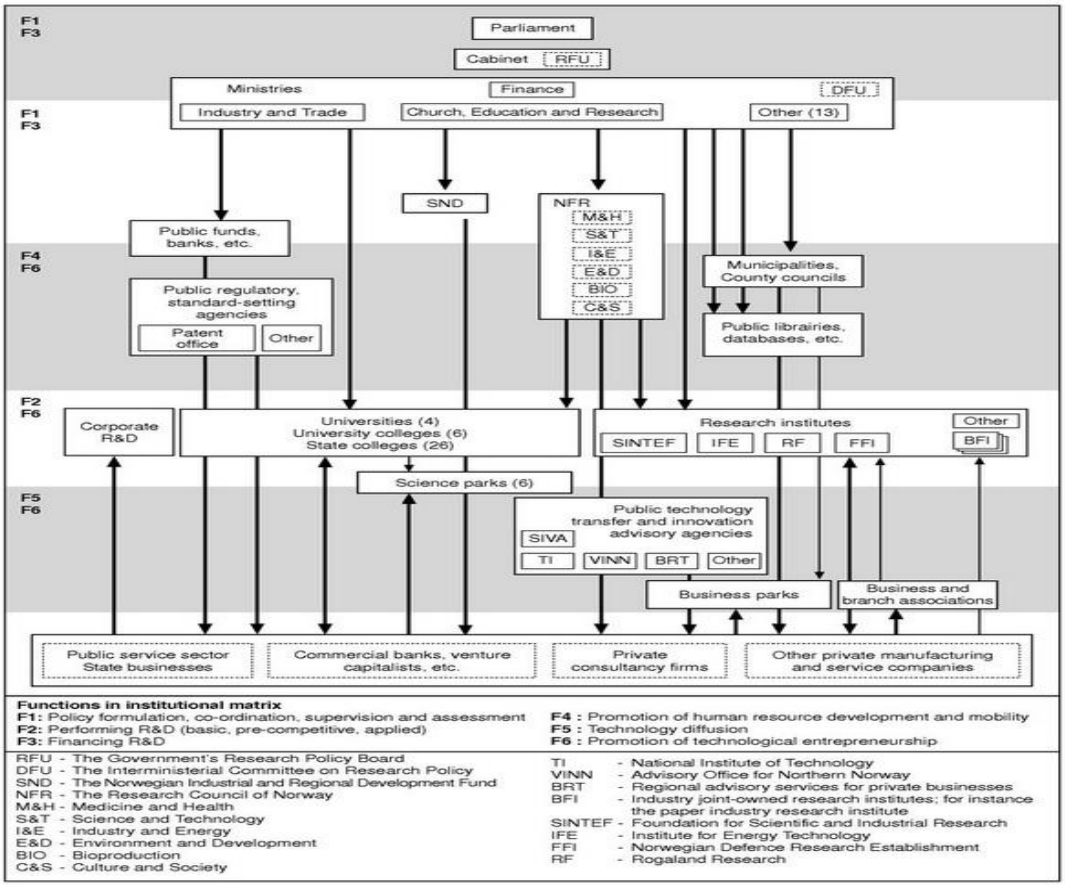


Figure 11 The Australian System of Innovation – Organizational Structure.(OECD 1999:28)

The Australian innovation system in the Figure 11 above shows a broad description of the innovation organogram. The national organogram in Australia is definitely different from others but yet it contains the major blocks needed to perform effectively. The institutional matrix in the first section contains government arm that formulates general policies, co-ordinates, supervises and assesses the conditions of the innovation systems per time. It is burdened with the function to ensure that government policies function properly. Its function includes coordinating a systemic flow of information between the ministries to improve efficiencies. The second layer performs R&D, the third deals with financing R&D, the fourth performs the bridging role by promoting human resource development and mobility, the fifth deals with ensuring technology diffusion and the sixth is the hub for private and business operation activities. (OECD 1999)

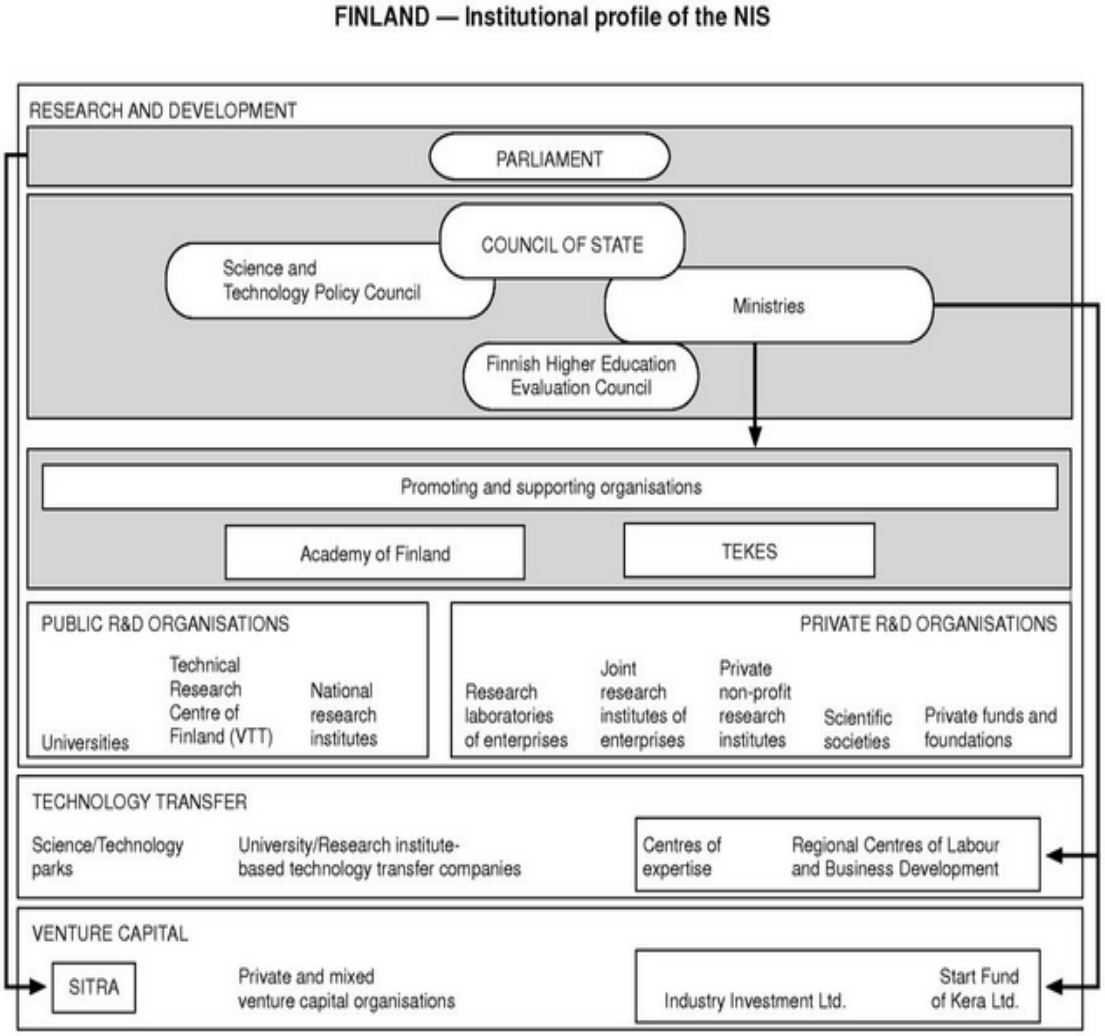


Figure 12 The Finnish System of Innovation – Organization Structure. (OECD 1999:106)

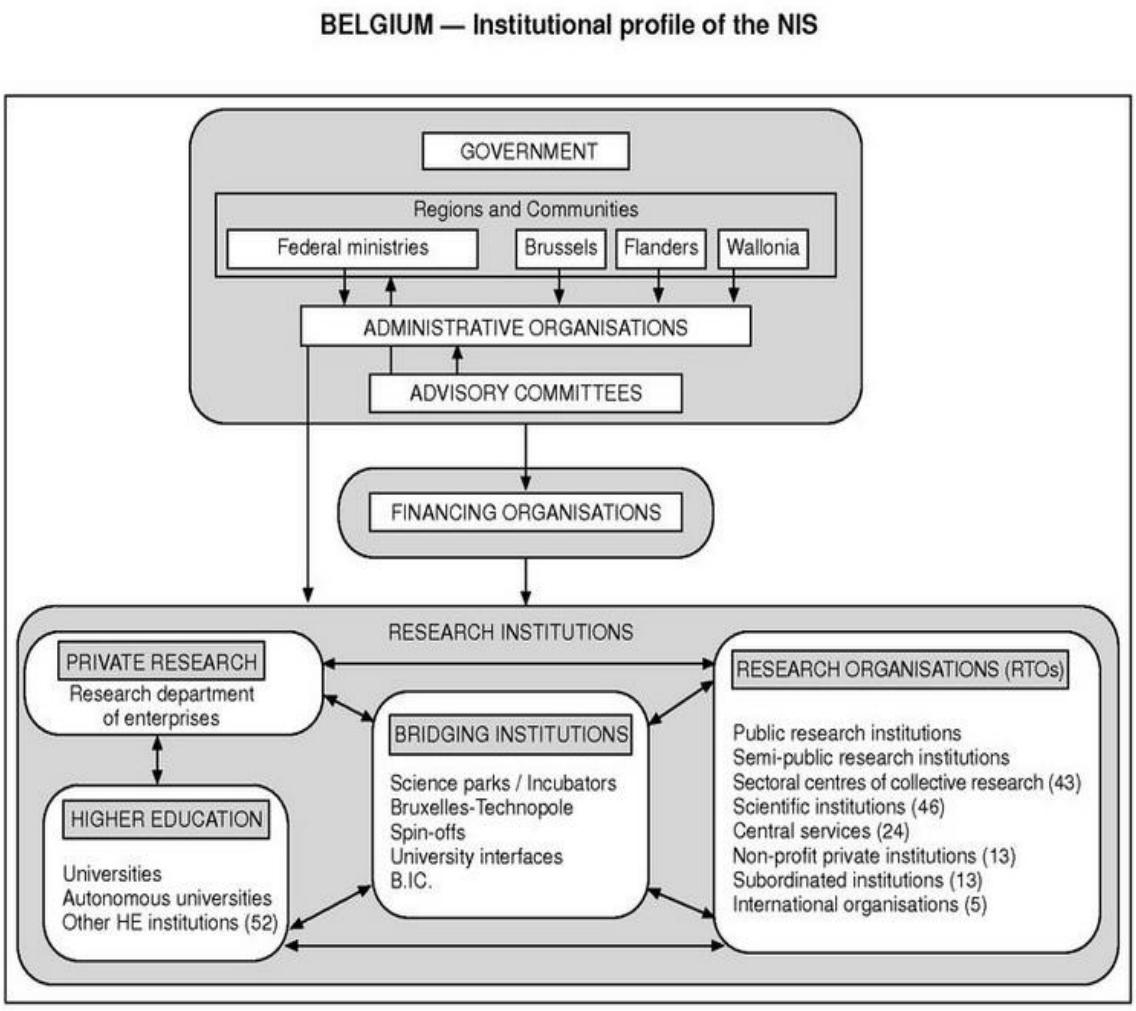


Figure 13 The Belgium System of Innovation – Organization Structures. (OECD 1999: 105)

Finland and Belgium national innovation systems' organogram (Figure 12 & Figure 13) gave a easier and direct approach to the actors influencing the innovation system. The innovation systems show a well categorised organogram. The first stage contains the policy and decision making sections. The section is practically government section arm. The government sections are clearly divided into subsections that deal with making general policies, science and technology, and academic related policies. In the Belgium innovation system, the second section is the financing organization. The final section deals with the research institutions, comprising of the private research, higher education, bridging institutions and the research organizations. The Belgium innovation system is simple and fascinating. It shows the actors with subheads they are directly responsible for.

These organograms explains how the innovation system works in a particular country. Though, innovation systems in each country are not the same based on factors such as the innovation history of the country, healthiness and effectiveness of the government, the stage of their development among others. An effective innovation system is the system that facilitates and ensures a constant and smooth flow of knowledge and collaboration among the actors of the system.

2.3 Industry/Institute Collaboration

The Energy Biosciences Institutes: The EBI was the result of institute-industry collaboration aimed at developing innovative solutions for a new sustainable biofuels and reducing the impacts of fossil fuels on global warming. The innovative institute was a collaboration between BP and three university partners (University of California Berkeley, University of Illinois Urbana-Champaign, and Lawrence Berkeley National Laboratory). The creation of the EBI has led to creation of new multidisciplinary field of study in the universities. This field is called 'Energy Biosciences'. This field has opened up new focus on researches and funding for the institutes. The collaboration has not only disrupted the traditional learning fields but also provided new source of funding, research focuses, new multidisciplinary streams of learners, new strategy to tackle the impact of fossil fuels on the global warming. With the collaboration funded with a 10 year $500 million grant, it therefore called for a purposeful and dedicated attention from both partners with a desire for innovative solutions. (Belfield et al, 2012)

Imperial Innovations: A fantastic story of a collaboration that has yielded enormous funding through its interaction between university and spin-outs. The Imperial Innovations is known as Imperial Innovation Group Plc founded in 1986. Imperial innovation was originally a section of the university carved out to handle and monitor technology transfer. Invariably, it deals with technological research outputs and commercialization of the innovations spinning out of the endeavours. This little arm of the university has grown today to be a private listed company on the stock market. The goal of this university arm was simply to help new technological growths to become a

sole sustaining private company. It has collaboration with over 80 companies and the Imperial University College. Recently, it has expanded to combine collaborations with other sound research centres increase its investments agenda. It has collaborations with partners like GlaxoSmithKline, Cambridge Enterprise, Oxford Spin-out Equity Management and UCL Business.

Among the many benefits of these collaborations include 2010 trade sale of RespiVert with gross earning of £9.5 million, Ceres Power Holdings with gross earning of £4.8 million, Thiakis with potential returning earning of £16.1 million as at 2008. In 2011, the group's asset value equalled £224.1 million, by 2012, the group has generated up to £20 million in returns from investments. The Imperial Innovation, once a technology transfer office of Imperial University College, specialized in dealing with new innovations and commercialization is now a self-funding public listed private company with a partial funding for the college and several industrial partners. Collaborations of institute and industries can be a substantial source of stream generation for the university partners in the collaboration. (Belfield et al, 2012)

California Institute for Telecommunications and Information Technology: The institute-industry collaboration has become the platform for research innovations and multinational collaborations. The California institute orchestrated itself as the strategist to bring this ideology to life. With a meaningful support from within and outside, the collaboration has become a hub for research, innovation jump-start and funding ground for further advancement. This collaboration includes the state of California, University of California and the industry partners. The resultant is known today as the Calit2. The Calit2 is now the platform for public-private partnerships, and supports about 1000 researchers and 300 industrial partners. It generates funding for the university campuses, provides long term research for industry partners that cannot be performed by them, and a platform for collaborations with other interested partners.

The benefits of Calit2 today are immense. It has supported several spin-outs, generated federal funding for research students and campuses of about $600 million, construction of the first nanotech clean room facility. The facility has been recorded to be a generous income provider. Institute-industry collaboration can definitely serves as the game-changer by shaping the structure, strategy and fundamentals of the university.

Universities can become the platform for industries to collaborate, expand their knowledge and research depth and innovation capacity, while still retaining their traditional learning centre for young minds. (Belfield et al, 2012)

Benefits Of Industry/Institute Collaboration

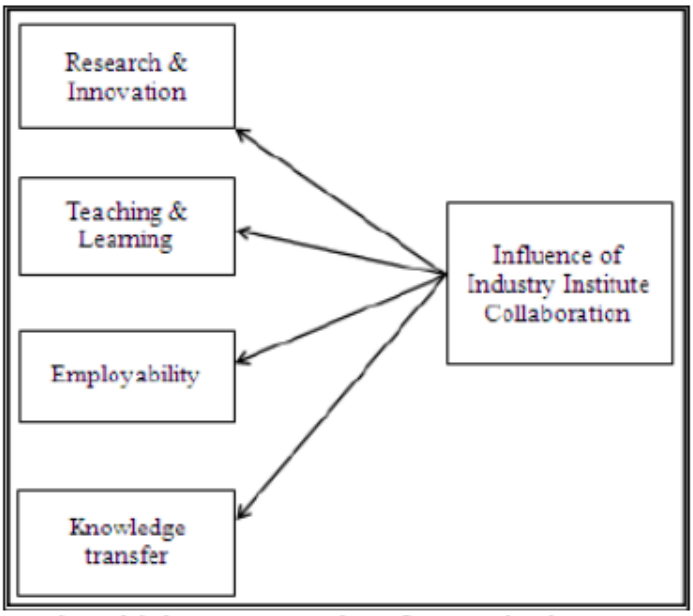


Figure 14 Conceptual model that represents the influence of industry – institute collaboration (Prasad, Shiva et al 2014).

The benefits of the collaboration between industry and institutions are numerous. The main positive influences are displayed in Figure 14 and explained further below.

Research & Innovation: Institutes conduct researches to unveil new knowledge and innovations that are relevant to the academia while industries embark on weighty researches that lead to patented innovations bringing profits to the organization. Institutes need funding to enrich and expand their researches and industries need new innovative solutions and minds to become more competitive and more profitable. The collaboration of these two partners leads to a commendable synergy when well-coordinated. Institutions get funded; apply their latent knowledge to solve industries' problems as well as bringing up new innovations. The industries get a boost towards

accelerated innovative solutions, access to young innovative minds from the academia and institute-industry partnership. (Borate et al, 2014)

Teaching & Learning: The partnership serves as a bridging conduit that facilitate the subway to meeting shortages of cross-disciplinary graduates that fits into the job requirements upon graduation. The collaboration bridges the gap existing between the fundamentally acquired knowledge in the school and the application capability of these knowledge by the same graduates. Collaboration opens up new degree programmes by modernizing the academic curricula. Engaging the capabilities of industry's experts to redefine the skill sets needed by the students and diving into new areas of research with impacts on the industries. New styles of teaching are introduced whereby the students receive experiential learning – learning by doing. They learn and practice it on real life scenarios. Working with industry experts and experiencing the working environment conditions, the students are oriented to a working condition approach. (Borate et al, 2014)

Employability: The collaboration serves as an avenue for direct employment for the graduates. Graduates of such programmes acquire skills that are directly employable due to the company projects and real life problems they have dealt with. Recruiters and company human resources do battle with miss match of qualities and job requirements with graduates of the traditional learning methods as compared to experienced graduates from the institute-industry collaboration. (Borate et al. 2014)

Knowledge Sharing: There is a large magnitude of knowledge sharing between the institutes and industries during collaboration. Knowledge extensively gathered by the industry partners through research and development are disseminated through projects. Institutes do enjoy software and data licences, and access to industrial equipment in the institute's labs. Formation of ventures and spin-off companies, delivery of seminars by industrial staffs, research collaborations and student job placement or internships are among the many other means through which knowledge is being disseminated. (Borate et al, 2014)

2.4 Technology Transfer

There is likely no concrete competitiveness without a technology supplement. The advanced economies associated with most innovative economies or highly competitive economies are those that have marginalised the use of technology. Technology is a basic factor that promotes development of an economy. The structural advancement of a region can also be hinged on their technological inclinations. From the advanced rail systems in Germany to the high speed rail systems in China, the multi-sky tower structure in Dubai, the submarine war engines, the oil refinery production edifices to the pocket calculator are all samples and output capabilities of technology. Technology rates of adoption have also been studied to be one of the main determinants of income disparities among nations. (Diego A. Comin, 2004). The transfer of technology is of critical importance to the rate of productivity by that economy. Economies that are opened and liberal to the use of newer technologies advance at a faster rate than their counterparts. Internet connectivity can be a direct example of this. The OECD internet economic outlook (2012) analysed the significance of the expansion of the internet on the economy. It has been a key economy driver as businesses connect and increase their productivity. Many national economies generate a high level of their GDP from the ICT sector. Finland and Korea generates over 1.5% of their GDP from the ICT sector. While other sectors are directly and indirectly connected to different forms of technology for enhanced productivity.

Technology transfer is a process that originates from different angles. Technology originates usually as an innovative idea, to experimentation and eventual real products. Transfer can occur between laboratories to laboratories, laboratories and business organizations, organizations and organizations, organizations and government departments. The university-industry collaboration is one solid example of the platform for technology transfer. Karolinska Development of Karolinska Institute Sweden and the Imperial Innovation Group Plc, the technology transfer office of Imperial University College UK are clear examples of technological transfer offices and spin-outs. (Roman, Gurbiel 2002)

Actors Of Technology Transfer

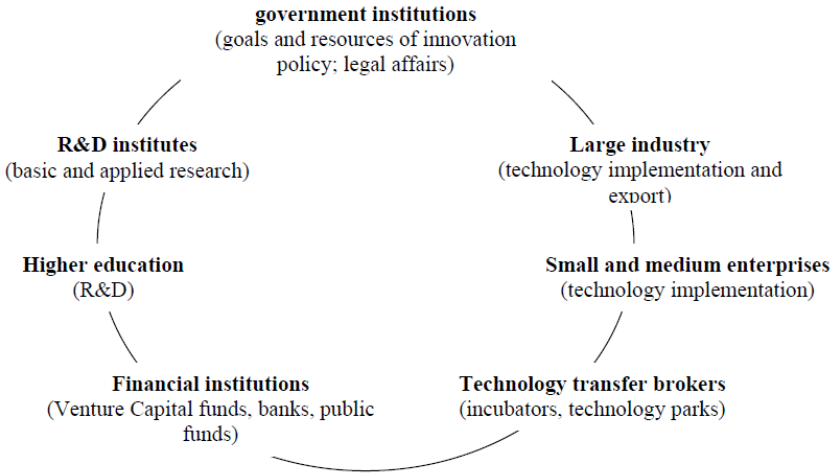


Figure 15 Technology transfer and innovation system participants (Roman, Gurbiel 2002:5).

The technology transfer actors are clearly indicated in Figure 15 above. They can be briefly divided into four sectors.

The Innovators: The innovators are the actors that dive into the research activities of generating ideas, filtering and conducting extensive research to develop a market viable innovation. They conduct basic and applied research either as academic or industries. These are the R&D institutes and the Higher Education.

Government Institutes: Government institutions are generally saddled with the responsibility of defining the policies that conditions the technology atmospheres. They deal with the legal affairs and setting up the boundaries for the sectors. They intervene to provide resources as needed by the other players to ensure a smooth running of the technology transfer business.

Industry Partners: The industrial actors engage in technology transfers for the benefits to be accrued. The industry deals with either the commercialization of the technology through sales and lending or buying for usage. This group of actors include multinational corporations, small and medium enterprises, and individual businesses.

Financial Institutions: Every investment needs financial guarantee for implementation. Many of the enterprises involved in the implementation of these technologies rely on the assuring power of their financiers. The financial institutions play a very crucial role in facilitating business operations and ensuring investments. These are the venture capital funds, banks, public funds.

Other: This group contain all the other players that are not included earlier. They are usually the technology transfer brokers. They consist of incubators and technology parks.

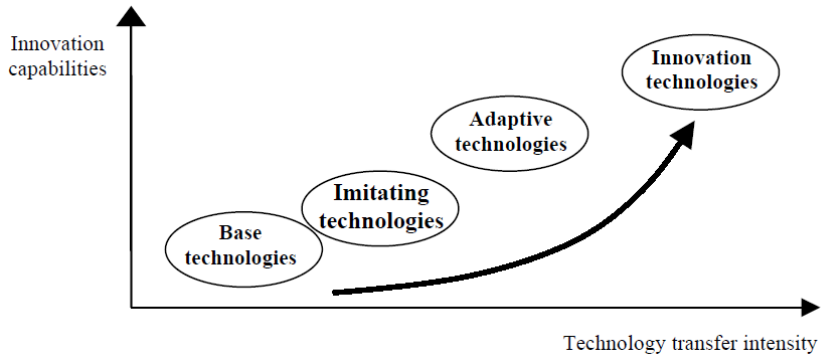


Figure 16 Interrelationship between investment flows and technology transfer (Roman, Gurbiel 2002:7).

The rate of technology transfer of an economy is reflected by its innovation capabilities as shown in Figure 16. The innovation capabilities are categorised into four sections namely the base technologies, imitating technologies, adaptive technologies and innovation technologies. As economies grow, they advance through the different stages of the innovation capabilities. When economies are at the base technologies, they are mostly resource based, lack the basic technical capabilities and have low productivity rate. Technology transfer to those economies is the base technologies due to the wide knowledge gap from the advanced economies. The economy has to be brushed up by improving its academic institutes and other infrastructural features to increase knowledge. At the imitating technology level, the economy is crowded by workforce with high school level graduates with basic knowledge to operate technological processes. There would be more inflow of technologies to the economy but not the latest of advanced technologies. The basic capabilities of the workforce could lead to

developing copies of the imported technologies. Progressing from the level of imitating technologies, then the economies can easily adapt advanced technologies into their economies to improve productivities. These economies are denoted as the efficient economies and could as well be a transition economy. These are economies with established institutions and literate workforce with good capabilities. Such economies are already developing innovative products but at slower rates when compared to the more advanced economies. The innovation economies are deemed the technology developers. Their economies are based on innovative strategies to drive competitiveness. Majority of their revenues are generated from innovation services. (Roman, Gurbiel 2002)

3 METHODOLOGY

3.1 Data Design

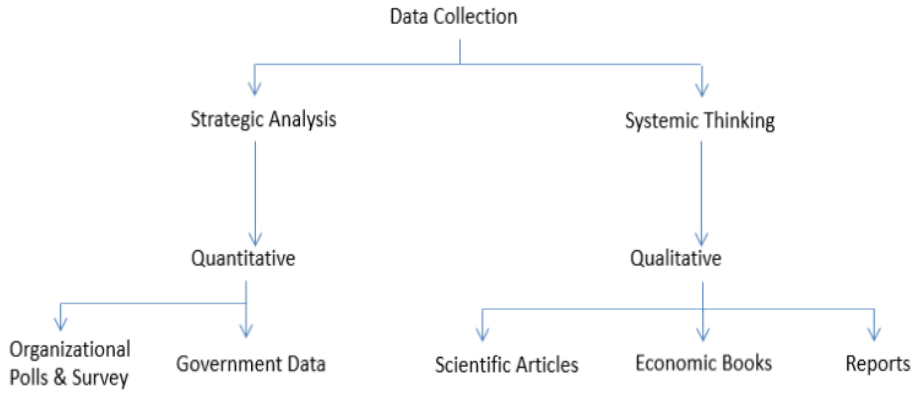


Figure 17 Data Design Organogram.

Figure 17 shows the systemic structure of the data collection, collation and analysis as used in this report. The two major approaches were the qualitative and quantitative methods. The collected data were approached with the consciousness of the set targets. Though, the targets were not conclusive before the collection of the data as the obtained data were not exact with the initial goal. The dataset were collected with the goal of analysing and measuring the impact of technology innovation on the economy. The target included a variety of initial factors that were eliminated due to insufficient and/or unavailable data. The data processing generally followed a systemic pattern as is highlighted in the figure above.

Data were generally collected in a large amount using the Microsoft Excel software. The collected data included gross domestic product, GDP per capita, number of patents filed, percentage of research and development, percentage of higher education enrolment, list of countries, value of imports and exports, foreign direct investment inflows and outflows, percentage of employment, industries contribution to GDP, years of adoption of technology specific products, stage of development, basic requirement sub index, efficiency enhancer sub index, innovation and sophistication factors and list of countries among many others.

The data were strategically analysed based on the parameters given and the conditions associated with them to consider their suitability for the analysis. The data gathered were quantitatively confined. The data were filtered by removing and erasing of insufficient and unavailable data from the list. The process was repeated for many innumerable numbers of times due to insufficient or unsuitable data gathered over time. The qualitative analysis of the data were comprised of systemic thinking broadly gathered through article reviews, organizational reports and economic books mostly that dealt with the role or impact of technology on the economic development. Additional resources were from other organizational reports with similar descriptions.

3.2 Data Sources

This report employed the use of quantitative analysis approach to define the impacts of technology on the development of an economy and some of the factors necessary for achieving the process of development. Quantitative approach was selected as a means of descriptively showcasing its importance to the economy. In the bid to actualise this against time factor, pre-existing research surveys, opinion polls and data were analysed and the most suitable were selected. The secondary data gathered are a result of the comparison of data from government and private research institutions. The dataset were gathered from four main sources but those were the results of several analysis and referencing from other sources. The four main sources of data gathered are described below:

Organization for Economic Co-operation and Development (OECD): The OECD was established in 1960 by fourteen member countries and has since been expanded to thirty-four countries. The organization seeks to monitor and analyse the macro-economic environments through '*policies having a potential to improve the economy's long-run performance (OECD 2016)*.' The organization annually monitors and conducts economic surveys on member countries and major non-member countries to define *'links between structural policies in these areas and macroeconomic performances*.'

Data are generally gathered from surveys and government archives for analysis and policy developments. (OECD Home, 2016)

Global Innovation Index: The GII committee was founded in 2007 and it is a key leader in innovation reference. It releases annual reports that focus on ranking the world's economies on innovation capabilities and results. The GII helps to create an environment in which innovation factors are continually evaluated. *'It provides a key tool and a rich database of detailed metrics for 141 economies this year, which represent 95.1% of the world's population and 98.6% of global GDP.(GII Home, 2016)'* The GII reports is focused on two sub-indices; the innovation input and the innovation output.

Pew Research Centre: It is a subsidiary of Pew Charity Trust and was established in 2004. It is committed to undertaking different research projects across several views by *'conducting public opinion polling, demographic research, content analysis and other data-driven social science research.'* (Pew Research Centre, 2016).

World Bank Group: The World Bank was established in 1944 and is comprised of five institutions. The group is committed to helping developing economies for policy advice, research analytics, and technical assistance. It majorly supports financing and capacity development in these economies. One part of its generous offerings is the provision of development data, from which substantial data were drawn for this report. (World Bank 2016)

The data collection process was roughly guided by the estimation of the expected outcome. The outcome is weighed against the research objectives which serves as the targets for the data collected over time. The targets are listed below

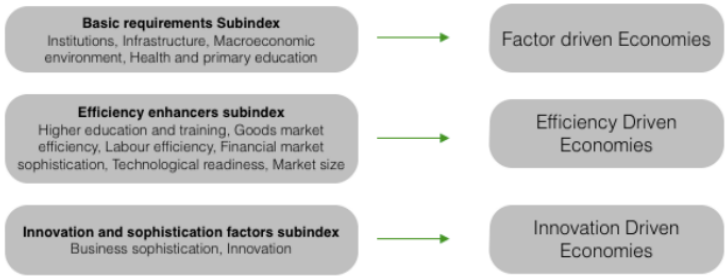
I. To understand and categorise the economies into their respective stages of development.
II. To compare and contrast the relationship between the innovation input factors and the stages of economic development.

III. To analyse possible influence of the innovation input factors on the output innovation factors.

IV. To analyse the relationship between the technology usage and economic development.

V. To compare and analyse the impact of technology innovation on the different economies.

3.3 Data Sets And Description



	STAGES OF DEVELOPMENT				
	Stage 1: Factor-driven	Transition from stage 1 to stage 2	Stage 2: Efficiency-driven	Transition from stage 2 to stage 3	Stage 3: Innovation-driven
GDP per capita (US$) thresholds*	<2,000	2,000–2,999	3,000–8,999	9,000–17,000	>17,000
Weight for basic requirements subindex	60%	40–60%	40%	20–40%	20%
Weight for efficiency enhancers subindex	35%	35–50%	50%	50%	50%
Weight for innovation and sophistication factors	5%	5–10%	10%	10–30%	30%

Figure 18 Economic competitiveness index (GCR 2014)

Figure 18 above defines the criteria analysed to assign countries into respective stages as deemed fit. The data in Figure 18 was an excerpt from Global Competitiveness Report 2014 edition. According to the data, there are five stages of development, but three major stages of development (stage 1: Factor-driven, stage 2: Efficiency-driven, and stage 3: Innovation-driven) and two transition stages (stage 1 to stage 2 and stage 2 to stage 3). The weights of the parameters for the stages of development are different from each other. The parameters are weighed to define the relevant factors as related to the stage. Stage 1 (factor-driven economies) are defined as those that rely heavily on mineral resources and unskilled labour. These economies generate GDP per capita less than US$2000, with priorities on developing factors associated with basic requirements sub index, followed by a less than average percentage share on the efficiency enhancers

sub index. These economies are innovation consumers, characterised by high mineral exports and technology imports. Economies in the transition from stage 1 to stage 2 are factor-driven with a higher GDP per capita between US$2000-2999, improved production efficiency.

Stage 2 (efficiency-driven economies) are economies that are more competitive and have higher productivity. Such economies are more developed and their competitiveness are driven by factors as higher education and training, well-functioning labour markets, efficient goods market, developed financial markets, technological readiness and a large market. Efficient economies do not only consume innovations but also invest in replicating foreign technology. Stage 2 development is characterised by a higher GDP per capita between US$3000 – 8999, focus on efficient production processes and competitive product quality, prioritize factors in both basic requirements sub index and efficiency enhancers sub index and are technologically improved. Transition from stage 2 to stage 3 development include economies with higher GDP per capita between US$ 9000 – 17000, well developed factors of the efficiency enhancers sub index and are redirecting more resources towards innovation.

Stage 3 (Innovation-driven economies) are the advanced economies burdened with higher wages and higher standard of living. Income from efficient production is insufficient to cover costs and need additional means of revenue generation. This stage is characterised by GDP per capita greater than US$ 17000, with priority towards innovation and sophistication sub index factors. These economies are innovators and do have high technology exports.

Table 1 is being analysed in the light of Figure 18. The data were gathered from the Global Competitive Report (2014-2015). The table is directly replaced with data of countries that fall into the different categories. Stage 1 economy is represented by Nigerian economy, stage 1 - 2 by Honduras, stage 2 by China, Stage 2 – 3 by Malaysia and stage 3 by Switzerland. The values are rated between 1 and 7, with 7 being the highest value that could be assigned. The GDP per capita thresholds are consistent with fig 2. Nigeria in stage 1 of the development has a value less than US$ 2000, China has a value of US$6 747 that falls appropriately between US$ 3 000 – 8 999 and Switzerland with US$ 81 324. The GDP per capita indicates each category as mentioned earlier.

Table 1 Stages of development. (GCR 2014)

	Stage 1 Score (1-7)	Stage 1 to stage 2 Score (1-7)	Stage 2 Score (1-7)	Stage 2 to stage 3 Score (1-7)	Stage 3 Score (1-7)
	Nigeria	Honduras	China	Malaysia	Switzerland
GDP per capita (US$) thresholds	1 692	2 323	6 747	10 548	81 324
Basic requirements sub index	3.2	4.0	5.3	5.5	6.2
Efficiency enhancers sub index	3.9	3.6	4.7	4.9	5.5
Innovation and sophistication factors	3.3	3.6	4.1	5.0	5.7

In the basic requirement sub index, Nigeria has the least value (3.2) below the average and Switzerland with the highest value (6.2). Nigeria clearly has to focus priority on developing these factors that improve its competitiveness. Nigeria according to the stage of development heavily rely on mineral resources to generate revenue, which is in line with the current state of the economy. Honduras falls between stage 1 and 2 and shows strength and readiness to advance to the next stage of development, thereby associated with being in transition. China is currently an efficient economy with focus on efficient production and processes, improved basic requirement like infrastructure. Malaysia in transition stage 2 – 3 has a value slightly higher than China. While Switzerland in stage 3 is an advanced economy with the basic and efficient requirements developed, thereby having a higher value than its companions.

China and Malaysia are two economies that belong to the efficiency enhancer stage 2 of the development. China, an efficiency-driven economy, has a slightly lower value less than Malaysia (4.7 to 4.9). Their figures indicate they have both reached the level to improve their competitiveness to the next level. When compared with Switzerland, the efficient-driven economies have a little improvement to cap on. By the economic profiles, the economies should be stronger in efficiency enhancers' factors. Clearly they all performed significantly well but Switzerland stand tall.

In the innovation and sophistication group, Switzerland stand out having taking the first position for about 6 years in a row. Economies in this category are concerned with increasing their revenues by improving their productivity, hence their competitiveness. They are innovation developer and generate revenue through advanced innovation process. Their advanced technological outputs compete at the highest level of quality. While others are trailing behind, they compete at high level of exportation. From table 1, innovation capacities are progressive from the first stage to the third stage of development.

Table 2 Innovation Factors. (GCR 2014, GII 2015 & World Bank (2014)

Countries	Stage of Development	GDP per Capita)(2014)	Higher Education (%Enrolment) (2014)	Higher Education (%GDP) (2014)	Domestic Patent App (2013)	R&D Expenditure (% of GDP) (2014)
Uganda	1	714,6	4,4	3,3	0,1	0,6
Senegal	1	1067,1	7,6	5,6	n/a	0,5
Kenya	1	1358,3	4	6,6	1	1
Pakistan	1	1316,6	9,8	2,5	0,2	0,3
Ghana	1	1441,6	12,2	8,1	n/a	0,4
Philippines	1-2	2872,5	28,2	2,7	0,3	0,1
Nigeria	1-2	3203,3	10,4	0	0,1	0,2
Bolivia	2	3124,1	37,7	6,4	n/a	0,2
Egypt	2	3365,7	30,1	3,8	0,7	0,7
Indonesia	2	3491,9	31,5	3,6	0,3	0,1
El Salvador	2	4120	25,5	3,4	n/a	0,0
Tunisia	2	4420,7	36,2	6,2	0,9	0,7
Jordan	2	5422,6	46,6	0	0,5	0,4
South Africa	2	6483,9	19,7	6,2	0,9	0,8
China	2	7590	26,7	0	13	2,1
Lebanon	2-3	10057,9	47,9	2,6	n/a	n/a
Mexico	2-3	10325,6	29	5,1	0,6	0,5
Malaysia	2-3	11307,1	37,2	5,9	1,7	1,1
Turkey	2-3	10515	69,4	2,9	3	0,9
Brazil	2-3	11726,8	25,5	5,8	1,5	1,2

Argentina	2-3	12509,5	80,3	5,1	0,7	0,6
Russia	2-3	12735,9	76,1	4,1	n/a	1,1
Chile	2-3	14528,3	74,4	4,6	0,9	0,4
Sweden	3	58898,9	70	6,8	5,4	3,4
Finland	3	49842,7	93,7	6,8	7,3	3,5
Singapore	3	56248,3	0	2,9	2,6	2
Switzerland	3	85616,6	55,6	5,3	3,3	3,1

Table 2 above contains data on 27 countries. The countries are characterized by six different factors of innovation. Data on stage of development were obtained from GCR 2014, GDP Per Capita from World Bank archive (2014) while the rest of the data were from Global Innovation Index (2015). Some of the data are noted 'n/a' which means that the data are not available and/or offset the boundaries of logic. The countries listed conform with the description given earlier for description to stage of development. The first five rows are economies in the first stage of development (Uganda, Senegal, Kenya, Pakistan and Ghana), next two by economies in transition from stage 1 to stage 2 (Philippines and Nigeria), followed by the eight economies in the stage 2 of the development (Bolivia, Egypt, Indonesia, El Salvador, Tunisia, Jordan, South Africa and China). Economies in transition from stage 2 to stage 3 include Lebanon, Mexico, Malaysia, Turkey, Brazil, Argentina, Russia and Chile. Finally, the table included four advanced economies (Sweden, Finland, Singapore and Switzerland).

The GDP per capita, to be explained later, defines the income level of the economies. The income level of the economies are observed to be increasing steadily as explained earlier, with Uganda generating US$714.6, while Switzerland generates US$85 616.6 as reported by the World bank 2014. The higher education enrolment data collected is to be tallied against the income level to analyse if there is any relationship between the two. The domestic application patent data is to be measured against the R&D expenditure data to analyse if the expenditure on research and development influences the outcome in the patent applications. Below are the descriptions of the factors of innovation noted in the table above.

GDP Per Capita (2014): The term refers to the total value of the gross domestic product generated in an economy divided by the average population of the country. GDP per

capita is also used to measure the standard of living in a particular economy. It can also be used to compare the rate of performance of economies with each other. According to Statistica 2016, Luxembourg has the highest standard of living (GDP per capita) of US$104 359.32, followed by Switzerland, Norway and Qatar. In the table above Switzerland has the highest with Singapore, Sweden and Finland following trail. Likewise, Uganda, Senegal and Kenya has the least GDP per capita in the table above. Per capita as a term refers to the average individual income generated in an economy.

Tertiary Enrolment(% gross): This column refers to the percentage of enrolment of persons in higher education in a particular economy. The enrolment includes those enrolling into science and engineering, economics and business. This factor has been used to indicate the rate of literacy at this particular level in a country and how it correlates with the income level of the workforce.

Domestic Patent Application (2013): This column refers to the number of patent applications filed in the patent offices in a particular jurisdiction or country as the case may be in order to protect the exclusive rights of the inventors to commercially exploit the invention for a period of 20 years. According to GII (2015), Patent is defined as *'set of exclusive rights granted by law to applicants for inventions that are new, non-obvious, and commercially applicable.'*

R&D Expenditure (% of GDP): This term defines the total amount of expenditure invested in research and development in particular economy as a percentage of the GDP irrespective of the source of funds. There are different sources of expenditure on R&D, this can be private or public. In well advanced economy, private sector bears the higher percentage of the investment. R&D investment has been taken into note in this table as an input to generate different kinds of innovations like process innovation, product innovation and substantial improvements on existing technologies. Thereby, it is tallied with the domestic patent application to determine their correlations.

Table 3 below is a description of the correlation between technology usage and the income level of different countries. The table seeks to analyse if technology usage has

any positive or negative influence in the income level of the economy or vice versa. The GDP per capita simulates the income level of the economy while the three factors in the columns represents the three different technologies measured with. The first three columns containing GDP Per Capita, Mobile Subscription and Internet Use were gathered from the World Bank archive (2014) while Social Networking and Smartphone Ownership were collected from Pew Research Center (2015) report.

Table 3 Relationship between Technology Usage and Income Growth. (World Bank, 2014 & Pew Research Center, 2015)

Countries	GDP Per Capita	Mobile Subscriptions	Internet use	Social networking	Smartphone Ownership
Uganda	714,6	52	17,7	7	4
Senegal	1067,1	99	17,7	25	13
Kenya	1358,3	74	43,4	28	19
Pakistan	1316,6	73	13,8	4	3
Ghana	1441,6	115	18,9	20	15
Philippines	2872,5	111	39,7	30	17
Nigeria	3203,3	78	42,7	28	19
Bolivia	3124,1	96	39	32	12
Egypt	3365,7	114	31,7	38	23
Indonesia	3491,9	129	17,1	19	11
El Salvador	4120	144	29,7	21	11
Tunisia	4420,7	128	46,2	34	12
Jordan	5422,6	148	44	40	38
South Africa	6483,9	149	49	27	33
China	7590	92	49,3	26	37
Lebanon	10057,9	n/a	74,7	41	45
Mexico	10325,6	n/a	44,4	35	21
Malaysia	11307,1	149	67,5	37	31
Turkey	10515	n/a	51	32	17
Brazil	11726,8	139	57,6	36	15
Argentina	12509,5	159	64,7	51	34
Russia	12735,9	155	70,5	57	23
Chile	14528,3	n/a	72,4	50	39

Mobile Subscription (100): The first indicator is the mobile telephone subscription per 100 people. The indicator measures the number of mobile subscriptions in a 100 people that are been used within the last three months of measure. The subscription provides access to mobile cellular services that include prepaid and post-paid services with offerings including voice communications. The mobile telephone subscriptions are to be tallied with the income level to see any correlation between them. Results would be shown in the result chapter. (World Bank 2016a)

The Internet Use: This indicator follows similar pattern as the mobile cellular subscription. It measures the amount of internet subscription in a number of people (100) that have been used in the preceding 12months to measure. The figure in the table shows a particular ascending trend in the number of people measured. (The World Bank 2016b)

Social Networking: The data for social networking represents the number of people that uses social network technology platforms in a particular economy. Is the use of social networking mildly correlated with the income level of the user? Does it have any influence either increasing or indifferent to the income generated by the user? These questions are to be assessed as the values of the social network are to be tallied with the GDP per capita and analysed in the succeeding analysis.

Table 4 below represents the impact of technology on the competitiveness of the economy. All the data, employment rate (%), industry (%GDP) and FDI Net Inflows, were collated from the World bank 2014 archive. The competitiveness of the economy is measured here in the rate of employment associated with manufacturing industries. The employment rate per country indicated in the table are combinations of the employment rate for both men and women within the capable workforce and are typically employed in manufacturing industries.

Table 4 The Impact of Technology On The Economy. (World Bank, 2014)

Countries	Employment rate (%)	Industry (%GDP)	FDI, Net Inflows (US$ bn)
Pakistan	40	20,9	1,78
Ethiopia	15	14,7	1,2
Philippines	29	31,4	6,2
Azerbaijan	28	58,3	4,43
Honduras	38	26,4	1,29
Armenia	34	28,6	0,4
Bulgaria	60	27,2	1,97
South Africa	44	29,5	5,74
Malaysia	53	40	10,61
Hungary	59	31,2	12,4
Chile	44	35,1	22
Finland	44	26,5	14,8
Singapore	36	24,9	67,5
Switzerland	39	26,3	22,7

The second column indicates the total value that is contributed by the industry in percentage to the total GDP generated in the economy. It is noted that there is a substantial percentage inflow to the economy through the industries. The third column represents the total foreign direct investment inflows to the economy as resultant effect of manufacturing industry measured in US$ billion. Foreign direct investment refers to individuals or companies of one country making direct investments in production or business in another country. It can also take a form of capital, reinvestments of earnings and other capitals. According to World bank (2016c), it is a 'category of cross-border investment associated with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy, with ownership of 10 percent or more of the ordinary shares of voting stock.'

4 RESULTS

4.1 Relationship between Innovation Factors (Input vs Output)

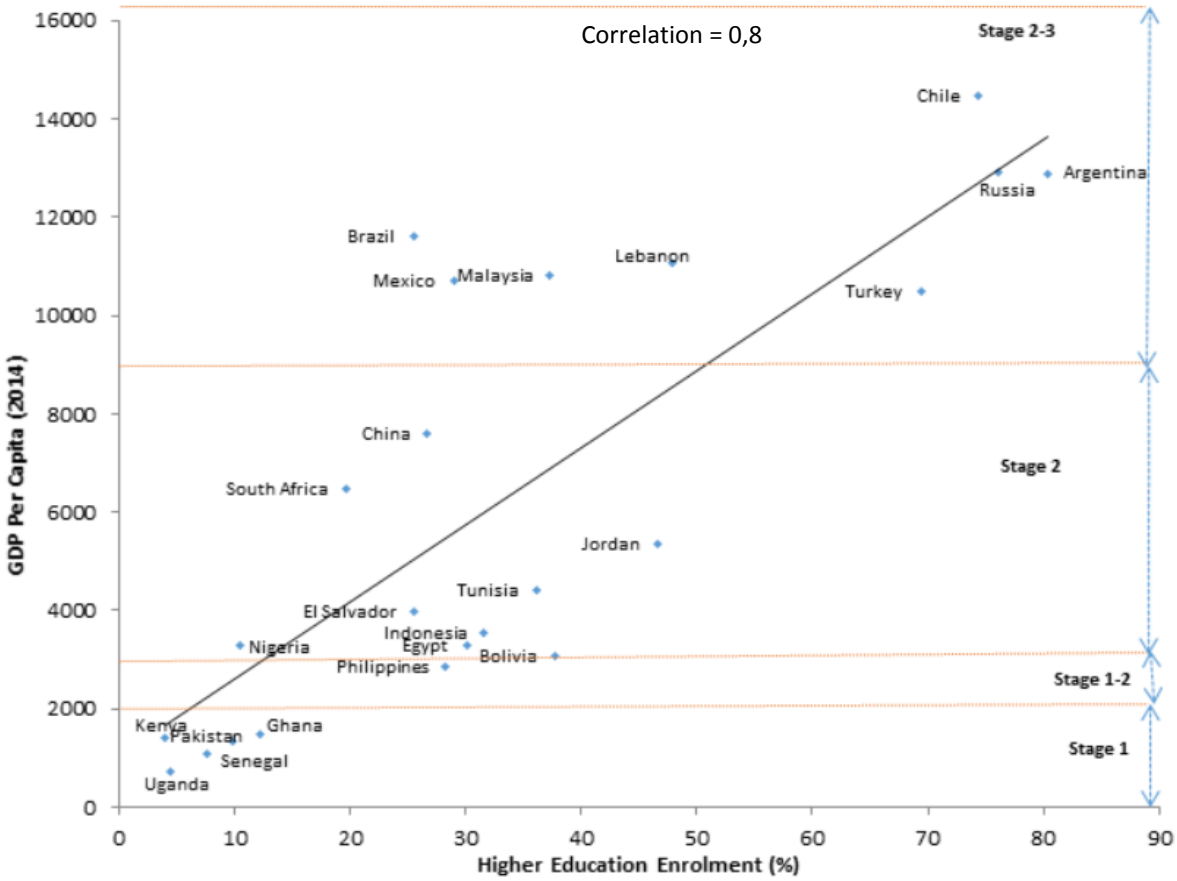


Figure 19 Income Level vs Education level.

Figure 19 above answers the question, does the level of educational attainment influence the level of income earned? Clearly, the graph depicts the different stages of development on the axis of the GDP per capital tallied against the higher education enrolment per economy as a measure of literacy in a particular economy. The graph segregates the economies to their separate stages of development. The regression line shows a positive correlation of 0,8, which means that the correlation between this two axes is a strong one. In other words, level of educational attainment strongly influence the level of income earned per economy. Ghana, Senegal and Pakistan with a very little higher educational attainment reflect a very low income level in their economies. The

higher the percentage of educational attainment the higher the income level increases. Chile, Russia and Argentina with increased level of higher educational attainment enjoys higher income. Literarily, economies in the lower cadet have populace with general primary educational attainment, lower higher education, those in the efficient economies have a boost of their competitiveness by capitalising on their vocational and training colleges for enriched technical competencies while the more advanced economies have a higher rate in higher institutions like university level graduates that focuses on to accelerate the innovation competencies and knowledge capabilities, Yet without neglecting to strategically improve their vocational and training schools for competencies. As the graph shows, the level of economic competencies is tied to its educational endowment.

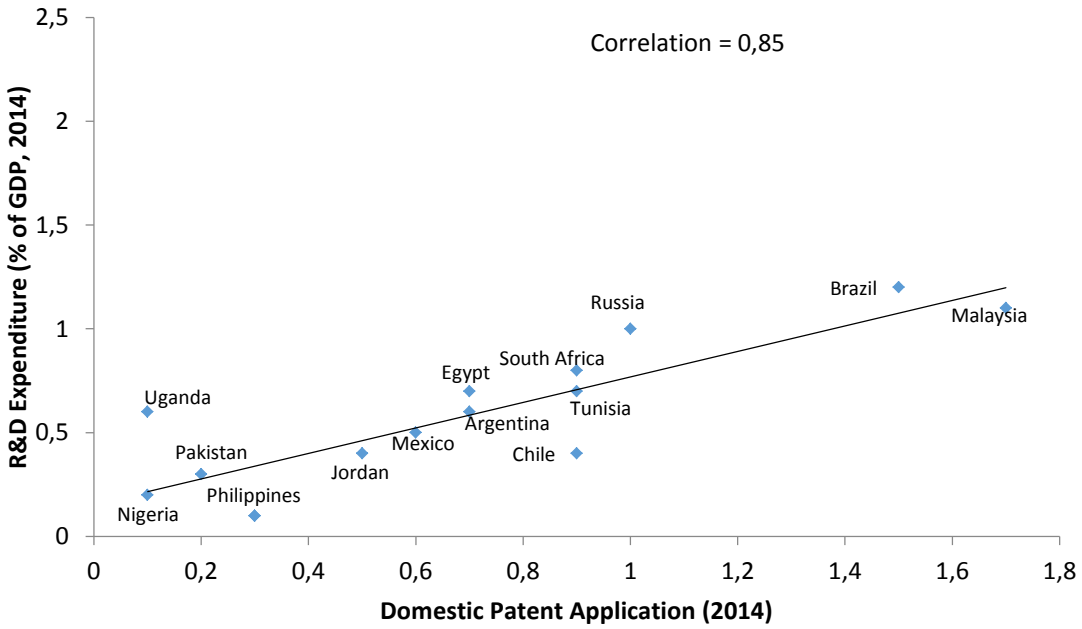


Figure 20 R&D Expenditure vs Patent Application.

Figure 20 above shows a strong correlation between the R&D expenditure and the Domestic Patent Application to be 0,85. This means that a high spending in research and development should lead to a high turnout domestic patents yield. While a low R&D investment should lead to a poor patent output. On the graph, Nigeria has invested a meagre amount of 0,2% of its GDP in R&D, Malaysia has invested around 1,1%

while Finland (not indicated on the graph) has spent about 3.5%. The resultant output were also in similar fashion, with Nigeria yielding very low of 0.1 applications, Malaysia 1.7 applications and Finland with 7,3 applications. The graph also shows that investment in R&D and its yield in patent applications follows their stage of development. Nigeria is in the early stages of development, while Malaysia is in transition to stage 3.

4.2 Relationship between Technology usage and Income Growth

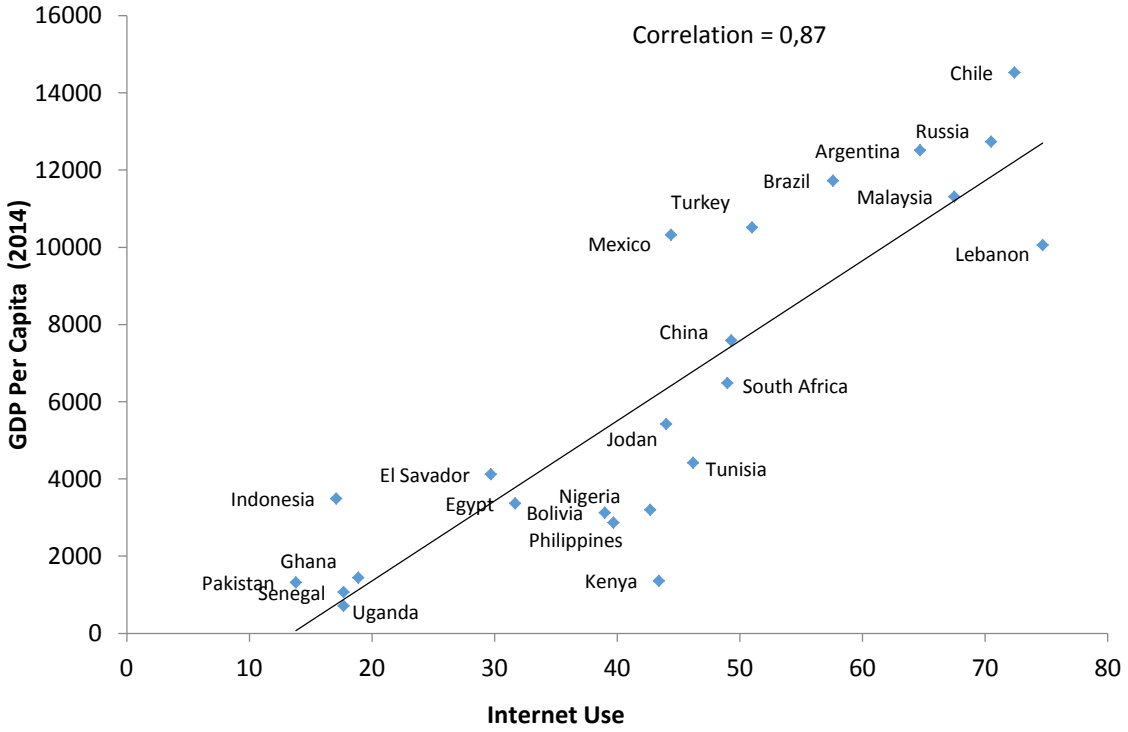


Figure 21 Income level vs internet use.

Internet usage is another technology measured against the GDP per capita. The positively inclined correlation line indicates that internet usage supports income levels. Countries with high rate of internet use are associated with high income, while those with low rate usage are associated with low GDP per capita. Countries in the first stage of development have a low rate usage lower than 25%, efficiency enhanced economies are increasing their internet penetration which is resultant in their GDP per capita while those in transition towards stage 3 are have higher rates and higher income level.

Malaysia has an internet penetration of about 67% and income level of over US$11300, meanwhile Chile is having about 72% of internet penetration and over US$ 14500. Advanced economies like Finland and Singapore have penetrations over 90% and higher income as high as over US$ 40000. So, there is a high correlation between internet usage and income level per economy. The correlation for this graph stands at 0,87, which is a very strong correlation and an upward movement on the graph. Countries with lower income need to embrace more technology penetration like internet usage to boost their income level.

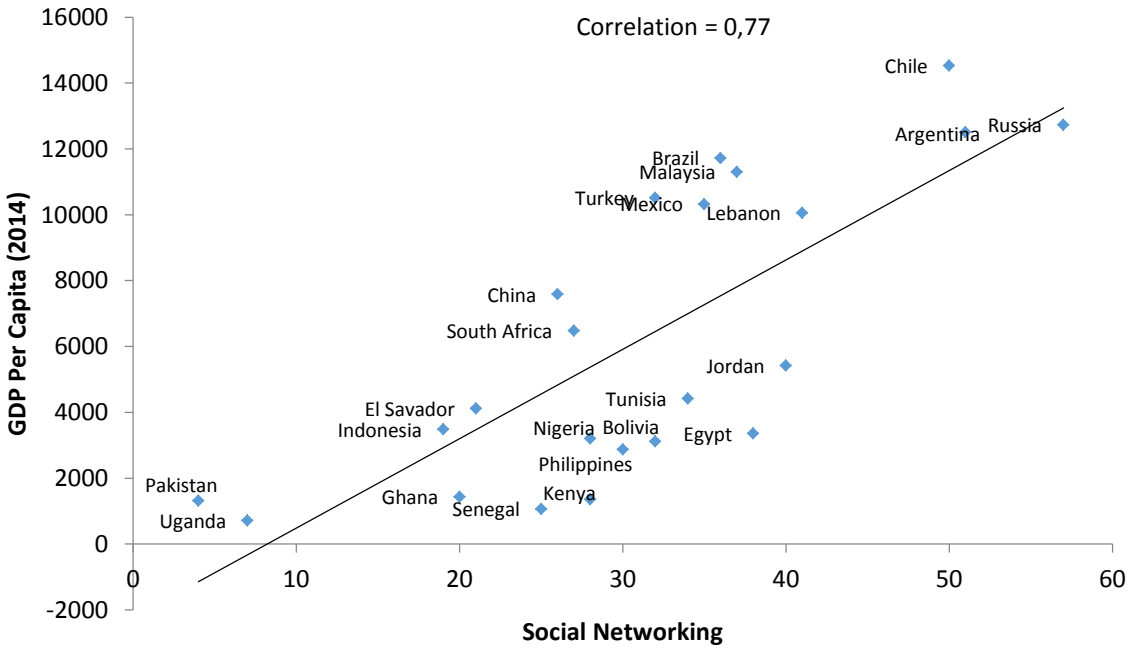


Figure 22 Income level vs Social Networking.

There is a very strong relationship between GDP per capita and social networking. The correlation for this data was 0,77. Social networking supports more income generation. Increase in the percentage of social interaction in the populace increase earnings. Interaction between people is also a means of idea generation for innovation. On the graph, Uganda and Pakistan have a very low social integration through technology and lower income. The most benefitting from the social networking are the relatively more advanced economies while the least benefitting are the least developed.

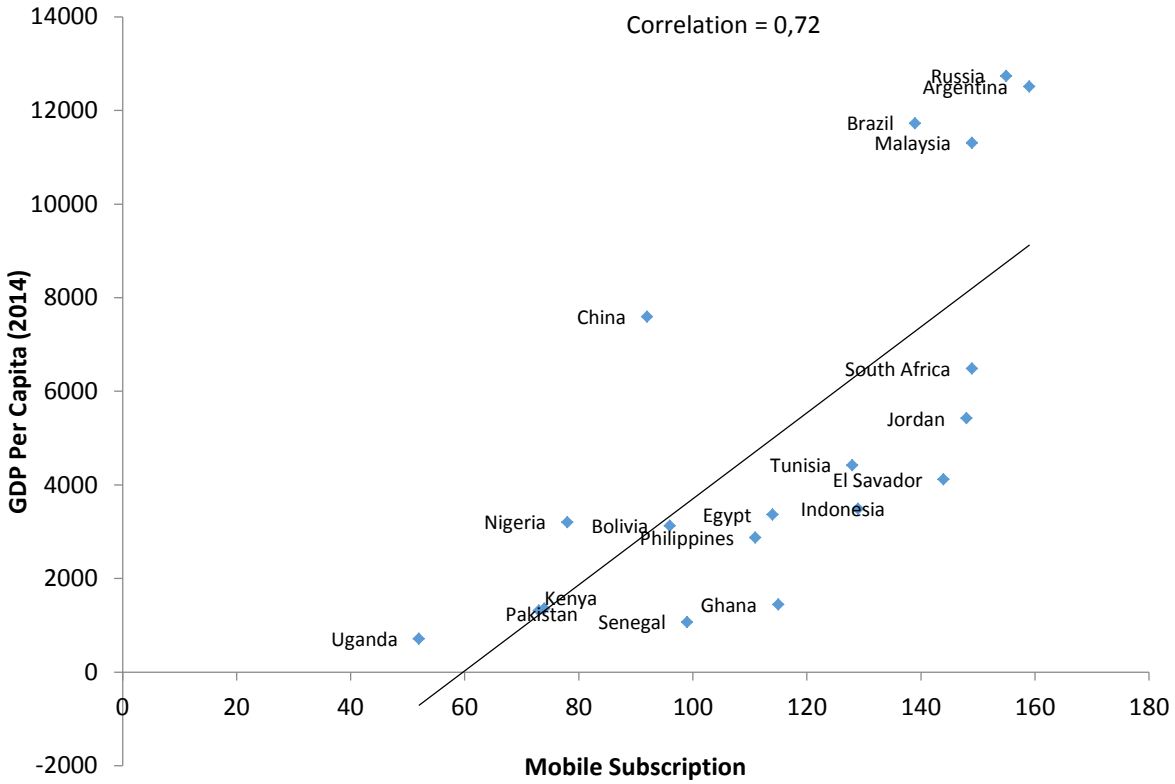


Figure 23 Income level vs Mobile Subscription.

Figure 23 depicts a very good relationship between GDP per capita and mobile subscription. In other words, mobile subscription directly links with increase in income generation. Pakistan and Kenya shows that a lower mobile subscription supports lower income level, while Russia and Argentina shows that a higher subscription supports higher income generation. Offset scenarios like Senegal and Ghana shows situation of unreliable network support in the countries that push the subscribers to subscribing for more without replicated increase in income level, while China experience the reverse.

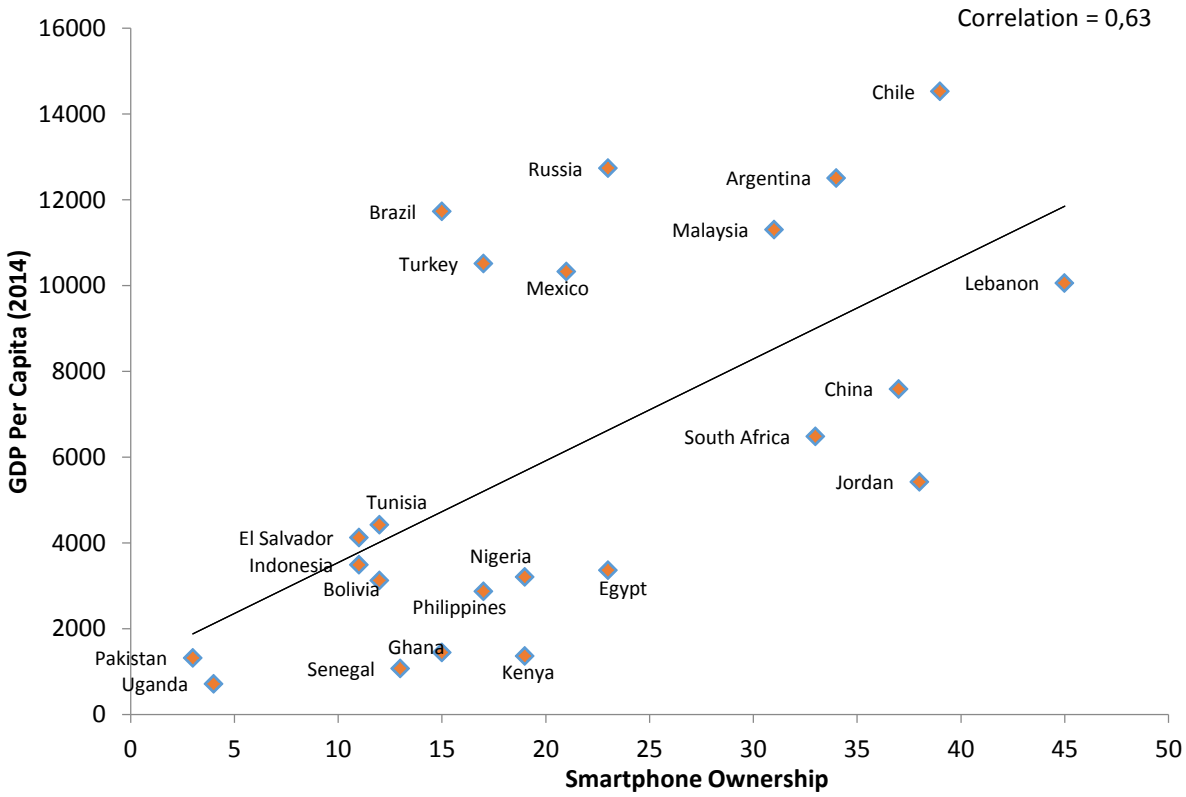


Figure 24 Income Level vs Smartphone Owners

The emergence of Smartphone has made private and business activities more profitable and easy. The correlation here stands at 0.63, a relatively mild value. Like other trends, the regression line is a positively-inclined line that supports the fact that having a Smartphone is mildly relevant to increasing the income level. Even though there is a mild correlation, the graph depicts also that Smartphone ownership has only a little more influence to non-smartphone ownership. Smartphones are not necessarily needed in most jobs but come in handy often times, while other jobs/tasks have a stronger requirements for smartphone. This among others shows the reason for a little weaker relationship compared to others. Yet smartphone ownership does corroborate with increasing income levels.

4.3 The Impact of Technology on The Economy

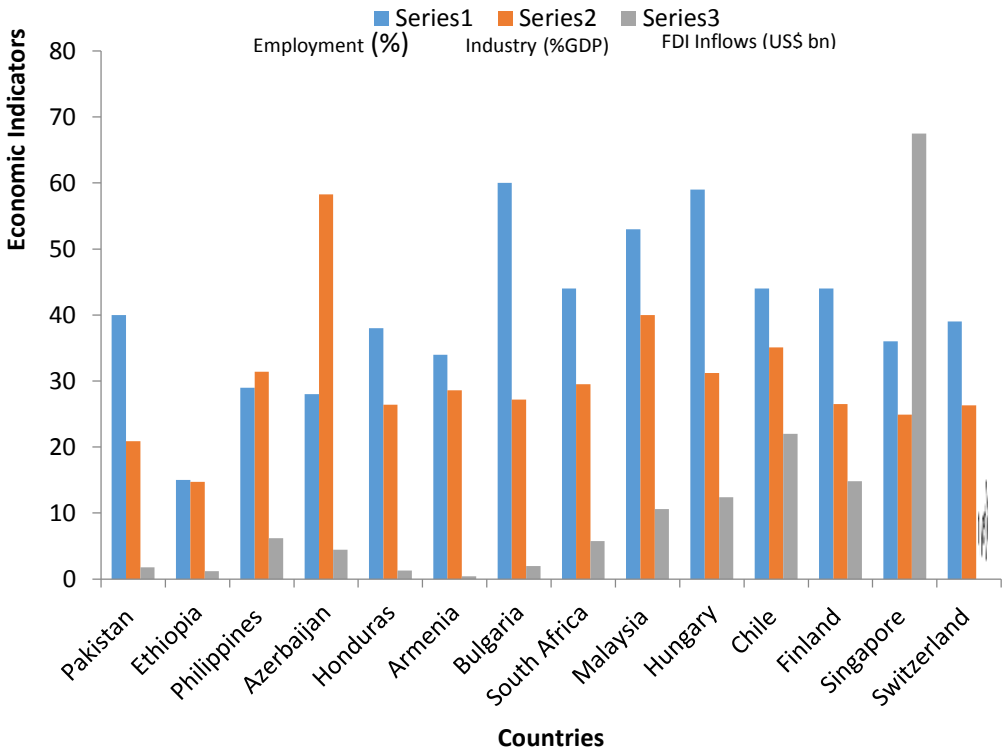


Figure 26.Income level per economy.

The consolidated impact of technology on the economy could be analysed from many indicators. Figure 26 depicts only indicators to show the impact of technology on the economy. Figure 26 depicts that employment rate associated with manufacturing industries are notable. Pakistan, a stage 1 economy, has about 40% employment in industries, Bulgaria with over 60% and Switzerland about 40%. The percentage of employment is least in economies in the early stage of development; efficient economies have the highest employment impacts, followed by the advanced economies. Contribution to GDP from the industry are the least with the weak economies and moderately same with the other categories. The Azerbaijan economy is an industrial economy that is performing well in oil and gas comprising about 90% of its exports, supported by metallurgy and electro-energy industries. The industry contributes about 61% to its GDP making it the highest contribution in the graph. Other economies from

stage2 above also have a strong contribution of about 30% to their GDP. Technology has a big impact on the economy being analysed. The last indicator, foreign direct investment inflows, is a big contributor to the economy of any nation. The graph depicts a trend that is incremental towards the advanced economy. Efficiency-driven economies do have a high inflow of foreign direct investment because of the state of their manufacturing. Singapore clearly has the highest contribution in FDI inflow in the graph. Singapore, an advanced economy, has a very strong manufacturing base and trending to a hub of research and development centre makes it a haven of FDI inflow. The economies in the early stages of development have shown a very poor contribution because of their macroeconomic environment and poor infrastructure which keeps such investments inflow at bay.

5 DISCUSSION

5.1 Answering research questions

Q1. How does technology innovation impact the development of an economy?

The role of technology to fast track the development of economies cannot be overstated. Technology innovation cut across the economy in its numerous impacts. The domestic impact of technology can be seen from the use of washing machine instead of traditional hand-washing, email and mobile SMS instead of the horse riders and birds, to the use of electric, hybrid and petrol-based automobiles used all over the world. New technology keeps rising everyday which transforms and simplify the way things are being done. Most importantly, the public impacts of technology are given sequentially below.

The most direct impact is the direct job creation. Thousands of jobs are created with the invention of technology, which changes the levels of the living standard per person. The ICT, for example, is expected to create about 758, 800 new jobs in the USA and 750 0000 jobs in Europe against 2020, and 25 000 annual jobs in Australia. In the aviation sector in 2014, about 58,1 million jobs were supported worldwide; 6.9 million jobs in Africa, 24.2 million jobs in Asia Pacific, 11.7 million jobs in Europe, 4.9 million jobs in Latin America and the Caribbean, 2 million in the Middle East, 8.3 million jobs in North America (ATAG, 2014). In social networking, Facebook supports about 4.5 million jobs worldwide; 1.92 million jobs in North America, 783 thousands in EU-28, 231 thousands in Brazil, 635 thousands in India among many others (Facebook Newsroom, 2015).

Technology innovation contributes to the GDP of the economy. Often times, whenever technology are used they generate income for the immediate user, the corporate and the government of the economy of the establishment. The preceding graph indicates that Azerbaijan manufacturing industries generates about 60% of the GDP (US$44 billion), which equivalent to US$7899 GDP per capita, Malaysia US$124 billion in contribution to GDP (US$10547 GDP per capita), Chile about US$94 billion (US$15775 GDP per capita). Facebook reported to have about US$227 billion impact on the world; US$148 billion through marketing, US$29 billion through platform use, and US$50 billion

through connectivity (Deloitte, 2013). Likewise, the aviation sector contributed about 3.4% of the world's GDP amounting to US$2.4 trillion through direct, indirect, induced and tourism catalysed jobs. (ATAG, 2014).

The invention and usage of technology have many indirect benefits to the society at large. It makes life easier and serves as a means for the implementation of newly generated ideas. The emergence of internet has catapulted new business activities including ecommerce, online shopping and social connectivity and marketing. It opens up the era of new opportunities for exploitation. The invention of rocket jets has driven man to outer space for exploitation.

Technology innovation impact the development of an economy by creating jobs for the masses, supporting the GDP of the economy through tax and other levies on the associated companies, provides means of income generation, induces new business activities and open up new sectors for exploitation.

Q2. How does technology capacity of an economy influence its rate of growth and development in relation to other economies?

Technology plays an important role in the development of an economy. The technology capacity of an economy is measured either in term of its innovation or adoption capabilities. In other words, countries most likely belong to either adoption or innovation group. Though there is no economy that thrives on either one of the two, it is usually a combination of both. Nonetheless, an economy is inclined to serve one of the two. The rates of technology adoption of the economies are definitely not the same. Some of the economies adopt at a faster rate while others are extremely low. The adoption rate is measured in the rate of diffusion. Not only that technology gets to the economy for use but the level of acceptance which is dependent on the mechanisms that would have been placed in position by the authorities to increase the fluidity and widespread use.

Some economies are only fit for adoption of lower grades of technology due to their capabilities. High-techs do not flow in as compared to lower graded ones. These economies are usually the less developed economies confined to stage 1 and stage 1-2. They are factor-driven and have poorly developed production sectors. This confinement

means that investments are made into the natural resources both by government and private institutions. Basic technology related products could be crude resources in semi-finished forms exported. Established companies are largely foreign owned producing basically for the domestic markets, which could include affiliated surrounding markets on the same level of development. The constant investments in the natural resources usually become the avenue for development and growth for the economy. According to the earlier description in the theoretical description, competitiveness is improved by consolidating the macroeconomic environment, improving the basic infrastructures etc.

The efficient economies are more developed than the previous economies. They are well-situated and prepared for the inflow of high-tech products. These groups fall between stage 2 and stage 2-3. Economies in this adoption group tend to import high-tech products. They are usually fast technology adopters. Technology keeps flowing into the economies through importation from FDI. At this stage, high-tech innovations are more appreciated with the high percentage of averagely educated workforce. The education of the workforce enables inflow and copying of such technology. By copying, it means that imported technologies are analysed and a similar domestic product is made for domestic consumptions. These kinds of products may not be up to the international standard but will be disruptive enough to have access in the local market. With improved technical capabilities and more sophistication of their production processes, these products become exported to economies on the same level or lower. Therefore, the newly found status of exportation balances out their importation. The economies become mostly high-tech importation and export domestic products. (Sach, D and McArthur, W 2002:167-170)

The technology innovation group are advanced economies. These economies encourage only high-tech products diffusion. Importations are generally for products of high international quality standard. Technology is adopted at a faster rate. Switching to new technologies is relatively easier due to higher income rate and higher level of education. These economies focus on developing and improving disruptive technologies which fetches more revenue when commercialised. Researchers Comin, D and Mestieri, M (2010) noted that advanced economies are highly developed because they are usually associated with technology invention. They enjoy earlier adoption and diffusion and commercialization of those technologies before the emerging economies get a taste of

such. He even noted that in the earlier ages, 1980s – 1990s, technology adoption takes decades before getting adopted in developing world and diffusion rate are usually slow because of the level of associated incomes. Advanced economies breathe on the invention and commercialization of high-tech products. They are associated with high percentage of investment capital on research and development.

Economic growth and development have been linked with major technological growth and advancement. Constant changes in technology infer changes in the development of developing economies. (Economics discussion 2015). The graph between technology usage and GDP per capita shows a very strong correlation, which corroborates the influence of technology on the economy.

The rate of growth and development of the economies is directly connected to their capacity to either innovate or adopt new technologies. Economies with the capacity to innovate new technologies have faster growth and development than economies that have capacities to adopt. Economies with fast adoption rates also have faster growth rates than economies with lower adoption capacities but trail behind economies with capacity to innovate. Therefore, their rates of developments are dependent on the fast diffusion of new technologies in the countries.

Q3. What are the transformational strategies and structures that make economies more competitive in comparison with others?

Nowadays, the common trend among scholars defining and exploring the different means that economic competitiveness can be improved is tied to innovation strategies. The main strategy generally accepted among scholars and international organizations are the innovating systems. The OECD and GII are specifically focused on analysing economic competitiveness based on a set of innovation factors. The innovation strategies that are common for implementation are the national innovation systems, the regional innovation systems, clusters of industries and global innovation networks as shown

Figure 10. There is more consideration to the National Innovation Systems as it directly overview the economy and the factors that could be employed in them. A national innovation system is a complex term that embodies the whole process and institutions of

innovation at a whole. There are many definitions from scholars like Freeman (1987), Lundvall (1992), Nioisi et al (1993), and Meltcafe (1995). The most suitable and adaptive of them was the citation from Feinson, et al (2003) which defines the system as

'*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)*.' Feinson et al (2003)

National innovation system is largely dependent on the focus of the development policy of the economy in view. Majorly, NIS generally focus on the ability and capacity of the individual economy to 'acquire, absorb (diffusion), and disseminate modern technologies' in the most effective ways to improve the economy's competitiveness. Developed economies, are as such, designed their NIS to be able to maintain and improve the already established systems. They are more focused on efficient diffusion and usage and creation of suitable environment for innovation creation. While developing economies are focused on ensuring fast and efficient adoption of modern technology. The design of the NIS of developing economy depends on their relative absorption capacity. Some developing economies are way up the ladder compared to others. The rate at which China absorb technology is different from the rate at which it is being absorbed in Philippines. Recent years has seen China developing its policies favouring heavy foreign direct investment while consolidating other important factors for competitiveness as infrastructural development. Other developing economies at the lower cadre have systems designed to improve their basic human capital and infrastructures. (Feinson et al, 2003)

Every economy has a NIS either well-formed or not. Innovation systems in each country are not the same based on factors such as the innovation history of the country, healthiness and effectiveness of the government, the stage of their development among others. An effective innovation system is the system that facilitates and ensures a constant and smooth flow of knowledge and collaboration among the actors of the system. The organogram below shows a simplified view of how the innovation system works in a particular country.

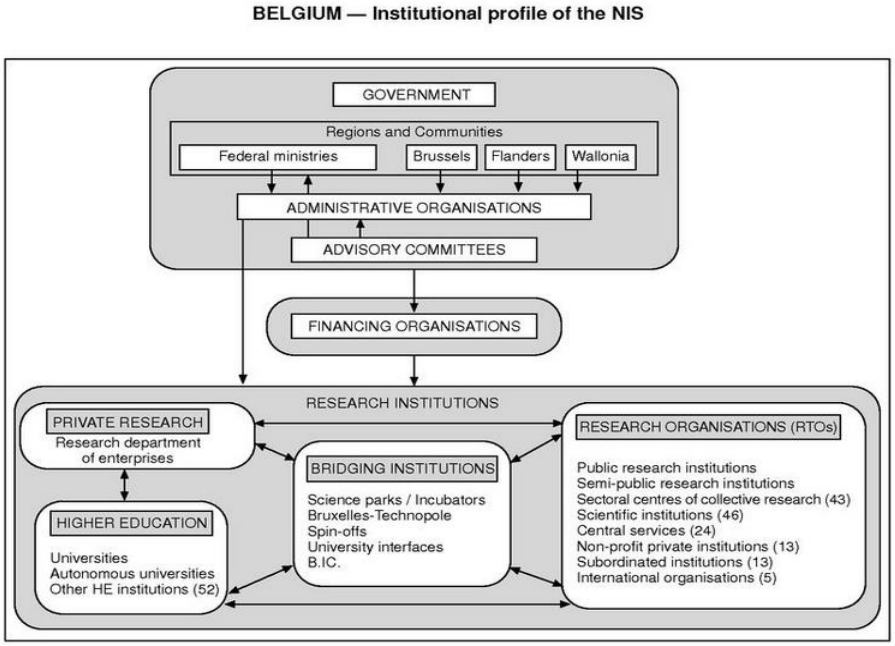


Figure 25 National Innovation System in Belgium (Feinson et al, 2003:26)

The figure above represents the National Innovation System in Belgium. It shows the knowledge flow in the system and the interactions of the main actors of the system. The main actors included are the government, the firms, the research and development institutions and the academic institutions. The first stage contains the policy and decision making sections. The section is practically government section arm. The government sections are clearly divided into subsections that deal with making general policies, science and technology, and academic related policies. In the Belgium innovation system, the second section is the financing organization. The final section deals with the research institutions, comprising of the private research, higher education, bridging institutions and the research organizations. The research institutions include the higher education and the industries. The resultant effect of this could be part of the bridging institutions like Spin-offs.

In conclusion, the major strategies employed to make economies more competitive in the 21st century is by developing systems and policies that focus on technology innovations.

Q4. Why is there a large income disparity between the developed and developing economies?

'The three-tiered global divide in technological capacity— those that are innovating at a high rate, those that are adopting at a high rate, and those that are largely excluded from the process of technological advancement—is also the major driver of the world's widening gaps in income over long periods of time. (Sach. D and McArthur W. 2002:167)' The income disparity between the world economies has been linked to technology adoption and diffusion rates as noted in Comin & Mestieri (2010) article. Empirically, it is observed that innovating economies do have a higher income level and are at the front end of economic advancement. Their rate of advancement is linked to technology usage. Most technology patents are observed to be filed from these economies. While adopting economies only follow the lead of the innovating economies.

There is a comparable technology adoption lag time that leads to income disparity. Depending on the individual economic circumstances, the lag time could account for a big income difference. Though the Asian economies, for example, have been observed to recently have a relatively lower adoption time. Even at the lowest adoption time, it does not guarantee to close the income gap but could bring them to a closer tie. The lag rate in the adopting economies varies significantly due to the different mechanisms in place for a fast and successful adoption and diffusion. Comin, D and Mestieri, M (2010) further noted that income disparity could further be stretched by the intensive and extensive margin of technology adoption. Simply explained, the extensive margin of adoption measures how long it takes a country to adopt a particular technology for its use. This is the lag time from commercialization of invention from the innovating economy to the time it is adopted for use in the adopting economy. The intensive margin of adoption measures the rate of diffusion of the adopted technology. Even though electric powered vehicles are in production, the intensive margin measure the rate at which it is being accepted and used in the economy. The rate of diffusion of technology affects the productivity as related to that technology. (Comin & Mestieri, 2010)

Innovating economies enjoy the grace of inventing and utilizing the technology first and as such generates a high productivity. USA, Japan, Germany, Switzerland, Sweden and

Finland are the leading innovation powered economies in the world (GII 2015). These, among many others, also shares the highest patent applications filed. For example, the correlation between the use of internet and income level is 0.87. Such a high correlation shows that internet use largely contributes to the income generation. Sweden, an advanced economy, has internet percentage usage of 92.5 and generates about US$58 898 GDP per capita in 2015, China, a technology adopting and stage 2 economy, has internet percentage usage of 49.3 and generates US$7590 GDP per capita while Pakistan, a stage 1 economy, has internet percentage usage of 13.8 and generates US$1316 in 2015. Correlatively, a high rate of internet penetration in Sweden has boosted their income level which is significantly higher to others. China shows an upward internet penetration but at a lower rate and subsequently their income level. Though to be noted that catching up economies like China are just starting to get into the race unlike advanced economies that would have nearly maximise the use of such technology. But with time, technology diffusion to adopting economies boosts such economies as well. Pakistan represents the lower income that have a very long lag time in high-tech penetration and likewise their income levels drags behind.

Technology diffusion might help the developing economy to boosts their income level but will not bring them to equal ranks with the innovating economies. The persistent lag time in technology diffusion is a big contributor to the income disparity experienced among the economies coupled with the fact that innovating economies tend to benefit far more than adopting economies. Thereby, they exhibit a large gap in their income ratios.

The large income disparity experienced between the developed and developing economies is tied to the rate of technology diffusion in the respective economies. The economies that adopt the latest technologies first, advance faster by reaping the positive effects of the technologies earlier than latecomers. The time difference in the technology adoption largely contributes to the income disparity experienced between the economies.

6 CONCLUSIONS

Economic development is an important topic in economics. The research report has briefly analysed the role of technology innovation in the context of economics. Technology innovation is seen as the engine block to the development and growth of any economy. Without it, economics would be in shambles and constantly decline without hope. The major strategies for the implementation and utilization of technology innovation to benefit the economy were highlighted. The major research questions were conclusively analysed. These report analysed technology innovation alongside their competitiveness. Combining these facts, a brief major overview is given in the following paragraphs.

The research reports in the beginning explained the different concepts related to the stages of development. The stages of development are three; stage 1 for the least developed economies, stage 2 for moderately developed economies as compared to stage 1, and stage 3 for advanced economies. There are also transition stages for economies that are transiting between one stage to another. The stage of development is an image of the level of competitiveness of every economy and their technology capabilities. The stages of development forced the economies to choose sides at every turn. An economy in stage1 of its development is characterised by many characteristics; they have insignificant or very low technology adoption rate, low foreign direct investments that could aid to improve their statuses, dependent on natural resources to survive and thereby subjected to international policies. Stage 2 economies are better on their stances; a better technology adoption rate that leads to easy imitation, well developed infrastructures and policies that attracts heavy foreign investments to the economy, literacy level is moderately higher to boost their productivity for a higher standard of living, usually transiting from core natural resources dependency to technology dependent as evident in their productivity. Economies confined to stage 3 are the economically more advanced countries e.g. Switzerland, Singapore, United Kingdom, Japan and United States of America among others. They are technology leaders, with concentrations on innovation through investments in research and development, high literacy rates at the higher institution levels and high productivity.

The competitiveness of these economies is strongly correlated with their technology capacities. The result analysis shows that two important input factors; research and development and higher education enrolment, have a high correlations with their level of GDP per capita. The results show that an intensified effort to innovation on the part of innovation economy yielded higher outputs and better standard of living. The second stage of the results analysed the impact of technology on the GDP per capita. The results likewise showed a strong correlation. Technology is an important factor to ensure a higher standard of living. The more technology is diffused and subsidized for use, the earlier the return on investment to organisations likewise the economy at large. The final part of the results indicated that the impact of technology at large on the economy is very important. It contributes about half the revenues to the stage 2 economies, draws in a higher percentage in foreign direct investment to the advanced economies and among the largest employer of labour in the economies. Literarily, it generates a high employment rate, open up new business activities, new sources of income, simplify the average life styles and promotes healthy competition in the economy.

Finally, technology innovation is the gateway to economic development. Technology innovation goes beyond research and development to policies that ensure constant flow of knowledge in the economy. The innovation input factors when correctly applied ensures a steady upward growth of the economy.

6.1 Research limitations and suggestions for further studies

The research work was restricted to data gathered from reports of previous researches. The accuracy of the data depends on the accuracy of the data reported in those reports. In order to ensure a higher reliability, the data was gathered from reports of organizations with international reputations. The organizations include The World Bank data archive, the Organization for Economic Co-operation and Development reports (OECD), the Global Innovation Index reports (GII) and the Pew Research Centre. Though extensive collections were made but the data were reduced to the most accurate and completed data. As there was no financial obligation attached to it, there was no primary research works conducted.

This research was limited in the impact of telecommunications technology on the economy. This is only a fraction of the sector of the economy. It is advisable that more intensive research studies be conducted to gather data on areas that have not being previously studied. This will give more elaborated data on the impact of technology on wider areas of the economy.

Quantitative approach has been focused on the execution of this report while the qualitative approach can also become more effectively utilized. Subsequent research could bring in more expert view from economic disciplines to access the arrays of the correlation and contribute their opinions on these impacts. A qualitative approach is needed to access the loopholes in the implementation of National Innovation Systems and the necessary economic factors to be considered for specific economy.

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