Technology Transfer Strategy: A Neglected Approach in Tanzania

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By

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Abstract

Despite technology capacity being low in Tanzania, technology transfer strategy is limited applied in the country. Inadequacy of political will, lack of adequate of technology transfer institutions and lack of readiness be among the main factors that had hindered the applicability of technology transfer approach in Tanzania. Despite the fact that technology transfer approach is not adequately applied in Tanzania, the strategy is still potential not only in Tanzania but in the Sub Sahara African region. Since, least developed countries are in advantage position to access technologies from the rich countries, it will be a mistake to continue to ignore the strategy despite the fact that the approach is proven to be profitable.

1.0 Background

Tanzania is one of the countries in the Sub-Sahara Africa, which characterized by massive deficit in science and technology. The main reason behind technology deficit in the country is a limited innovation capacity. The innovation capacity is low due to a number of factors including inadequate of innovation drivers such as poor quality and quantity of human capital, inadequate of R&D institutions and infrastructure and poor political will. Due to the inferiority of the country's economy and innovation inputs, there is a limited possibility for Tanzania to advance in science and technology in a near future. There are two main reasons that push the author to disqualify the capability of Tanzania to increase its capacity of innovation output in a near future: The first factor is inadequate of funds required to finance R&D and technology production activities. According to Tanzania development vision 2025, the country is a lower income country and is expecting to become at least a middle-income country by 2025, therefore there is limited possibility for Tanzania in the near future before 2025 to gain adequate financial capability required to boost innovation activities in the country: Second, is the fact that it takes time to groom the quality and quantity of human capital particularly to a country like Tanzania where nearly 79% of the country population holds less than secondary school education qualification[1]. Based on these arguments, adoption of technology transfer strategy is the only hope for low-income countries including Tanzania to advance technologically. Despite the fact that innovation capacity is low in Tanzania, the country is rarely applying technology transfer approach as a strategy to cover the gap of technology deficit in the country, and this is the main concern of this study.

Fundamentally, there three main ways the country can opt to advance technologically: first, based on generating own technologies through creativity, discovering and invention. However, capability of the country to enrich the indigenous technologies depend much on the effectiveness of various innovation inputs including availability of knowledgeable population, availability of fund, policies and institutional arrangement: secondly, the country can advance technologically through technology sharing with the source: and the third approach is through both sharing and

[1] FinScope Tanzania, (2017), Insights that drive innovation, FinScope Tanzania, Dar es Salaam, Tanzania. p. 16.

generating own technologies simultaneously. However, Tanzania is neither effective on developing indigenous technologies nor transfer of knowledge and technology, as the result the country has been characterized by the technology deficit. Despite the fact that the Sub Sahara African countries including Tanzania are technologically backward in comparison with the rest, and despite the fact that innovation inputs are very inferior to the extent of jeopardizing innovation activities in the country, and despite the fact that it is on the advantage of developing countries to access and share globally available technologies, transfer strategy is limitedly applied in Tanzania.

1.2 Methodological Aspects

The objective of this work is to assess the applicability of technology transfer approach as the strategy to enhance technology advancement in Tanzania. The hypothesis is; among the main factors, which hinder technology transfer process in Tanzania, are poor political willingness, lack of adequate technological information machinery; and inactiveness and ineffectiveness of the foreign instruments. According to hypothesis, this study intend to interrogate the concept of technology transfer as an appropriate approach in boosting technological competitiveness in developing countries. Another objective was to develop a technology transfer roadmap for Tanzania and other least developed nations with the aim to induce the decision makers in Tanzania and probably in other developing countries to adopt author's approach of technology transfer. In order to be able to respond to the objective and hypothesis of the paper, this work as set to addressed the following questions; How far did the transfer of technology approach been effectively utilized in Tanzania? What role did foreign instruments played to enable sharing of technologies and knowledge? Is there political will to boost technology transfer and adaptation activities in the country? Is there adequate pragmatic evidence elsewhere, which reveals the profitability of technology transfer strategy?

In order to fulfill the objective of the paper, three categories of data has been presented and examined. In order to determine the capability of Tanzania to transfer technology in comparison with the other nations, data from the WIPO annual report (*the Global Innovation Index*) and the Word Economic Forum Report (*the Global Competitive Report*) were presented and examined. Based on these two reports, the gap between Tanzania and the rest in terms of capability of the country to transfer technology has been uncovered. Moreover, in order to site examples about the status of the technology transfer situation in Tanzania, a physical survey was conducted in some selected cases. For a case the CARMATEC in Arusha and the TIRDO in Dar es Salaam were randomly selected as examples to reveals the situation. In addition, the empirical evidence from the South East Asia countries and USA were presented as successfully stories of technology transfer activities. Based on the empirical evidence, the author was able to reveal the gap between Tanzania and the rest in terms of techniques and applicability of technology transfer approach. Moreover, the empirical evidence was also applied as the basis to develop the necessary conditions for technology transfer to occur which eventually are the recommendations of the paper. The last research technique was uncovering and interrogation of drivers of technology transfer as part of theoretical frameworks. The theoretical frameworks were later applied as the basis to assess the capability of Tanzania to transfer technology.

1.2 Problem

Studies revealed that, technology transfer strategy had been deployed by the most of the advanced South East Asian countries including China, Republic of Korea, Singapore, Japan, Hong Kong and Taiwan to enable a tremendous advancement in science and technology[2]. They have been applying knowledge shifting, copying and reverse engineering strategy to transfer technology and innovation from the Western Countries to their respective countries[3]. One thing, noticeable about the mentioned South Asian countries is that, they managed to not only move out of poverty but also to attain middle and higher income status just within the period of 4 decades[4]. The point here

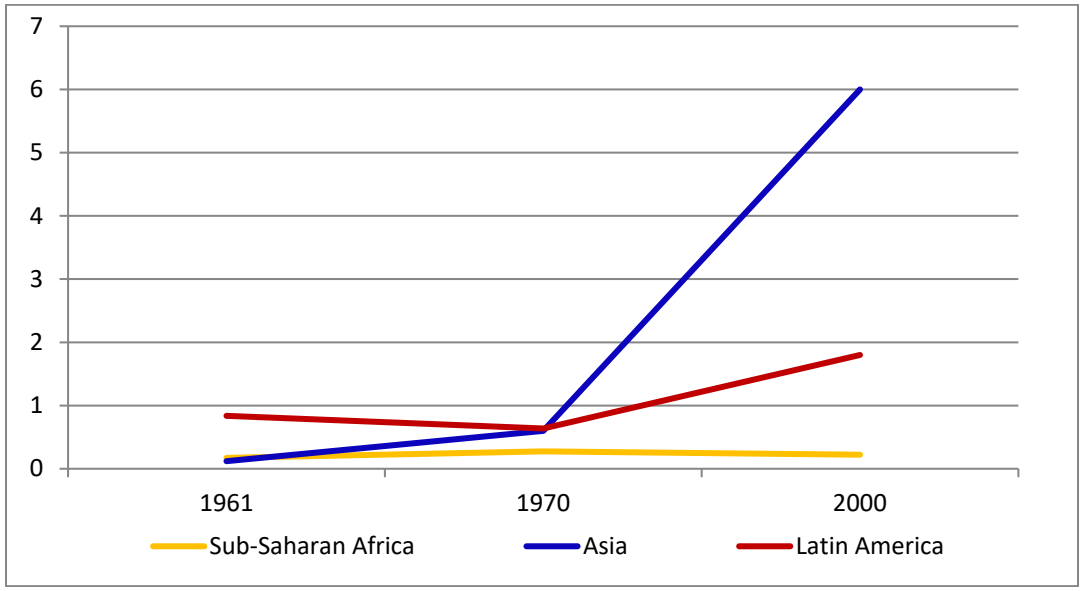
[2] Dahlman. C, (2007), Technology, globalization and international competitiveness: Challenges for developing Countries", Industrial development for the 21st century, Department of economic and social affairs of United Nations, USA.
[3] Ibid.
[4] Ibid.

is that technological advancement in Asia went in parallel with economic achievement. In addition, it is true that African countries are still characterized by technology deficit gap and underdevelopment as well as poverty crisis. At some point during (1960's-1970's), the Sub-Sahara African Countries used to be in the comparable level with the South East Asian countries in terms of technological advancement. For instance; the number of the available tractors in the Sub-Sahara Africa region in 1961 was 172,000, higher than number of available tractors in Asia region (120,000). Three decades later in 2000 the quantity of tractors available in the Sub Sahara Africa region recorded insignificant increase to 220,000 from 172,000, but in the same period of timeframe, the number of tractors in Asia region increased massively from 120,000 tractors in 1961 to 6,000,000[5] in 2000 (*See Chart 1.1*). This is just a pragmatic example which revealed two aspects; massive rate of technological advancement in Asia region; and technology stagnation in the Sub-Sahara Africa region. However, what matters most is that the Sub Sahara African countries including Tanzania are not doing enough to pull themselves out of the technological stagnation trap, as the result the technology deficit gap in the Sub-Sahara African countries keep on increasing. The view of the author is that the African states including Tanzania need to use whatever option available to advance technologically and scientifically in order to mitigate from falling into technological trap risk. Actually, the author agreed with many scholars including Dahlman (2007), who argued that, developing countries including Tanzania can grow fast if they transfer technology from the more advanced countries[6]. Among the factors, which associate with the innovation and technological advancement, is presence of adequate political willingness. Unfortunately, there is limited political will to enhance innovation activities in Tanzania. The government is playing limited role to enable technology adaptation as well as to enhance innovation activities. Based on the combinations of factors, there is great chance for Tanzania to fall into technology stagnation trap.

[5] Sims.B and Josef Kienzle.J, (2016), Making Mechanization Accessible to Smallholder Farmers in Sub-Saharan Africa, in Environments Vol. 3, No. 11 MDPI, Basel, Switzerland. Pp. 6.

[6] Dahlman. C, (2007), Technology, globalization and international competitiveness: Challenges for developing Countries", Industrial development for the 21st century, Department of economic and social affairs of United Nations, USA. (Pp. 32 -34)

Chart 1.1: Tractors available in different Regions in (1961-2000) (in millions)



Source: Adopted from Sims and Kienzle (2016)[7]

2.0 The Concept of Knowledge and Technology Transfer

There is no common accepted definition of the term technology transfer; various scholars have come up with various definitions depending on their interpretation of what it means by technology. In the search of common understanding over the term technology transfer Rose, Whab and Osman (2012)[8], interrogated various definitions and finally argued, "*Majority of the researchers have affirmed that technology transfer is closely associated with the transfer of information, know-how, technical knowledge which is embodied in the products, processes and managements"*. According to Mateso (2014)[9], there are different model a recipient can apply to transfer technology including; knowledge and capacity transfer model which involved knowledge empowerment and capacity

[7] Sims. B and Kienzle. J, (2016), Making Mechanization Accessible to Smallholder Farmers in Sub-Saharan Africa, in Environments Vol. 3, No. 11 MDPI, Basel, Switzerland. Pp. 6.
[8] Rose, Whab and Osman, (2012), defining the concepts of technology and technology transfer: A literature analysis, in international business research. Vol. 5, No. 1, Kuala Lumpur, Malaysia. Pp. (61-65).
[9] Mateso.P, (2014), Technology transfer: the concepts, practices, and lessons for Tanzania and its TVET system, presented in VET forum, Arusha, Tanzania. Pp. (4-13).

building, which consequently enable beneficiaries to design and produce a new technology independently[10]; Another model is contextual collaboration model[11], which involves the joint project done in collaboration between the source and recipient under the condition that the end product will be owned by the recipient; Another type is material transfer model[12], that involves the process of shifting a physical or tangible innovation to the recipient; and the last, is the design transfer model which refers to an acquisition of the technical design including the blueprints and specifications requirements[13]. The view of this study is that technology transfer is not limited to transfer of the physical technology but it covers transfer of knowledge, skills, designs and education. The South East Asian and the Pacific countries in particular Japan[14] and Korea Republic[15] are cited as an example of a successful model of technology transfer.

2.1 Drivers of Technology Transfer and Adaptation

A number of preconditions need to be addressed by the recipient country in order to be able to successfully transfer technology. This study agrees with many authors including Choi (2009)[16], Mateso (2014)[17] and Dahlman (2007)[18], who consider among other aspects the necessary inputs to technology transfer is the quality of education, government prioritization, policies, strategies and the institutional and legal frameworks.

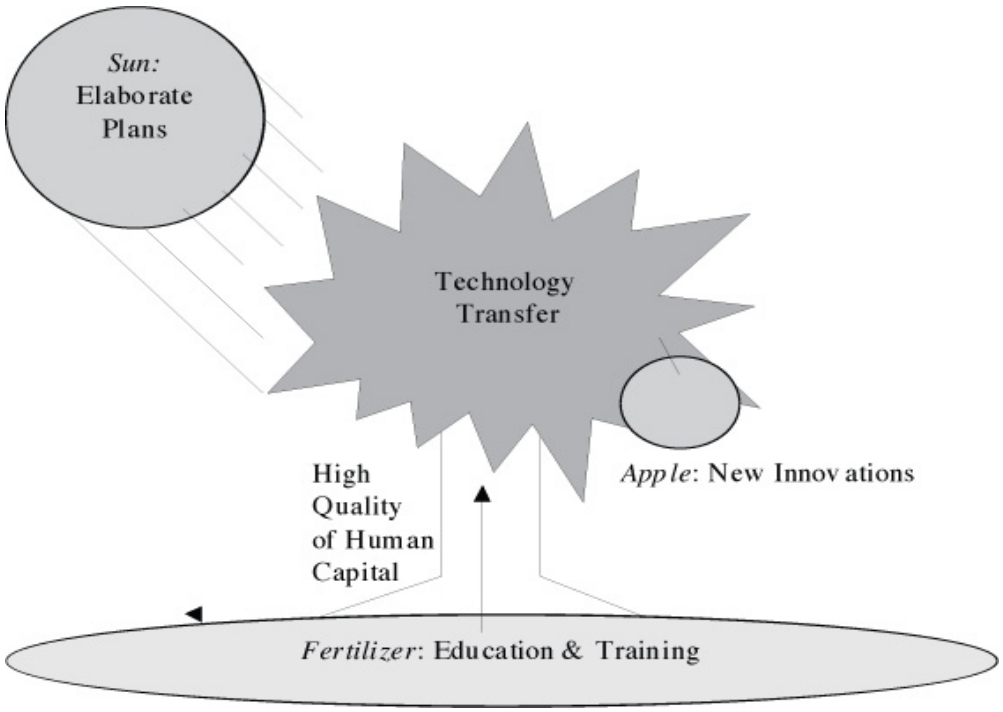
[10] Ibid. Pp. 9.
[11] Ibid. Pp. 9.
[12] Ibid. Pp. 9.
[13] Ibid. Pp. 9.
[14] Mateso.P, (2014), Technology transfer: the concepts, practices, and lessons for Tanzania and its TVET system, presented in VET forum, Arusha, Tanzania. Pp. (20-21).
[15] Choi.J, (2009), Technology transfer issues and new technology transfer model. The Journal of Technology Studies, Vol. 35, No. 1, Pp. (49-57).
[16] Ibid
[17] Ibid
[18] Dahlman. C, (2007), Technology, globalization and international competitiveness: Challenges for developing Countries", Industrial development for the 21st century, Department of economic and social affairs of United Nations, USA

2.1.1 Human Capital

The impacts of education can be realized widely through innovation of new technology after long term of investment in education. The pragmatic experience from the South East Asia and the Pacific countries particularly China, Korea Republic, Singapore, Taiwan and Hong Kong, which are considered as a successful model in technology transfer, reveals that; education was among the key pillars, which enabled economic miracles in the region. According to Choi (2009)[19], in order for technology transfer process to be successful, the quality of human capital must be adequate *"to assimilate, adapt, modify, and generate new technology"*[20]. Therefore, investing in education in order to boost quality of human capital is the crucial condition for a successful adaptation[21]. Based on Choi's model of technology transfer, education facilitate technology transfer while plan, strategies and institution collaboration are enhancer of technology transfer process (*see figure1.2*). Choi (2009)[22] has demonstrated through a tree model the role of education and government plan on boosting technology transfer in the country (see *Figure 1.2)*. Based on this discussion, this study is convinced that human capital is among the crucial enabler of technology transfer. Technology stakeholders and personnel working in technology transfer instruments such as R&D institutions need to possess adequate quality of skills and knowledge in order to be able to search and adapt new technologies.

[19] Choi.J, (2009), Technology transfer issues and new technology transfer model. The Journal of Technology Studies, Vol. 35, No. 1, Pp. (49-57).
[20] Ibid. Pp. (54-55).
[21] Ibid. Pp. (54-55).
[22] Choi.J, (2009), Technology transfer issues and new technology transfer model, in The Journal of Technology Studies, Vol. 35, No. 1, Pp. (49-57).

Figure 1.2: Education as a foundation, and plan as a catalyst to technology transfer



Source: Taken from Choi (2009).

Technical and Vocational education and training (TVET)[23] and Universities are not only a platform for human capital empowerment, but also can be used as the Centre for knowledge transfer[24]. Transfer through education can be implemented in three main ways; first, through invitation of potential professors from high ranked Universities around the world or to invite experts from the technological advanced countries to lecture in domestic institutions; second, can be done through enabling students exchange program such as Erasmus program; third, is through running technology transfer programs as capacity building to students in order to stimulate transfer of culture. Examples of Universities which placed to induced technology transfer culture to

[23] Mateso. P, (2014), Technology transfer: the concepts, practices, and lessons for Tanzania and its TVET system a paper presented at the vet forum held in December 10/11/2014, in Arusha, Tanzania

[24] Chen, Patton and Kenney, (2016), University technology transfer in China: a literature review and taxonomy, in The Journal of technology transfer, Vol. 41, No. 5, Pp. (891–929), Springer, USA

students include; the University of Stuttgart in Germany[25]; University of Southern California in USA[26]; and Hanoi University of Science and Technology (HUST) in Vietnam[27].

2.1.2 Policy and Political Willingness

This study agrees with many scholars including Ramanathan (2008)[28], Mateso (2014)[29], Sachs and McArthur (2002)[30] and Saggi, (2005)[31], who suggested that policy, strategy, legal framework and political willingness are crucial drivers to technology transfer. The government as a political machinery is the main enabler of the transfer and adoption of technology in the country. The governments through decision making, policy adjustment, strategies formulation can harmonize the technology transfer environment in the country. Government directives, policies and strategies can provide guidelines necessary to influence and motivate the transfer activities. Moreover, the government instruments particular foreign apparatus are necessary enabler or facilitator of partnership and collaboration between foreigners and the domestic stakeholders[32]. In addition, foreign policy, objectives and ministries as government instruments can be structured or placed to attract the inflows of FDIs and enable educational collaboration between domestic and foreign stakeholders in order to promote technology transfer activities[33]. For instance, the USA and China's governments through their foreign instruments had created specific policies to attract

[25] University of Stuttgart, Knowledge and Technology Transfer
Accessed [03/05/2018] https://www.uni-stuttgart.de/en/research/technology-transfer/
[26] University of Southern California, Innovation and Technology Transfer in Universities Accessed [03/05/2018] https://about.usc.edu/steven-b-sample/speeches/innovation-and-technology-transfer-in-universities/
[27] Hanoi University of Science and Technology (HUST), Priority to strengthen the Knowledge and Technology transfer in Vietnam (VETEC project) Accessed [03/05/2018]
https://en.hust.edu.vn/display-students/-/asset_publisher/sum9Zls6uqmE/content/priority-to-strengthen-the-knowledge-and-technology-transfer-in-vietnam-vetec-project-
[28] Ramanathan. K, (2008) , An overview of technology transfer and technology transfer models. [Accessed 06/07/2017] https://www.researchgate.net/publication/228320556_A_Review_on_the_Technology_Transfer_Models_Knowledge-Based_and_Organizational_Learning_Models_on_Technology_Transfer.
[29] Mateso.P, (2014), Technology transfer: the concepts, practices, and lessons for Tanzania and its TVET system, presented in VET forum , Arusha, Tanzania. Pp. (5-20).
[30] Sachs.J and McArthur.J,(2002), Technological Advancement and Long-Term Economic Growth in Asia, in "Technology and the new economy" MIT Press Cambridge, MA, USA. Pp. (157 – 185).
[31] Hoekman, Maskus and Saggi, (2005), Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options in World Development Vol. 33, No. 10, Pp. (1587–1602), Elsevier Ltd, UK. Pp. (1590-1592).
[32] Ibid.
[33]Hoekman, Maskus and Saggi, (2005), Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options in World Development Vol. 33, No. 10, Pp. (1587–1602), Elsevier Ltd, UK. Pp. (1590-1592).

experts and potential personnel including scientists to work in their countries; they set policies which enabled foreign instruments to search and identify potential personals with potential skills, and then grant them residence permits and citizenship. In order to enhance competitive advantage, some countries which, are considered as successful in technology transfer such as China[34], Republic of Korea[35] and Vietnam[36] have constructed specific technology transfer laws and strategies as a means to enhance their technological competitiveness. In general, the government institutions, policies and political willingness are crucial drivers to technology transfer. Among the impacts of effectiveness in political willingness, institutional arrangement and policy is to reshape business environment in the country[37]. Business environment can enable or discourage establishment of firms, availability of credits for SMEs and trade across the borders[38].

2.1.3 Infrastructure

Both the Global Competitiveness Reports and Global Innovation Index consider infrastructure as a crucial driver for technological advancement. In addition, Porter's theory of competitive advantage of nations highlighted infrastructures as one of the key inputs to competitive advantage of a nation. Quality, reliability and affordability are necessary features of good infrastructures for technology transfer activities. The nature and quality of infrastructures can influence technology development and transfer in various ways; first can attract or discourage inflows of FDIs into the country; second, digital communication is among enablers of internetworks of people and products regardless of the geographical limitation. The effectiveness of ICT infrastructure in the country can influence adaptation in multiple ways; can enable technology transfer frontiers in the country

[34] Zhijian.H, (2016), China's Policies on Technology Transfer and Transformation of Scientific and Technological Achievements, Chinese Academy of Science and Technology for Development (CASTED), Beijing, China.
[35] Republic of Korea, Technology Transfer and Commercialization Promotion Act (Act No. 8108 of December 28, 2006, as last amended by Act No. 9689 of May 21, (2009)
[36] New Technology Transfer Law in Vietnam aims to promote adoption of latest advances and commercialization of research, [Accessed 20/09/207], http://opengovasia.com/articles/7760-new-technology-transfer-law-in-vietnam-aims-to-promote-adoption-of-latest-advances-and-commercialisation-of-research
[37] Cornell University, INSEAD, and the World Intellectual Property Organization, (2017), Global Innovation Index (GII) 2017; Innovation Feeding the World, 10th (Ed), the World Intellectual Property Organization (WIPO) and the Confederation of Indian Industry (CII), Geneva, Switzerland, and New Delhi, India. Pp. 47-54
[38] Ibid.

to adequately access information about foreign knowledge and technologies; can enable domestic technology stakeholders to interact with foreigners and create partnership or collaboration; can enable peoples to access foreign resources and consequently enhance agility of the country to absorb and apply new technologies[39]. In general, ICT services and infrastructures are among of the crucial drivers to technology adaption in the country[40]. In addition, technology transfer infrastructures include availability of reliable and adequate power supply including both electricity and gas.

2.1.4 Availability of Technology Transfer Instruments

2.1.4.1 Technology Transfer Information Centres

Because information is power and necessary input, an availability of competitive information is one of the requirements in technology transfer process. Therefore, the success in adaptation of technology can be highly influenced by availability of information as an input[41]. Because marketability of the final product in market is a key motivator to technology transfer activities, availability of adequate information about the profitable technologies in the World market can be a determinant of the success of the transferred technologies. However, an availability of the accurate, reliable and valuable information depend much on presence of information platforms or machineries which collect, analyze and disseminate knowledge to stakeholders. Therefore, countries particularly low income nations which do not have competitive innovation instruments need to create a series of information enrichment instruments known as Center or Institute for scientific and technological information. The main responsibility of national institute for scientific and technological information is to facilitate the availability of scientific and technological information to stakeholders. Pragmatic evidence reveals that most of the South East Asia and the Pacific countries, which are considered as successful in technology and knowledge transfer,

[39] World Economic Forum, (2016), The Global Competitiveness Report 2016–2017, World Economic Forum, Geneva, Switzerland. Pp.54.
[40] Ibid.
[41] Parthasarathy. S, (1975), national information system for science and technology, Presented in the seminar on towards the evolution of information system for national development, Indian national scientific documentation center (INSDOC), .Vol 22 No) .New Delhi, India. Pp ,4179-184).

adopted this strategy. Most of these countries including Japan, Korea Republic, India, China and Vietnam created a series of scientific and technological information machineries during 1950's and early 1970's. In 1952 UNESCO supported India to established the Indian National Scientific Documentation Centre (INSDOC). However, in 2002 INSDOC was merged with the National Institute of Science Communication (NISCOM) to form the National Institute of Science Communication and Information Resources (NISCAIR)[42]. China established its Institute of Scientific and Technical Information of China (ISTIC) in 1956[43]; Japan created The Japan information Center of Science and Technology (JICST) which apparently employed about 260 staff was created in 1957[44]; Korea Republic created The Korea Institute of Science and Technology Information (KISTI) in1962[45]; and in 1972 Vietnam created the Central Institute for Scientific and Technical Information (CISTI) which later in 1990 was transformed into the National Agency for Scientific and Technological Information (NASATI)[46]. Most of these nations, ranked high in Global Innovation Index; for instance Japan was ranked 14 from the top, Korea ranked at 11, China was ranked 22 and Vietnam was ranked 47 out of 127 surveyed by the Global Innovation Index in 2017[47].

2.1.4.2 Technological Intelligence as a Catalyst to Technology Transfer

Another crucial driver to technology transfer is technological intelligence, which some authors refer to it as competitive intelligence. The focus of this part is to address the link between intelligence and technological advancement. There is no universal definition of the term intelligence. Hans and Marina (2007) defined Intelligence as *"the activity and process by which information is systematically collected and made available to Government officials in a usable form*"[48]. Colibasanu (2008), defined Competitive Intelligence (CI) *"as the process through which*

[42] National Institute of Science Communication and Information Resources (NISCAIR). Accessed [17/02/2018] http://www.niscair.res.in/aboutus/about.asp?a=topframe.htm&b=leftcon.asp&c=introduction.htm&d=t
[43] Institute of scientific and technical information of china (ISTIC) Accessed [19/03/2018 https://www.istic.ac.cn/English/
[44] Kozi. A, (1959) "The Japan information center of science and technology and its activities", Aslib Proceedings, Vol. 11 No. 11, Pp. (301-304). Accessed [03/04/2018] https://doi.org/10.1108/eb049713
[45]The Korea Institute of Science and Technology Information (KISTI) Accessed [19/03/2018] https://eng.kist.re.kr/kist_eng/main/
[46] National Agency for scientific and technological information, Vietnam (NASATI). Accessed [17/03/2017] https://sea-eu.net/stakeholder/88
[47] Cornell University, INSEAD, and WIPO, (2017): The Global Innovation Index 2017: Innovation Feeding the World, Ithaca, Fontainebleau, and Geneva. Pp. (xviii- xix).
[48] Hans and Marina, (2007), Democratic Control of Intelligence Services: Containing Rogue Elephants, Switzerland. Pp. (4-6).

you acquire and apply knowledge to become more successful than the others"[49]. Based on these definitions, four elements of intelligence can be noticed: information collection, secrecy, information collected to support decision or policymaking[50] and intelligence for national competitive advantage. Therefore, intelligence approach can be deployed to enable technological advancement in the country. As it has been revealed before, one of the inputs of technology transfer is availability of the reliable information about foreign technologies and market situation. The technology transfer stakeholders need to be informed about transfer inputs available in the advanced countries including, availability of experts and options of competitive technologies. In addition, information regarding availability, cost and quality of parts required in manufacturing of adapted technology are crucial in making decision on whether to import, to produce own parties or to do a combination of both approaches, import and produce own parts. In addition, the good decision regarding marketability of the transferred technology requires information about the response of demand in a comparable environment where the technology was used previously. Moreover, in order to make a good decision regarding investing in a particular technology, it is necessary to have reliable and adequate information about the following elements of transferred technology; cost of the whole process of technology transfer, market value, production cost and details of the comparable technologies available in the global market. However, many multinational and transnational companies have a tendency of hiding information regarding their breakthrough technology as a means to enhance or maintain their competitive advantage and technology monopolization in global market[51]. Contemporary, countries as well as firms are increasing to develop a protection mechanism against technology transfer through incorporating a strict intellectual property right laws and policy. According to Shashikant and Khor (2010), intellectual property rights laws and trade secrets laws are obstacles against technology and knowledge transfer and not the vice-versa[52]. This means the current initiatives to strengthen the intellectual property rights and trade secrets instruments at local level and globally, hinder extensively the whole process of technology transfer. Tightened intellectual property rights as well

[49] Colibasanu. A, (2008), Between Intelligence and Espionage in the Contemporary Business Environment, in the Ekonomika a Management, Vol. 4, Bucharest Academy of Economic Studies, Bucharest, Romania. Pp. 2-3.
[50] Gookins.A, (2008), The Role of Intelligence in Policy Making, SAIS Review, Vol. 28, No. 1, Pp. 65-73, The Johns Hopkins University Press, USA.
[51] Dahlman. C, (2007), Technology, globalization and international competitiveness: Challenges for developing Countries", Industrial development for the 21st century, Department of economic and social affairs of United Nations, USA
[52] Shashikant.S and Khor.M, (2010), Intellectual property and technology transfer issues in the context of climate change, in Intellectual property rights series 14, TWN, Penang, Malysia

as trade secrets are now becoming a huge obstacle against technological intelligence activities and consequently erode the effectiveness of technology transfer process.

As it has been argued before, either a firm or state apparatus depending upon the purpose and main beneficiary can carry technological intelligence activities. In order to enhance intelligence activities it requires possession of necessary inputs such as fund to run the whole process, intelligence labour and the infrastructures. In general, it is an expensive task, which requires possession of special skills in its execution, therefore without the government support, it is almost impossible for SMEs to apply intelligence as technology transfer enabler. About private sector, only big companies particularly multinational companies can afford to establish competitive intelligence units or departments within their companies. Therefore, the small and medium enterprises (SMEs) cannot possess the capability to establish and run technological intelligence units. Based on these arguments, State's intelligence apparatus has an obligation to intervene and support the SMEs technically in order to enhance technology transfer activities in the country.

3.0 Why Technology Transfers is Crucial in Low Income Countries

According to scholars including Yeh (1989)[53], Choi (2009)[54], Mateso (2014)[55] and Dahlman (2007)[56], Hoekman, Maskus and Saggi, (2005)[57], Agola (2016)[58] and UNCTAD (2014)[59] it has been revealed that, technology transfer and adaption approach was crucial contributor behind economic miracle happened in the South East Asia and the pacific region. However, most of them had highlighted their concerns about the limited incorporation of technology transfer approach in

[53] Yeh.S, (1989), Understanding development: Modernization and cultural values in "Asia and the pacific region", University of Hawaii, UNESCO. Pp. (31-32).
[54] Ibid
[55] Ibid
[56] Dahlman. C, (2007), Technology, globalization and international competitiveness: Challenges for developing Countries", Industrial development for the 21st century, Department of economic and social affairs of United Nations, USA
[57] Hoekman, Maskus and Saggi, (2005), Transfer of Technology to Developing Countries: Unilateral and Multilateral Policy Options in World Development Vol. 33, No. 10, Pp. (1587–1602), Elsevier Ltd, UK. Pp. (1590-1592).
[58] Agola. O, (2016), Technology transfer and economic growth in Sub-Sahara African countries: Lessons from East Asia, Springer-Verlag Berlin Heidelberg, Germany. Pp. (7-13).
[59] UNCTAD, (2014), Transfer of technology and knowledge sharing for development: science, technology and innovation issues for developing countries, in UNCTAD current studies on science, technology and innovation, No. 8, United Nations Publication, New York, USA and Geneva, Switzerland. Pp. (4-12).

the Sub Sahara African countries. UNCTAD (2014)[60] established a link between poverty in Africa and technology deficit gap. According to UNCTAD (2014)[61], what distinguished the developed countries and low-income countries are technology gap. However, what matters most is the fact that the gap in terms of science and technology keeps on increasing[62]. Because of the weakness of technology inputs, technology has become inaccessible to billions of people in least advanced countries[63]. According to Gessese (2006), African countries are behind in terms of industrialization because of the deficit in knowledge and technological capability[64]. According to Global innovation Index report (2017), the most competitive countries in innovation inputs and outputs in the world is Switzerland; the most wealthy region in terms of innovation is the North America region followed by Europe and the South East Asia, East Asia and Oceanic regions; and the poorest region in term of economic performance and innovation capacity is Sub Sahara Africa (*See table 1.1*)[65]. What is worried most is the huge innovation and technological gap between the Sub Sahara Africa region and advanced countries. According to *table 1.1*, innovation inputs gap between Africa and North America region is 103% while innovation outputs gap is 186%; and innovation inputs gap between Africa and Switzerland is 110.6% while innovation outputs gap is 293.7%[66]. The gap between the Sub Sahara Africa and the South East Asia, and Oceanic regions in terms of innovation inputs is 59%, while innovation outputs gap is 113%[67]. The performance of almost all innovation inputs in Sub Sahara Africa are very poor in comparison with Asian and Europe regions, however what erodes most the competitiveness of innovation in Africa is poor quality of human capital and R&D facilities[68]. According to *table 1.1*, the quality of human capital and research in Switzerland is 63.3% out of 100 scores; in North America region is 55.3% out of 100 scores; South East Asia, East Asia and Oceanic regions is 41.4% out of 100 scores; while in

[60] Ibid. Pp. (4-12).
[61] Ibid. Pp. (4-12).
[62] Ibid. Pp. 3.
[63] Ibid. Pp. 12.
[64] Gessese.N, (2006), African Regional Implementation Review for the Commission on Sustainable Development (CSD-14): Report on the Review of African Sustainable Industrial Development, United Nations Economic Commission for Africa (UNECA) and UNIDO, Addis Ababa, Ethiopia.
[65] Cornell University, INSEAD, and the World Intellectual Property Organization, (2017), Global Innovation Index (GII) 2017; Innovation Feeding the World, 10th (Ed), the World Intellectual Property Organization (WIPO) and the Confederation of Indian Industry (CII), Geneva, Switzerland, and New Delhi, India. Pp. (29-33).
[66] Ibid.
[67] Ibid.
[68] Ibid.

Sub Sahara Africa is 18.5% out of 100 scores[69]. This implies that the quality of human capital and research activities in the Sub Sahara Africa is more than two times below the South East Asia region and three times below the North America region. The big picture here is that there is huge innovation and technological deficit in Sub Sahara Africa than anywhere in this planet, as result the region is characterized by very low quantity of knowledge and technology outputs (*see table 1.1).*

Table 1.1: Global Innovation Index (GII), top 10 Countries, Regional and Income Groups

Country/Economy	GII	Institutions	Human capital and research	Infrastructure	Market sophistication	Business sophistication	Input	Knowledge and technology outputs	Creative outputs	Output	Efficiency
Switzerland	67.69	89.47	63.29	65.10	67.51	62.61	69.60	69.06	62.50	65.78	0.95
Sweden	63.82	88.31	63.71	69.13	64.87	62.58	69.72	62.51	53.33	57.92	0.83
United Kingdom	63.36	88.24	54.70	63.32	59.02	63.69	65.79	62.88	58.97	60.92	0.93
United States of America	61.40	86.25	57.21	61.04	83.45	56.41	68.87	54.38	53.48	53.93	0.78
Finland	60.89	88.44	63.32	67.14	70.19	52.18	68.25	46.49	60.54	53.52	0.78
Singapore	58.70	91.43	66.13	63.19	70.17	52.50	68.68	43.93	53.48	48.71	0.71
Ireland	58.69	94.36	63.67	69.15	71.20	62.88	72.25	47.33	42.94	45.14	0.62
Denmark	58.49	92.18	66.41	64.35	61.59	60.12	68.93	48.79	47.32	48.06	0.70
Netherlands	58.39	83.53	60.13	61.55	60.00	51.44	63.33	51.06	55.85	53.46	0.84
Germany	58.13	87.62	55.07	62.06	55.05	54.51	62.86	55.88	50.94	53.41	0.85
Average	**37.12**	**63.05**	**34.03**	**46.19**	**47.23**	**34.97**	**45.10**	**25.77**	**32.53**	**29.15**	**0.63**
Region											
Northern America	57.53	88.62	55.26	61.54	78.56	52.13	67.22	46.52	49.14	47.83	0.71
Europe	47.10	75.57	46.41	56.10	51.72	42.93	54.54	35.24	44.05	39.65	0.72
South East Asia, East Asia, and Oceania	44.03	69.62	41.40	52.80	57.37	41.08	52.46	33.73	37.50	35.61	0.68
Northern Africa and Western Asia	34.33	59.33	32.43	46.35	44.87	28.62	42.32	22.80	29.89	26.34	0.61
Latin America and the Caribbean	31.73	54.51	26.84	43.56	45.11	31.11	40.23	17.35	29.13	23.24	0.58
Central and Southern Asia	28.53	47.28	24.25	37.52	43.78	27.29	36.02	20.57	21.51	21.04	0.59
Sub-Saharan Africa	24.88	52.19	18.53	30.45	36.21	27.88	33.05	14.77	18.64	16.71	0.51
Income level											
High income	48.85	79.28	48.34	58.64	55.46	44.41	57.23	36.65	44.30	40.47	0.70
Upper-middle income	34.13	59.47	31.50	45.74	45.69	31.05	42.69	21.14	30.00	25.57	0.60
Lower-middle income	28.80	47.61	22.34	35.91	43.48	27.02	35.27	19.75	24.92	22.34	0.62
Low income	23.38	49.11	17.44	28.32	33.13	28.99	31.40	14.17	16.55	15.36	0.49

Source: Global Innovation Index (2017)

Note: The WIPO used score/value, ranging from 1to 100 to rank innovation competitiveness of the countries; where one value is the lowest (weakest) score and 100 is the highest value.

[69] Cornell University, INSEAD, and the World Intellectual Property Organization, (2017), Global Innovation Index (GII) 2017; Innovation Feeding the World, 10th (Ed), the World Intellectual Property Organization (WIPO) and the Confederation of Indian Industry (CII), Geneva, Switzerland, and New Delhi, India. Pp. (29-33).

This study agrees with those scholars who consider technology transfer as a necessary solution against technology deficit in the Sub Sahara Africa. The basis of this argument is the fact that innovation inputs such as quality of human capital, R&D institutions and budget allocated for innovation are very weak[70] in the Sub Sahara Africa, therefore the capability of innovation in many African countries is limited. Based on that fact, the nearby and necessary solution is to transfer and adapt.

However, there are advantages as well as disadvantages in connection to technology transfer activities. The first possible negative effect of technology transfer activities is eroding economic advantages including profit to the source or original owner of innovation/technology. Some technology transfer practices particularly those associated with industrial espionage can have immense negative impacts to victim nations; actually, it can lead to zero sum game consequence. However, this study is not advocating unlawful technology transfer activities, particular those projects which damage other countries' competitiveness in order to enhance theirs. On the other hand, technology transfer and adaptation activities are enablers of equality among nations. Through technology transfer and assimilation, recipient countries can save cost, resources and time required to develop potential technologies independently[71]. Moreover, technology transfer can bring multiplier impacts to the home countries including, enabling poor in low-income countries to access high quality products at low price, and consequently reduce the technology's deficit gap between high- tech countries and low-income countries. However, by discouraging monopoly in science and technological business, technology transfer activities erode the competitiveness of high-tech countries through reducing firms' profit, distortion of business plan[72] and loss of market space. Despite the fact that technology transfer activities erode the economy in high - tech countries, the big picture seen here is that, the practice has multiple positive effects to the global population: First, sharing of knowledge, market and technologies eliminate a long term monopolization of economic opportunities in the world hence reduce inequality gap. Under

[70] UNCTAD, (2014), Transfer of technology and knowledge sharing for development: science, technology and innovation issues for developing countries, in UNCTAD current studies on science, technology and innovation, No. 8, United Nations Publication, New York, USA and Geneva, Switzerland. Pp. (11-13).
[71] Danielson. M, (2009), Economic Espionage: A Framework for a Workable Solution. The Minnesota Journal of Law, Science & Technology,Vol.10(2): pp. 503-548, USA
[72] Ibid

enabled technology transfer environment, no nation or firm can monopolize the entire market space and own all breakthrough technologies all the time. Moreover, technology transfer is an enabler of economic equality among nations. The existence of the big gap in innovation, science and technology between low-income and advanced economy countries places the low-income countries in a most disadvantageous position economically[73]. Utilization of technology transfer approach can enable the least developed countries to access both the knowledge and breakthrough technologies available globally at a limited cost and time. By doing so, technology transfer activities can be a bridge to enable the low-income countries to effectively participate into a global economic competition.

4.0 Background of Technology and R&D Instruments in Tanzania

Most of the public owned R&D instruments in Tanzania were established during Ujamaa Socialism period. Tanzania turned into socialism in February 1967. The country became a socialist state after adoption of 'Ujamaa' (socialism) and self-reliance ideology through endorsement of 'Arusha Declaration'[74]. Socialism ideology was practiced in Tanzania as political and economic system for a period of nearly two decades until 1986. Under Ujamaa ideology, all major means of the economy were legally confiscated into government ownership. In addition to nationalization of private property, a number of state owned enterprises were created. Among the public instruments established during Ujamaa period, were innovation and technology instruments. Most of the technology and innovation machineries available to date were established in (1970's - 1980's) during president Nyerere's administration. The main idea behind the decision to create innovation and technology instruments was to enable technology advancement in the country. Hereby, are state owned technology's manufacturing firms established as means to enhance technology availability in the country; Agricultural Technology Company ltd (Zana za Kilimo - ZZK Mbeya) which was established by the government in 1982; Ubungo Farm Implements (UFI)

[73] Clerc. P, (1997), "Economic intelligence": in World information report, Unesco, Paris, France. Pp. (304-317).
[74] Dias. C, (1970), Tanzanian Nationalizations: 1967-1970, in Cornell International Law Journal, Vol. 4: No. 1, Digital Repository (61- 65)

created in 1980; Small Industries Development Organization (SIDO) established in 1973; the Kilimanjaro Machine Tools Manufacturing Company (KMTC) created in 1984; and Mang'ura Mechanical and Machines tools Ltd - 1976[75]. Another technological based firm was the Tanzania Automotive Technology Centre's (TATC) which was established in 1985[76]. With the exceptionality of TACT, SIDO and KMTC which are still operating as SOE's, almost all other firms had their business collapsed immediately after their privatization during the late 1990's and early 2000's.

For the same aim of enhancing science and technology capacity in the country, the government of Tanzania during 1970 has created a number of R&D institutions. Among the R&D institutions created include; Tanzania Industrial Research and Development Organization (TIRDO) which was created in 1979; Tanzania Bureau of standards (TBS) created in 1975; Tanzania Industrial Studies and Consulting Organization Company (TISCO) established in 1979; and the Metal Engineering Industries Development Association (MEIDA) in 1979[77]. Others are Tanzania Commission for Science and Technology (COSTECH), which was established in 1986, The Centre for Agricultural Mechanization and Rural Technology (CAMARTEC) created in 1981, and the Tanzania Engineering and Manufacturing Design Organization (TEMDO). Furthermore, in 1985 the first National Science and Technology Policy for Tanzania was Created[78]. In addition, for the first time in 1990 the Ministry responsible for science and technology called 'the Ministry of Science, Technology and Higher Education (MSTHE)' was established[79]. Creation of these instruments in 1970's and 1980 has revealed the presence of adequate political willingness to boost technology advancement in the country during socialism era. Despite all these initiatives, contemporary almost more than three decades after establishment of the mentioned instruments, the level of technological and innovation advancement are still at its inferior status[80]. According to the

[75] Mothander, Kjærby and Havnevik, (1989), Farm Implements for Small-scale Farmers in Tanzania, Scandinavian Institute of African Studies, Motala Grafiska, Uppsala, Sweden. PP. (172-185)
[76] http://www.tatcnyumbu.or.tz/ Accessed [09/12/2017]
[77] Mothander, Kjærby and Havnevik, (1989), Farm Implements for Small-scale Farmers in Tanzania, Scandinavian Institute of African Studies, Motala Grafiska, Uppsala, Sweden. pp.21
[78] Mukama. B and Yongolo. C, (2005), Development of science and technology system and experience of Tanzania on S&T data collection, A paper in the Regional Workshop on Science and Technology Statistics, Entebbe, Uganda. PP. (8-9)
[79] Ibid.
[80] Tanzanian government, (2016), National Five years Development Plan 2016/17-2020/21, Ministry of Finance and Planning, Dodoma, Tanzania. Pp.17.

Tanzania National Five year Development Plan 2016/17-2020/21, the country recognized science, technology and innovation as crucial driver to development; however, the initiative to boost advancement in technology is still low in the country[81].

5.0 Competitiveness of Knowledge and Technology Transfer in Tanzania

According to the Global Innovation Index (*as presented by WIPO reports; 2013; 2014; 2015; 2016; 2017*), the innovation capacity in Tanzania is among the most inferior in the world. The reason behind the poor innovation capacity in the country is inadequate capacity of innovation inputs such as poor education, poor quality and quantity of R&D activities, inadequate number of researchers and scientists, etc. Because Tanzania is characterized by an inadequate innovation inputs, the author is worried that the country is heading towards innovation trap; meaning the poor innovation inputs will always result into poor innovation output. The incapability of the country to enrich the innovation inputs is one of the main factors, which motivated the author to raise the concern about the risk of innovation trap in developing countries including Tanzania. In addition, the incapability of the least developed countries such as Tanzania to access global available innovation wealth at affordable cost is another shortcoming, which hinders technology competitiveness in low-income countries. While Tanzania and other developing countries are facing innovation trap risk, developed countries are increasingly investing on innovation, meaning that they keep on generating an innovation wealth. This implies that the innovation gap between the low-income countries including Tanzania and the developed countries can keep on expanding. In order to deviate from falling into innovation trap, Tanzania and other low-income countries need to incorporate the technology transfer strategy as an immediate solution against the deficit in technology capacity. They need to find an appropriate and affordable mechanism to access global available innovation wealth rather than focusing on invention of their own technology. The author's argument is based on the fact that, there is a limited chance or possibility for Tanzania under available resources to generate a competitive innovation outputs. Meaning that the country

[81] Ibid.

should not expect the technological miracle under current situation where the technology's drivers are inadequate. The author's philosophy is that, technology transfer strategy can boost the capability of the country to utilize global available innovation wealth, and eventually close the technological gap between the poor and the rich nations.

Despite the fact, that many scholars consider technology transfer approach as an appropriate strategy for developing countries, there is limited evidence of applicability of the strategy in Tanzania. The role and implications of the technology transfer approach on the development of the South East Asia and the Pacific region provides a pragmatic evidence of the effectiveness of the strategy. Despite the fact that state owned R&D institutions in Tanzania are legally directed to incorporate technology transfer approach as a strategy, the approach is rarely applied. This implies that Tanzania has been recognizing the role of technology transfer strategy for long time since 1980's when many R&D institutions were established but neglected to apply the strategy. There are a number of evidences, which reveal the underutilization of technology transfer and adaptation approach in Tanzania. One of the signs of poor application of technology transfer strategy is limited ability of Tanzanian firms to adapt or absorb new technologies. Under competitive business environment, competitive firms are expected to be able to utilize superior innovation outputs as soon as invention is exposed to the global market. The study of series of annual reports of Global Competitiveness Index show that, Tanzanian firms are among the slow absorbers of innovation outputs in the world. *Table 1.2* reveals the rate of Tanzanian firms to absorb new technology. During 2012/13 - 2015/16, the rank of Tanzania in global competitiveness index has been ranging among 15 to 21 countries with worse competitiveness in the world in terms of firm's level of technology absorption (*see Table 1.2).* This implies that, the ability of Tanzanian firms to adapt to the new technologies was low.

Table 1.2; Trend of Firm's Level of Technology Absorption in Tanzania

Indicator		2012/13	2013/14	2014/15	2015/16	2016/17
Firm's Level of Technology Absorption	Score	3.9	3.9	3.8	3.8	4.2
	Rank	**129**/144	**127**/148	**129**/144	**129**/140	**98**/138

Source: Data was extracted from a series of annual reports of the Global Competitiveness Reports, (2012/13; 2013/14; 2014/15; 2015/16; 2016/17)

Note: i. World Economic Forum used score/value, ranging from one to seven to rank competitiveness of the countries; one value being the lowest score as and 7 as the highest value.

ii. Also fraction represents rank of the country out of the total number of countries involved in the competitiveness study; one being the highest (most successful country)

Among the methods of transfer is the inflow of FDIs; therefore, attraction of FDIs is one of the enablers of technology adoption and adaptation. According to the series of the reports of Global Innovation Index as shown in table 1.3, Tanzania has been recorded among highly competitive countries in terms of FDI net inflows as percentage of the GDP during 2013–2017. In 2013 Tanzania was ranked 51 out of 142 countries in the world; in 2015 Tanzania was ranked at position 28 out of 141 countries; in 2017 the country was ranked at position 32 as the best country out of 127 countries involved in the survey (*see table 1.3*). Based on the data presented in *table 1.3*, Tanzania has been a good destination for foreign investments, which automatically comes with superior foreign technologies and innovation.

Table 1.3: Trend of FDI net inflows, as % of GDP in Tanzania

Indicator		2013	2014	2015	2016	2017
FDI net inflows, % GDP	Score	4.6	4.6	5.6	4.3	4.4
	Rank	**51**/142	**46**/143	**28**/141	**37**/128	**32**/127

Source: Data was extracted from the series of annual reports of the Global Innovation Index; (2013; 2014; 2015; 2016; 2017)

The overall effectiveness of technology transfer activities in Tanzania, includes the competitiveness of both FDI inflows and physical transfer of technologies, the country was ranked

by Global Competitiveness reports at position 99 out of 144 countries in 2014/15, 108 out of 144 countries in 2015/16 and 96 out of 144 countries in 2016/17 (*see table 1.4*). This implies that in exception to FDI inflows, Tanzania is not competitive in term of technology adaptation or assimilation. Another fact to be noted is that transfer of technology through FDI inflows is only limited to the transfer of the high tech for large-scale firms, therefore the approach has limited impact to SMEs development.

Table 1.4: General Competitiveness of FDI and Technology Transfer in Tanzania

Indicator		2012/13	2013/14	2014/15	2015/16	2016/17
FDI and Technology Transfer	Score	4.7	4.6	4.2	3.9	4.0
	Rank	**66**/144	**77**/148	**99**/144	**108**/140	**96**/138

Source: Data was extracted from a series of annual reports of the Global Competitiveness Reports, (2012/13; 2013/14; 2014/15; 2015/16; 2016/17)

Note: i. World Economic Forum used score/value, ranging from one to seven to rank competitiveness of the countries; one value being the lowest score as and 7 as the highest value.

ii. Also fraction represents rank of the country out of the total number of countries involved in the competitiveness study; one being the highest (most successful country)

5.1 Effectiveness of Technology Transfer Environment in Tanzania

As it has been argued in the conceptual frameworks, many scholars consider technology transfer as a shortcut solution to success in developing countries environment. The author agree with many scholars including Choi (2009)[82], Mateso (2014)[83], UNCTAD (2014)[84] and Dahlman; (2007)[85], who advocated the incorporation of technology transfer approach as an enabler to technological

[82] Choi. J, (2009), Technology Transfer Issues and a New Technology Transfer Model, in the Journal of Technology Studies, Vol. 35. No.1, Pp. 49-57.
[83] Mateso. P, (2014), Technology transfer: the concepts, practices, and lessons for Tanzania and its TVET system a paper presented at the vet forum held in December 10/11/2014, in Arusha, Tanzania
[84] UNCTAD, (2014), Transfer of technology and knowledge sharing for development: science, technology and innovation issues for developing countries, in UNCTAD current studies on science, technology and innovation, No. 8, United Nations Publication, New York, USA and Geneva, Switzerland.
[85] Dahlman. C, (2007), Technology, globalization and international competitiveness: Challenges for developing Countries", Industrial development for the 21st century, Department of economic and social affairs of United Nations, USA

advancement in least developed countries. Based on the scholars' arguments, developing countries such as Tanzania need to borrow a leaf from South East Asia and the pacific countries such as Japan, Hong Kong, China, Republic of Korea, Singapore, and Taiwan which initially had acquired lots of their technologies through trade, copying, reverse engineering and technology licensing. They first used technology transfer approach to develop technologically; and later after they became developed, they started to strengthen their R&D instruments in order to increase their capability to develop their own technologies. Together with incorporation of technology transfer approach, they also invested to improve the quality of education provided.

5.1.1 Quality of Human Capital in Tanzania

It is not the intention of the author to open discussion about quantity and quality of education provided in Tanzania. However, the main aim of the author is to remind the audience about the implications of poor education to technology transfer activities. According to Choi (2009)[86], education and training is one of the crucial drivers to technology transfer activities. Therefore, the poor rate of enrolment of students into education as well as the poor quality of education provided particularly science and technology education are obstacles against technology transfer activities in Tanzania. The quality of human capital in the country is not pleasing as the status of education qualification to the majority of Tanzanian population nearly 79% is not above the primary school education qualification[87]. With this quality of population and under available strategies, it is almost unfeasible to advance technologically. What matters most is the fact that the quality of science and mathematics education is very low in Tanzania. According to the Global Competitiveness Reports, (*2012/13; 2013/14; 2014/15; 2015/16; 2016/17*), it has been revealed that, during 2012-2017 Tanzania has been ranked in the list of the 22 countries with the very poor quality of mathematics and science education in the world. The quality of Tanzania's science education reached at its critical low level in 2014/15, whereby out of 144 countries in the world the quality

[86]Choi. J, (2009), Technology Transfer Issues and a New Technology Transfer Model, in the Journal of Technology Studies, Vol. 35. No.1, Pp. 49-57.
[87] FinScope Tanzania (2017), Insights that drive innovation, FinScope Tanzania, Dar es Salaam, Tanzania. Pp. 16.

of Tanzania education was placed at ranked 137. Based on the data presented, indeed the quantity and quality of education particularly science education provided in Tanzania is very weak to the extent that it jeopardize the enhancement of scientific and technological advancement in the country.

5.1.2 Effectiveness of Technology Transfer Institutions in Tanzania

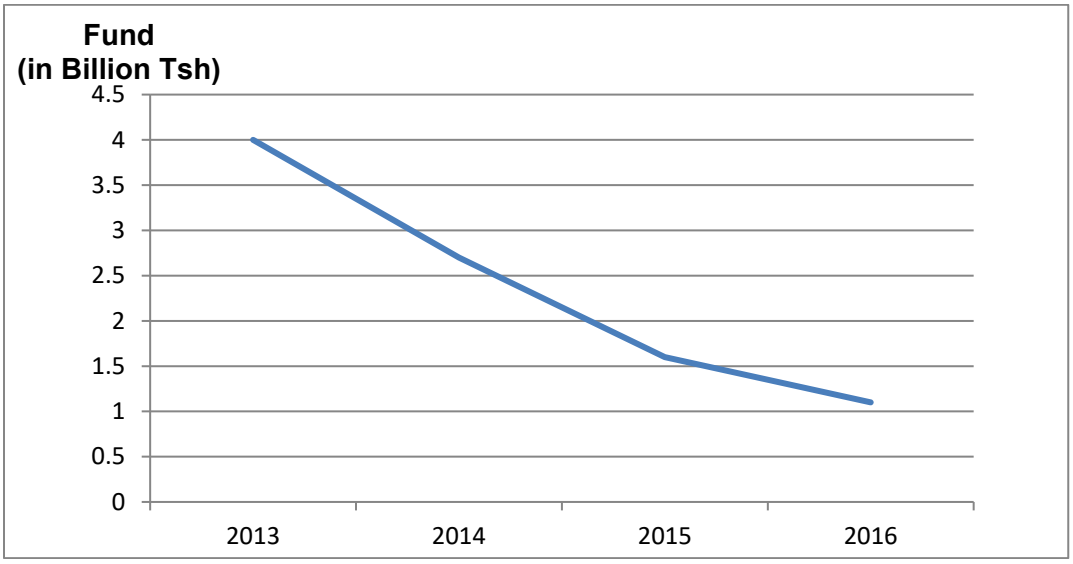
Technology and knowledge transfer activities can be enabled through three main platforms; R&D; Production; and commercialization. Therefore, the transfer of knowledge and technology can be done either through R&D institutions or through production firms. As presented before, the innovation institutions in Tanzania particularly TIRDO, COSTECH and CAMARTECH are legally directed to transfer and adapt foreign technologies. Despite the presence of legal permission, there are limited adaptation activities in the country. There are a number of shortcomings, which had eroded the effectiveness of R&D institutions in Tanzania.

The first obstacle is the limited role of private sector in R&D activities. The government owns most of the available R&D institutions in Tanzania, and therefore there are limited platforms for private sector to be involved in R&D activities. Under competitive market situation, the private sector is supposed to dominate and determine the transfer of technology. Based on the fact that, the private sector possess the competitiveness attribute, and based on the fact that they are always driven by profit making principles, the private firms are more likely to succeed in technological market in comparison with the public institutions. Since the private sector is driven by profit making desire, they are superior on making decision regarding what, where and how to transfer, produce and sale. Therefore, technology transfer as part of the chain of technology production and business can effectively be executed by private sector. The government is supposed to remain as an enabler to technology transfer environment, and not as a sole actor. It is on the opinion of the author that, the government should incorporate private sector through PPP projects within R&D framework in order to boost capability of the R&D institutions to transfer technology in Tanzania.

The second obstacle against technology transfer activities is the inadequacy of human capital particularly lack of engineers, scientists and researchers. For example; the outcome of the interview conducted at the Centre for Agricultural Mechanization and Rural Technology (CAMARTEC) revealed that, the total number of researchers and technicians working at the centre as innovation frontiers are only limited to 18 people. Out of 18 available experts, only one researcher was the professor; two researchers hold master degree qualifications; six researchers are bachelor degree holders; five technicians hold ordinary diploma qualifications *(See question 2 in the appendix I).* The CAMARTEC a public institution with two branches (Arusha and Tabora branches) is the only R&D instrument, which specialized on agricultural mechanization and technology in the country. The quantity and level of the researcher's qualification at CAMARTEC is very low, considering around 67% of the country's labour forces depend on agriculture. It is almost impossible for one professor together with 17 frontiers working at CAMARTEC to make an impact in a country of a population of more than 55 million.

Another huge obstacle is lack of fund required to finance the R&D activities including technology transfer. The quantity of budget allocated for R&D activities has been always very low (not more than 0.52% of the GDP per year). Amount of funds allocated to some R&D institutes such as CAMARTEC is always low and keep on decreasing year by year (*see question 13.1 in appendix I*). Based on the interview conducted, the amount of money allocated by the government to the CAMARTEC keeps on diminishing year by year. According to Chart 1.2, during (2013–2016) the amount of fund CAMARTEC received from government decline by 72.5%, from Tanzanian Shillings (TSH) 4.09 billion in 2013 to Tsh 1.1 -13824 in 2016.

Chart 1.2: Trend of fund allocated to CAMARTEC during (2013–2016)



Source: Written interview with CAMARTEC in 2017; see Appendix II, question 13.1

According to Table 1.5, the amount of funds allocated to the Tanzania Industrial Research and Development Organization (TIRDO) is smaller than that allocated to CAMARTEC. In 2014, TIRDO a public R&D institution that deal with industrial research received no funds for R&D activities from either the Government or donors. As it is seen in *table 1.5*, the sources of most of the TIRDO's funds come from self-generation. Because the Institute normally receives a limited amount of research's funds, TIRDO used to generate its income from its own sources using various means in order to survive. One of the means used by TIRDO to generate its fund is to rent its properties to other enterprises including non-research firms such as Banks. As it is seen in table 1.5, research funds at TIRDO are very small to the extent that the institute cannot even be able to offer sponsorship to 15 PhD students. What disturbs most, the government contribution to TIRDO and CAMARTEC research budget is very limited. This gives an impression that the policy makers ignore the R&D activities and there is limited political will to boost innovation activities in the country.

Table 1.5: Amount and Composition of TIRDO's Research Budget

Year	Amount of Money Received and the Source (USD)			Total (in USD)
	Government	Donner	Self-Generation	
2013	61,000	47,000	329,000	437,000
2014	-	-	376,000	376,000
2015	211,268	-	404,000	615,000
2016	234,742	47,000	423,000	705,000

Source: Written interview with TIRDO 2017; see Appendix II; question 13.1

Another obstacle against technology transfer activities is an inadequate of collaboration among stakeholders in research projects. Inflows of the high-qualified researchers from advanced countries into Tanzania are necessary inputs to knowledge and technology transfer. However, there is limited number of foreign researchers who play part on domestic research projects. For example: the outcomes of the interview conducted at TIRDO and CAMARTEC revealed that, neither TIRDO nor CAMARTEC which hosted any foreign research fellows during (2014-2016) (*see question number 3 and 4 in Appendix I and II*). This shortcoming is more associated with weakness within the foreign instruments; and the R&D institutions are just victims of the situation. Based on observation, there is no official bridge between the innovation instruments and the foreign instruments, as outcome it has become challenging to enable international collaboration in research and innovation activities, and this is one of the obstacle against knowledge and technology transfer. One of the officials at the TIRDO, whom did not want to disclose her /his identity, confirms that there is neither proper connection with any of the foreign instruments nor adequate coordination and support they get when it is needed from the foreign machineries. The official argued that; when it is found critical to get in touch with the foreign instruments, they normally depend on the assistance from a relative of one of the TIRDO's officials who works in the Ministry of Foreign Affairs and East African Cooperation to get the required support from the ministry.

Inadequacy of technology transfer readiness is another key obstacle against adaptation activities in Tanzania. The R&D institutions doesn't consider technology transfer activities as one of their

key responsibilities, therefore, the transfer activities are ignored. Based on the survey done at TIRDO, it was found that there were no any technology transfer projects executed by TIRDO during 2014-2017. What surprised most is the fact that TIRDO as R&D institution did not have any intention to engage itself in technology transfer activities despite the fact that legally technology adaptation is one of the responsibilities of the TIRDO. One of the indicators that technology transfer activities have been ignored at TIRDO is insufficiency of staff allocated to deal with the transfer activities. One of the department/directorate at TIRDO is ICT and technology transfer. Despite dedicating of specific department to deal with technology transfer activities, the department was completely dormant. The technology transfer department was never assigned with any staff/expert dedicated to deal with adaptation activities since its establishment, therefore the Head of the department is always there alone, doing nothing in connection with transfer activities but get paid. Based on these details, it is clear that lack of adequate political willingness and lack of technology transfer readiness is the main factor behind neglecting technology transfer activities at TIRDO.

5.1.3 Competitiveness of Technology Production and Commercialization in Tanzania

The most important step in technology transfer is Technology production and commercialization. Actually, productivity and business are the main determinant of the whole technology transfer process. Here is where the importance of incorporating private sector to technology transfers process comes in. Any attempt to stimulate transfer of technology without incorporations of market frontiers can lead to technology transfer failure. Technology production investments are within the framework of Industrial sector. According to the Speech of the former Minister of Industry, Trade and Investment – Tanzania, Charles Mwijage, the number of large scale and small and medium scale industries in Tanzania by 2013 were 49,243. 99.5% of the total number of industries available in Tanzania was SME's, and only 0.5% of the industries were large-scale firms[88]. The data presented reveals that, industrial sector in the country is dominated by SME's. According to the

[88] Speech on Plan and Estimates of Revenue Collection and Expenditure of the Ministry of Industry, Trade and Investment for 2017/2018, Presented in the Parliament of Tanzania by Minister of Industry, Trade and Investment, Charles Mwijage, May, 2017

ministry responsible for industry and business, Tanzania is not the only country in the world where SME's dominated the industrial sector; it is normal all over the world[89]. For examples; the number of SME's in Japan is equal to 99% of all industries available; Kenya 98%; Malaysia 97.3%; Indonesia 99.9%; Canada 98%; German 99%[90]. According to Minister of Industry, Trade and Investment – Tanzania, Charles Mwijage, the growth of industrial sector in Tanzania was 6.5% in 2015 and 7.8% in 2016. This implies that the rate of growth of industrial sector (7.8%) was slit higher than GDP growth (7%) in 2016. The contribution of industrial sector to GDP was 5.2% in 2015 and 5.1% in 2016. Based on the available data, industrial sector provide employment to 146,892 people in the country in 2016. Because SME's are the backbone of the economy, it is an obligation of Tanzanian government to facilitate and enhance establishment and performance of SME's in the country.

In order to facilitate development of SME is in the country; 'Small Industries Development Organization (SIDO)' was created in 1973 to facilitate the growth of SME's in the country. According to SIDO's Corporate strategic plan for 2014/2015 – 2016/2017, the instrument was created to execute four main objectives; first is to enhance SMEs Innovative capacity, access to technology, infrastructure and technical services; second, to boost business skills in order to enable SME's growth and competitiveness; third, to support SME's access to market and information; fourth, to enhance SMEs access to credit and finance services[91]. As it has been seen before, one of the SIDO's objectives is to support SME's technologically. SIDO support SME is through three main platforms; first, provide technical support to SME's; second is through creation of technology incubators centres around the country. Technology incubators centre project, which started in 2003 involved provision of support services and the workspace equipped with necessary innovation inputs. The main purpose of SIDO's incubators is to enable the junior innovators including talented young people to gain necessary experience and skills, and consequently transform their ideas into industrial products. Moreover, incubator beneficiaries are supported to gain market skills, commercialization knowledge and technical advisory services in order to make them competent

[89] Ibid.
[90] Ibid.
[91] Small industries development organization (SIDO), (2014), Corporate strategic plan for 2014/2015 – 2016/2017, Dar es Salaam, Tanzania

enough to establish their own SMEs. The government keeps on establishing technology incubators in various regions and districts for purpose of accelerating the rate of creativity and establishment of SME's in the country. Third, SIDO created 'Technology Development Centre (TDC)' around the country as mechanism to enable accessibility to technologies by SME's. The main function of TDC is to develop and produce technologies such as machines demanded by local SMEs. The main aim of TDC is to use innovation or technology transfer approach to produce technologies that enable further establishment of rural SME's. Up to July 2017, there was seven TDC established in seven regions; moreover the country is still working to meet the target of creating at least one TDC in each region in the country. One of the issues emphasized in the SIDO's Corporate strategic plan for 2014/2015 – 2016/2017, is the need to invest more on transfer of technologies. Technology development centre (TDC) has been directed to focus on technology transfer in order to speed up rural industrialization process in the country[92]. According to SIDO's Corporate Strategic Plan for 2014/2015 – 2016/2017, SIDO has been requested to establish strong partnership and collaboration with R&D institutions in order to enhance effectiveness in implementation of technology transfer approach[93]. The author is pleased with strategic directives on technology transfer[94]: However, the partnership should not be limited to R&D institutions only; instead, SIDO need to extend strong partnership and collaboration with all technology transfer frontiers including foreign stakeholders.

Moreover, the author is pleased with the SIDO's mission and objectives. Based on author's observation, SIDO is a proper model or platform for PPP between the government and SME's. The government can use SIDO's platform to enhance the performance of SME's in the country. However, it has been revealed that there is a limited government willingness or intention to enhance development of the SME's in the country. Poor budget allocated to SME's development in the country is an indicator of the limited willingness to support small and medium enterprises. SIDO's budget during financial year 2016/17 was Tanzanian Shillings (TSH) 8.6 billion (USD 3.7 million); in 2017/2018 was nearly doubled to TSH 14.1 billion (USD 6.1 million)[95]. Although

[92] Small industries development organization (SIDO), (2014), Corporate strategic plan for 2014/2015 – 2016/2017, Dar es Salaam, Tanzania
[93] Ibid.
[94] Ibid.
[95] The Citizen, Government Boosts SIDO's Capacity

SIDO's budget was increased during 2016-2018, still the fund allocated to SIDO is not sufficient to fulfil the requirements. Based on the opinion of Controller and Auditor General (CAG), the amount of budget allocated to SME's is small to the extent of jeopardizing the prosperity of SME's development in the country[96]. Due to budget deficit, the capability of SIDO to support the development of SME's has been limited to only 7%[97]. Based on the report of Tanzanian Controller and Auditor General (CAG) for 2016/2017, the performance of the SMEs in Tanzania during 2013/14 – 2016/17 was characterized by higher rate of failure. The failure rate of SMEs was 8% while the rate of success or growth was 5.6%[98]. Moreover, the contribution of SME's to GDP has been below the target; its contribution to the GDP in 2016/2017 was 35% while the expected target was 40%[99]. During the same period, SME's contribution to employment was 40%, which is below estimated target rate of 60%[100]. When responding against CAG findings, the former minister of industries, trade and investment, Charles Mwijage insisted that the main reason behind poor performance of SME in the country is poor technology[101].

Despite the presence of SIDO, data reveals that productions of technologies are inadequate in Tanzania. According to table 2.31, Tanzania is among of the countries in the world, which characterized by the deficit in latest technologies. The review of series of annual reports of (Global Competitiveness Reports; 2012/13-2016/17), shows that in 2012/13 Tanzania was among the 22 countries out 144 countries which recorded the lowest level of availability of latest technologies in the World; in 2015/16 the country was included among 13 countries out of 140 countries with the highest deficit in latest technologies in the world (see table 1.6). Due to poor manufacturing and importation of technology, the country characterized by an insufficient quantity of the latest technologies available in the country.

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http://www.thecitizen.co.tz/News/Govt-boosts-Sido-s-capacity/1840340-4393004-meyphh/index.html Accessed [15/04/2018]

[96] The Citizen, Government Boosts SIDO's Capacity http://www.thecitizen.co.tz/News/Govt-boosts-Sido-s-capacity/1840340-4393004-meyphh/index.html Accessed [15/04/2018]

[97] The Citizen, Government Boosts SIDO's Capacity http://www.thecitizen.co.tz/News/Govt-boosts-Sido-s-capacity/1840340-4393004-meyphh/index.html Accessed [15/04/2018]

[98] Tanzania to boost SMEs via a 28bn/- injection http://www.azaniapost.com/economy/tanzania-to-boost-smes-via-a-28bn-injection-h15625.html Accessed [15/04/2018]

[99] Ibid.

[100] Tanzania to boost SMEs via a 28bn/- injection http://www.azaniapost.com/economy/tanzania-to-boost-smes-via-a-28bn-injection-h15625.html Accessed [15/04/2018]

[101] The Citizen, Government Boosts SIDO's Capacity http://www.thecitizen.co.tz/News/Govt-boosts-Sido-s-capacity/1840340-4393004-meyphh/index.html Accessed [15/04/2018]

Table 1.6: Availability of Latest Technologies in Tanzania

Indicator		2012/13	2013/14	2014/15	2015/16	2016/17
Availability of Latest Technologies	Score	4.1	3.9	3.8	3.7	3.7
	Rank	**122**/144	**125**/148	**126**/144	**127**/140	**122**/138

Source: Data was extracted from five series of the Global Competitiveness Reports, (2012/13; 2013/14; 2014/15; 2015/16; 2016/17)

In addition, the effectiveness of technology production and business in the country can be seen through quantity of technologies exported per year. Based on *table 1.7*, the percentage of High-Tech products manufactured in Tanzania was 0.9% of the total goods manufactured in the country in 2013; 0.3% in 2016 and 0.1% in 2017. Therefore, the exportation of the High – Tech products as percentage of the total exports of all commodities during 2013 – 2017 have always been less than 1%. Moreover, the exports of the High-Tech in Tanzania have been declining year by year and reached its lowest level of 0.1% in 2017 (see *table 1.7*). The data presented provide a proof of the deficit in new technologies and limited capacity of technology production in the country. Based on the trend as presented in *table 1.7*, the situation is not getting any better, the rate of technologies manufacturing and export keeps on declining year by year.

Table 1.7: Quantity of Technologies Manufactured and Exported during 2013-2017 as % of total of all goods produced domestically and total trade respectively

Indicator		2013	2014	2015	2016	2017
High & Medium-High-Tech Manufactures as % of total trade	Score	11.0	10.5	0.1	10.0	0.1
	Rank	**72**/142	**74**/143	**101**/141	**77**/128	**82**/127
High-tech Exports less Re-exports, % total trade	Score	0.9	0.9	0.5	0.3	0.1
	Rank	**78**/142	**70**/143	**77**/141	**91**/128	**112**/127
ICT services Exports, % total trade	Score	2.1	0.4	0.4	0.6	0.4
	Rank	**117**/142	**104**/143	**96**/141	**93**/128	**104**/127

Source: Data was extracted from the series of the Global Innovation Index; (2013; 2014; 2015; 2016; 2017)

There are many factors behind limited production and application of technologies in Tanzania; one of the factors being the deficit in human capital. According to *table 1.8*, the rate of quantity in knowledge of the workers available in Tanzania is 22% of the expectation. But what matter most is the declining in the rate of knowledge of the workers in the countries; the trend of the rate of knowledge of the workers as revealed in *table 1.8*, keeps on declining year by year from 21.2% in 2013 to 14.2% in 2017. Based on the reports of Global Innovation Index during (2013–2017), Tanzania has always been included among 10 countries in world, which are characterized by low knowledge of the workers (*See trend in table 1.8*).

Table 1.8: Capacity of Knowledge of the Workers in Tanzania

Indicator		2013	2014	2015	2016	2017
Workers' Knowledge	Score	21.2	19.7	13.4	13.3	14.2
	Rank	**133**/142	**123**/143	**133**/141	**121**/128	**119**/127

Source: Data was extracted from the series of the Global Innovation Index; (2013; 2014; 2015; 2016; 2017)

Note: i. The WIPO used score/value, ranging from 1 to 100 to rank competitiveness of the countries; where 1 value is the lowest (weakest) score and 100 is the highest value.
ii. Also fraction represents rank of the countries out of the total number of countries involved on the competitiveness study; 1 being the highest the (most successful country).

5.1.4 Effectiveness of Tanzanian Foreign Instruments to boost Transfer of Technology

The Government role to influence foreign environment is one of the necessary inputs to technology transfer process. There are four main instruments, which deal with foreign activities in the country; the first instrument is foreign policy and objectives. Apparently, the government is dedicated to secure the foreign economic objective; second, is the Ministry of Foreign Affairs and East African Cooperation; the third instrument is Tanzania Intelligence and Security Service (TISS); and fourth instrument is the Immigration Department.

Contemporary, the main Tanzanian foreign agenda is enrichment and protection of country's economic interest abroad, famously known as economic diplomacy[102]. The government is keen to use bilateral, multilateral and regional platforms to utilize foreign economic opportunities, and consequently to enhance domestic economic situation[103]. Among the strategies applied by the government to enrich nation economic interest abroad includes, forming partnership with the potential international actors through bilateral and multilateral Diplomacy, endorsing good relationship with neighbours, and enhancing international peace and security. Also include enhancement of regional economic cooperation and integration such as supporting South-South Cooperation, and Cooperating with Multinational Corporations[104]. Based on the author's analysis and understanding, Tanzania foreign strategies are too broad, focusing more on enhancing country's involvement in diplomatic platforms than executing or implementing specific issues or agenda. The author was expecting to see specific areas of economic interest; the country is keen to gain from its participation in international platforms in order to boost domestic economy. On author's view, the policy was supposed to outline specific areas of interest and strategies the country intends to apply to fulfil her foreign objectives. For instance, the policy is silence about the means or strategies the country intends to use to enhance FDI inflows and enhancement of transfer of technology and knowledge. Moreover, the policy does not provide guideline on how the ministry will enable utilization of foreign education opportunities and enhancement of inflows of human capital. In addition, the policy is silent about means used by foreign instruments to enhance advancement in science and technology. Under the current foreign policy, foreign frontiers including diplomats and intelligence officials are not adequately guided to execute or secure specific foreign objectives. Therefore, it is optional for diplomats to enable transfer of technology and knowledge. What is clear is that, under Magufuli's administration the main government agenda abroad is to persuade and attract FDI inflows into the countries.

Under normal circumstance, the Ministry's structure is supposed to be set to address or execute specific policy issues or areas of interests rather than being too general. In addition, the departments in the foreign ministry were supposed to be designed or arranged based on the

[102] http://www.foreign.go.tz/index.php/ Accessed [01/09/2017]
[103] Ibid.
[104] Ibid.

country's interests abroad. The main purpose of each department/directorate should be to execute specific issues of interests abroad; therefore, the nature of the country's objectives abroad should be a key determinant of the structure of the ministry as well as the quality of diplomats. Borrowing a leaf from USA: the US foreign policy had pinpointed specific policy issues, which the foreign instruments are required to secure abroad. Moreover, the departments or units in the US Department of State are assigned to implement a specific policy issues. For examples, the Bureau of Oceans and International Environmental and Scientific Affairs[105] and the Office of the Science and Technology Adviser[106] were placed to secure specific scientific and technological objectives abroad. Unlike in the USA, the structural arrangement of Tanzanian Ministry of foreign affair and quality of the foreign policy does not adequately promote transfer of knowledge and technology. Based on the inadequacy of foreign policy and poor structure of Ministry of Foreign affairs, there is poor link between technology transfer instruments and the ministry responsible for foreign affairs. Therefore, there is a need for the Tanzanian government to review the structural arrangement of the ministry of foreign affairs and foreign policy in order to make it adequate to respond to country's main foreign agenda. Based on the author's observation, enabling technological adaptation needs to be prioritized as one among the main foreign objectives in Tanzania. Moreover, the structure of Ministry of foreign affairs, East Africa, Regional and International Cooperation need reformed in order to make it adequate to fulfil country's objectives abroad including technology transfer objective.

Another foreign instrument is the Tanzania Intelligence and Security Service (TISS). According to (*Tanzania Intelligence and security service Act, 1996; Sec 15 (4) and Sec 18 (b) (1)*), TISS in collaboration with the Ministry of Foreign affairs is allowed to operate abroad. The core functions of the TISS include; collection, analysis and dissemination of information[107]. Based on the TISS law, the power of the instrument is limited to collection and analysis of security information only. Therefore, the collection and analysis of technological related information is not part of its responsibility. However, Tanzania Intelligence and security service is the only instrument, which

[105] Bureau of Oceans and International Environmental and Scientific Affairs, US Department of State, USA https://www.state.gov/e/oes/index.htm Accessed [20/04/2017]
[106] Office of the Science & Technology Adviser, US Department of State, USA https://www.state.gov/e/stas/index.htm Accessed [20/04/2017]

[107] Tanzania Intelligence and security service Act, 1996; Sec 14 (1-4), Tanzania

technically and legally possesses capability and mandate to collect, analyse and distribute information in the country. Therefore, the isolation of the intelligence service from the gathering of technological and scientific information abroad is underutilization of the instrument. Based on author's view, securing country's economic interests abroad including technological and scientific interests is supposed to be part of the functions and responsibilities of intelligence service.

Based on the data presented, the collection of economic, scientific and technological information is not part of the functions or responsibility of any foreign instruments. Therefore, it is neither TISS nor Foreign Ministry is mandatory to collect technological and scientific information abroad. This is a huge obstacle against technology transfer activities in the country as information about the potential technologies and innovations available in foreign environment are crucial input to technology transfer process. According to the National five year development plan 2016/17-2020/21 (2016), one of the things which hinder the advancement in technology is the limited knowledge about the new technologies. Domestic's technology stakeholders are lacking necessary information about foreign knowledge and technology, and consequently limit their ability to enable adaptation of technology. The author is not concerned much about, the large-scale enterprises and the multinational companies as they possess know how, resources and capital to access foreign knowledge and technologies. The small and medium scale enterprises (SMEs) are the most affected group as they do not possess adequate capability to access or utilize foreign technologies without support from the government. SMEs do not have capital, knowhow and strategies to collect information about technological situation in the global market. Borrowed leaf from European Union (EU) experience: probably after they recognize the necessity of information to innovation and technology transfer, and understanding the inferiority of SME's to access to information, the Europe Union (EU) in 2002 established a specific economic intelligence project with the aim to enable SME's to access competitive innovation and technologies and consequently to improve their competitiveness[108]. "*The main objective of ETI projects was to use dedicated networks and information sources to promote innovation in SMEs, to gather, analyse and disseminate information on technological developments, applications and markets relevant to*

[108] Directorate General for Research European Commission, (2006), Economic and Technological Intelligence (ETI) projects for SMEs: Volume 1, European Community, Brussels, Belgium,

SMEs, and to identify and disseminate best practice. Moreover, the project aimed to improve SMEs competitiveness in Europe. The projects' generic goals were the creation of groupings of SMEs with shared innovation needs; the participation of SMEs and SME groupings in research projects and the promotion of trans-regional co-operation between SMEs and networks of industrial incubators[109]. The project by itself is an innovation, which can be transferred to intercontinental level and country's level. If the European countries which are considered as advanced countries technologically and economically, found it was profitable to apply intelligence tactics to empower SME's technologically, it's a matter of very important deal to developing countries particularly Tanzania to adapt the EU approach as the SME's in the country are more inferior in comparison with European SME's. Meaning the approach would be more useful in the developing countries such as Tanzania than it was in Europe. Despite the fact that the ETI projects were undertaken long time ago almost 17 years back, neither country including Tanzania nor regional community in the Sub Sahara Africa has made any efforts to adapt the EU approach of technology transfer. Tanzania needs to review its intelligence law to make the intelligence service accountable to collect information abroad about competitive knowledge, new technologies and innovation: The information that can be utilized by domestic SME's and R&D institutions to transfer knowledge and technologies.

Another good pragmatic example about the role of foreign instruments to facilitate technology and knowledge transfer is '*Operation Paperclip*' in USA: the Paperclip project was US secret program, which intended to bring Nazi Scientists to USA[110]. Operation Paperclip was designed and implemented by CIA immediately after the end of World War II. The main objective of the operation was to recruit the former NAZI scientists and assimilate them into US science and technology machinery[111]. US officials were convinced that, German's experts possess adequate expertise required to create new civilian industries, and consequently produce jobs in USA. Certainly, German scientists were involved in developing synthetic rubber which used to create a

[109] Ibid
[110] Freeman. M, (1991), Tell the truth about the German rocket scientists, in the Executive Intelligence Review, Vol. 18, No. 35, USA.
[111] Jacobsen. A, Reviewed by Watkins. J, (2014), Operation Paperclip: The Secret Intelligence Program to Bring Nazi Scientists to America, in the Studies in intelligence, Vol. 58No. 3, Pg 575, CSI Publications, USA.
https://www.cia.gov/library/center-for-the-study-of-intelligence/csi-publications/csi-studies/studies/vol-58-no-3/operation-paperclip-the-secret-intelligence-program-to-bring-nazi-scientists-to-america.html [Accessed 9/6/2016]

number of products including an automobile tires, the ear thermometer, electromagnetic tape, and miniaturized electrical components, etc[112]. It is said, under Operation Paperclip many German Scientists, engineers and technicians were transferred from German to USA and became part of the US successful innovation frontiers. One of the transferred scientists is Werner von Braun who led the project of Apollo Moon Landing[113]. Another important Nazi's recruited under *Operation Paperclip* is Dr. Hubertus Strughold[114]. According to Jacobsen, as reviewed by Watkins (2014), Dr. Hubertus played an important role in space medicine by developing space suits and other life-support systems. In June 1948, he put a rhesus monkey named Albert in the pressurized nosecone of a V-2 rocket in a pressurized nose cone, the first experiment in the effort to send people to space[115]. There is no way the *Operation Paperclip* would be successful without the influence of intelligence and immigration instruments.

The US legal and policy framework has created a loophole for intelligence instruments particularly the CIA in cooperation with the other foreign instruments to spot, recruit and move foreign scientists and potential experts into USA. Under the Section 7 of the Central Intelligence Agency Act of 1949, the director of the CIA, in coordination with the Attorney General and the Director of the US Citizenship and Immigration Services (USCIS), has a power to grant a lawful permanent resident status to a limited number of aliens each year[116]. Moreover, Section 204 (5) (h) of the US Code of federal regulation[117] created the extraordinary ability option to facilitate attract and keep potential people such as researchers and high skilled expert into the USA, so that they could contribute to their field and to the economy[118]. There is a good possibility that some of the scientists including the former Nazi scientists and other foreign scientists were able to acquire easily the US permanent resident permits or citizenship because of the implications of the US laws including the CIA law and federal laws. Tanzania does not have infrastructure to support or facilitate the transfer of expertise in the country. The pragmatic example was uncovered in order

[112] Ibid.
[113] Ibid.
[114] Ibid.
[115] Ibid.
[116] Central intelligence agency Act of 1949, Sec. 7, [As Amended through P.L. 112–87, Enacted in 2012]. USA.
[117] Title 8 of code of federal regulations, Immigrant petitions, Sec. 204 (5), Petitions for employment-based immigrants, USA.
[118] When a Scientist Can Petition for a Green Card Based On Talent, With No Job Offer, Nolo
https://www.nolo.com/legal-encyclopedia/when-scientist-can-petition-green-card-based-on-talent-with-no-job-offer.html
[Accessed 2/9/2017]

to reveal the role the foreign instruments can play to facilitate transfer of knowledge and technology in the country.

6.0 Conclusion and Recommendations

Based on the data presented it has been verified that the capacity of the country to generate technology is very limited in comparison to other countries. It has also been revealed that the main factors, which hinder the advancement in science and technology in Tanzania, are poor innovation capacity and inadequate application of technology transfer strategy. Therefore, this work has verified that it is true; the low innovation capacity and inadequate in application of technology transfer approaches are the main reasons behind the deficit in technology outputs in Tanzania. This imply that the hypothesis proved to be true. However, the focus of the study was not to uncover the innovation capacity in Tanzania. Instead, the key objective was to assess the applicability of technology transfer and adaptation approach in Tanzania. Despite the fact that technology instruments have been requested by the Tanzanian laws to incorporate technology transfer as part of their functions, Tanzania has been witnessing limited adaptation activities. Based on the findings, among the main factors, which eroded the application of transfer approach in Tanzania, include; inadequacy of the political willingness, inadequacy of the technology transfer instruments; and the lack of the technology transfer awareness/readiness in the country. The first obstacle is an ineffectiveness of the foreign instruments to enable the transfer of knowledge and technologies. Ministry of foreign affairs, East Africa, Regional and International Cooperation and the Tanzania Intelligence and Security Service as foreign apparatus were not set to facilitate transfer of knowledge and technologies in the country. Based on Tanzania intelligence law, Foreign policy and structural arrangement of the ministry responsible for foreign affairs, Tanzania foreign instruments have limited capability to influence the transfer of knowledge and technology. Tanzania foreign policy is silence about the country's core policy issues and specific areas of interest. Moreover, there is no a department or a unit within the ministry responsible for foreign affairs which was placed to secure the technological and education interests abroad. Based on the structural arrangement of the ministry, the intelligence law and the foreign policy, the foreign

frontiers including diplomats working abroad are the one who define and interpret the specific issues or areas of interests the country is keen to secure abroad. The country needs to review its foreign policy and the structure of its foreign ministry in order to enhance the effectiveness of the foreign instruments. In addition, the TISS law needs to be reviewed in order to allow the intelligence service to effectively participate in technological intelligence. The law and policy should provide a mandate to intelligence in collaboration with diplomats to gather information about foreign innovation, technologies and other economic opportunities available in foreign environment.

Country's law and policy need to be reshaped in order to make foreign instruments accountable to the following; first, to enable education exchange programs and scholarships for Tanzania students. Since quality of education gap between Tanzania and developed countries is too huge, by enabling education partnership and collaboration between Tanzanian institutions and Universities in advanced countries, knowledge and skills can be easily transferred to Tanzania. Moreover, foreign instruments can be used as enabler for inflows of high skilled experts, academicians and researchers into Tanzania. This can be achieved through identifying the potential high skilled personnel abroad; and then attract and persuade them to move and work in Tanzania. Also through easing entrance, work permit and permanent resident permit to potential personnel particularly high-qualified scholars, the country can influence the movement of people with potential expertise into Tanzania. Tanzania needs to borrow leaf from advanced countries such as USA and China on how to attract and persuade potential people to move into Tanzania. Hereby is a pragmatic evidence from USA experience; USA is one of the countries which applied the approach of knowledge transfer through recruitment of potential scientists and experts from different countries in order to enhance the competitiveness of US firms. The US legal structure gives a room for foreign instruments to influence the process of knowledge transfer. Because of the presence of favourable foreign environment, USA is among the countries in the world, which attracts and hosts many high skilled peoples particularly scientists from foreign countries. For instance, all six winners of Nobel Prize in USA during 2016 in scientific and economics areas had immigrants background[119]. It is also said that about 40% of all of the Nobel Prize winners in

[119] Anderson. S, (16/10/2016), Immigrants Flooding America With Nobel Prizes

scientific field during 2000 – 2016 are US residents with immigrant's origin[120]. Probably after learning a lesson from US, in January 2018, China officially adapted knowledge transfer approach through easing residence permit regulations[121]. In order to attract inflow of high skilled peoples from abroad, China introduced a new law, which allows potential technology practitioners, entrepreneurs, and scientists from in-demand sectors to acquire long-term multi entry visas, which will consequently let them, stay and work in China for long time up to10 years[122]. This type of mission cannot be successfully without the presence of an adequate collaboration among foreign stakeholders including Intelligence, Diplomacy and Immigration authorities as well as a legal basis and the foreign policy directives.

Another shortcomings observed, is inadequacy of information enrichment machinery and research collaboration platforms. Technology and innovation information institutions are instruments, which collect, analyze and distribute knowledge or information to technology transfer stakeholders including R&D institutions and SME's. It has also been revealed that information about the new technologies and innovation are crucial input to technology transfer process. Therefore, lack of information machinery in Tanzania is a huge obstacle to technology adaptation in the country. Borrow leaf from China's experience: According to Clerc (1997), China is among the first nations in the world to create information machinery to support innovation and technology development. The field of scientific and technical information was introduced in the mid 1950's as an official discipline in the China's academic institutions particularly science academy[123]. In 1956, China established the first Institute of Scientific and Technological Information of China (ISTIC) as machinery to exploit and utilize information from scientific and technological networks[124]. By 1958, there were thirty-three state owned institutions and thirty-five regional institutes in ISTIC network, and some 60,000 peoples were employed by the Institutes[125]. ISTIC was the first

https://www.forbes.com/sites/stuartanderson/2016/10/16/immigrants-flooding-america-with-nobel-prizes/#725246256cb6 Accessed [12/10/2017]

[120] Ibid.

[121] BBC News, (5/1/2018), China offers 10-year visas to 'high end talent' http://www.bbc.com/news/business-42575436 Accessed [17/03/2018]

[122] Ibid.

[123] Clerc. P, (1997), Economic Intelligence, in the World Information Report, Pg 304 – 317, UNESCO, Paris, France.

[124] Ibid.

[125] Ibid.

information institution to be established and sponsored by the China's Government[126]. Stations of ISTIC were created as departments or units within various public apparatus such as Provinces offices, and State owned enterprises[127]. The major role of ISTIC was to enhance technological and scientific advancement through cultivation and distribution of information resources to innovation and technology stakeholders. Tanzania can adapt China model by creating a series of technological and innovation information institutions in order to enable inflow of knowledge and information resource to technology transfer stakeholders. The proposed information institute can operate as the bridge between technology and innovation stakeholders and foreign instruments. In addition, information instrument can be mandated to operate as a bridge or networks enabler for technology and innovation instruments in the country. Therefore, the information instruments can be created to execute two main tasks; first is to gather, analyze and distribute information to stakeholders; second, to operate as partnership and collaboration hub for technology and innovation stakeholders.

Another obstacle against technology transfer activities in Tanzania is inadequate of the political will and poor technology transfer readiness. The country does not have political agenda to facilitate adaptation activities in Tanzania. Due to the presence of limited political willingness, the budget allocated for technology and innovation activities is very limited. Due to poor political will, foreign instruments has not been facilitated to enable transfer activities and the government is doing less to influence technology shift.

This paper is ending with the conclusion that inadequacy of political willingness and the lacks of technology transfer readiness are the main obstacles against technology transfer activities in Tanzania. Due to the multiplier effect of inadequate on the political will as well as lack of readiness, all technology transfer inputs or drivers are dormant or underutilized.

[126] Kahaner. L, (1997), Read Competitive Intelligence: How To Gather Analyze And Use Information To Move Your Business To The Top, Touchstone, New York, USA.
[127] Ibid..

6.1 Recommendations

Based on the data presented, there is a limited chance for low-income countries, which are characterized by low GDP per capita, inadequate R&D budget, poor quality of human capital, and poor infrastructures to adequately enrich their innovative capacity in any near future. It will take time for the low-income countries to enhance the efficiency of their innovation inputs as some of the inputs such as education and infrastructures take time to materialize. The intention of this study is not to undermine innovation enhancement initiatives, instead the low-income countries are encouraged to keep on investing on education particularly science and technology education as well as to develop innovation infrastructures. However, it is a fact that education enhancement is long-term solutions to technology advancement. Based on this situation, it is crucial for the low-income countries to dedicate their efforts on enhancement of technology and knowledge transfer activities while keeping on investing in education in order to influence technology advancement in the region. Since other regions particularly North America, Europe and South East Asia and the Pacific are rich in terms of innovation wealth, low-income countries particularly the Sub-Sahara African countries, have a chance to share the knowledge and technologies available in the advanced countries. However, technology and knowledge transfer cannot be successful until the following conditions have been fulfilled:

i. The first condition is technology transfer readiness. The readiness of the government and private sector as key stakeholders can influence the rate of transfer and adaptation. Government and its instruments including R&D institutions, regulations, policy and political willingness can play major role to reshape ability of the country to adapt and absorb foreign technologies. In order to smoothen or fasten technology transfer activities, a country can create the technology transfer and adaptation laws, regulation and strategy. Culture, education, policy and regulations can be applied to enhance the readiness of the people and firms to adapt foreign technologies.

ii. Second condition is activeness of foreign instruments to facilitate the transfer of technology. Foreign instruments, which include the foreign policy, diplomacy and

intelligence, are bridges, which can connect domestic technology stakeholders and foreign economic environment. The foreign instruments to access acquire and utilize foreign technology and knowledge can support technology's actors, which have limited access to the foreign environment including SMEs and R&D institutions. However, effectiveness of foreign instruments depend much on presence of the following; political will in terms of government agenda to enable transfer activities; policy and regulation which push foreign instruments to engaged in facilitation of adaptation activities; and legal frameworks which empower the foreign instruments.

iii. Another condition is availability and activeness of technology transfer instruments. Transfer and adaption process comprised all instruments in a value chain of technology transfer, ranging from education and training, manufacturing and R&D institutions. In addition, it includes SMEs and large-scale firms, testing platforms as well as standards and quality assurance regulatory agencies. All these instruments need to be legally, strategically and politically positioned to facilitate transfer of technology in the countries. Technology transfer actors need to be able to interact, complement each other and share responsibilities in order to enable success in transfer activities. Moreover, these instruments need to be technologically ready, willing and capable to facilitate the transfer process.

iv. Another crucial condition is availability of innovation and technology information machinery; some countries call it technology transfer centre or institute. This is crucial input in developing countries environment where many technological stakeholders such as SMEs are financially and technically weak. This is an instrument, which enables inflows of potential information and knowledge to domestic stakeholders about foreign technology and innovation. In addition, it is the instrument, which enable partnership and collaboration among technology stakeholders in the country. Foreign instruments can be interconnected with the domestic technology transfer stakeholders through these instruments. These are the machinery, which facilitates and stimulates transfer and adaption activities in various platforms within and outside the country; it is an apparatus, which needs to be legally empowered and technically capable to enhance technology transfer activities.

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Appendix

Appendix I: Written Interview questions for CAMARTEC

Target organization: the Centre for Agricultural Mechanization and Rural Technology (CAMARTEC) - Tanzania

Name of Interviewer: _____ Title: _____
Highest academic qualification: _____
Date of interview: _____

I am Edson Mwabukojo, a PhD student at University of Bucharest Romania and Institute for Cultural Diplomacy Berlin, Germany. I am here to collect data about the effectiveness of national's strategies toward agro technology transfer and innovation in Tanzania. The focus of this interview is to collect data about the role your Institute played to enhance agricultural mechanization and technology in the country. This interview is undertaken as part of fulfillment of the requirements of PhD study and not otherwise. Therefore, you are assured; information collected will be kept strictly confidential. I will appreciate if you will be truthfully when you answer the questions. Thank you in advanced

1. What circumstance leads to the establishment of CAMARTEC? You can provide attachment to support your answer.

_____
_____
_____

2. What is the academic status of the current available researchers? Please provide details in the following table.

	Academic level	Quantity (Number)
1	Senior Professor	
2	Professor	
3	Assistance Professor	
4	Associate Professor	
5	Post Doctorate	
6	Dr. of Science	
7	PhD	
8	Master degree	
9	Bachelor degree	
10	Diploma	

3. Out of the total number of researchers available are there any foreign research fellows working with CAMARTEC. i. ☐ Yes ii. ☐ No. If yes, please provide their academic details in the following table.

	Academic level	Quantity (Number)
1	Senior Professor	
2	Professor	
3	Assistance Professor	

4	Associate Professor	
5	Post Doctorate	
6	Dr. of Science	
7	PhD	
8	Master degree	
9	Bachelor degree	
10	Diploma	

4. How many foreign's research fellows your institute has hosted in the previous three years.

	Academic level	Quantity (Number)	Years		
			2014	2015	2016
1.	Senior Professor				
2.	Professor				
3.	Assistance Professor				
4.	Master Degree				
5.	Undergraduate				

5. Does your researchers goes abroad to work as research fellows to the foreign research institutions?
i. ☐ Yes ii. ☐ No. If yes, please provide details about their research projects abroad in the following table for the past three year. (You can attached document to support your answer)

	Researcher's Academic Qualification	Name of the Foreign Research institution	Project Name	Year and Month	
				From	To
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

6. Did CAMARTEC has research corroboration or partnership agreements with other foreign research institutions? i. ☐ Yes ii. ☐ No. If yes, please provide details about the nature of the relationship in the following table.

	Foreign Research Institute		**Core Research activities**	**Type of Relationship**	**Year of Agreement**
	Name	**Country**			
1					
2					
3					
4					
5					
6					
7					
8					
9					

10					

7. Does your researchers have a regular access to professional development training? 1. ☐ Yes.
2. ☐ No. If yes, please outline the hosting countries and the name of the training provided in previous four years in the following table?

	Name and type of the Training	**Country**	**Period Month &Year**		**Name of Training Provider**	**Sponsor**
			From	To		
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						

8. Is technology and knowledge transfer among responsibility/function/objective of your organization/company/institute? i. ☐ Yes ii. ☐ No. If yes, please mentioned the legal and policy, which give your instrument a mandate to carry on the activities?

a._____

b._____

c._____

9. Is there any specialized department, section or directorate within CAMARTEC which deal with technology and knowledge transfer? Please outline the details. i. Yes ii. ☐ No. If yes, please name them.

_____

_____

10. Is there any partnership, support or assistance in relation with technology and knowledge transfer CAMARTEC receive/benefit from government? i. ☐ Yes ii. ☐ No. If yes, please tick appropriate support CAMARTEC normal receive from government among the following.

i. Information regarding breakthrough technology ☐
ii. Support professional development Training ☐
iii. Political directive ☐
iv. Policy ☐

11. Is economic/competitive/industrial, business intelligence practice incorporated by CAMARTEC as one his competitive advantage strategy? i. ☐ Yes ii. ☐ No. If yes;

(A). what are the main objectives of incorporating intelligence approach? Please tick the right answer among the following.

i. Enhancement of technology transfer operations ☐
☐
☐

ii. Knowledge and skill empowerment

iii. Market competitive advantage

iv. Protection of economic interest against external threats ☐

(b). Is there any specific department/ section or unit within your organization which deal with intelligence activities? i. Yes ☐ ii. No. ☐ If yes, please mention the name ……..

12. What are the major achievements of your institution in term of agro technology innovation and technology transfer in the past two years? Please answer by filling the following tables. (You can provide attachment to support your answer).

	Nature and Name of achievement (machine/technology or knowledge)	**Year**	**Nature of making**		**Capacity**
			Innovated	**transferred**	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					

13. Does CAMARTEC. Received adequate financial resources to run its activities?

1		Yes	2		No

13.1 What is trend of CAMARTEC budget for the past four years? Please answer by filling in the following table.

Year	**Annual Budget (in Tsh)**	**Amount of Money Received and the source (in Tsh)**		**Deficit (in Tsh)**	**Name of the Financial Contributor (Other than Government)**
		Government	Donner		
2013					
2014					
2015					
2016					

14. How does CAMARTEC link with agricultural stakeholders'? Please provide details by filling in the following table. (You can provide an attachment to support your answer)

	Type of Stakeholders	Explanation
1	Small Scale Farmers	
2	Large Scale Farmers	
3	Smallholder enterprises	
4	Large Scale processing industries	
5	Government	

6	Agricultural Machines/Technology producers	
7	Ministry responsible for Foreign Affair	
8	Economic information gathering organs	
9	Global partners	
10	Regional Partners	
11	Ministry responsible for trade and Industries	
12	FDI	

16. How does CAMARTEC collect information about breakthrough strategies, policies and other advance technological information from advanced countries?

_____
_____
_____
_____

17. How does CAMARTEC share or access information regarding knowledge transfer, better policies and strategies from other foreign agricultural research institutions?

_____
_____
_____

Thank you very much for your participation in this interview. Your answers will be very useful for my research. Moreover, I promise to give your Institute a copy of my PhD thesis upon completion.

The End

Appendix II: Written Interview questions for TIRDO

Target organization: the Tanzania Industrial Research and Development Organization (TIRDO)

Name of Interviewer: _____ Title: _____
Highest academic qualification: _____
Date of interview: _____

I am Edson Mwabukojo, a PhD student at University of Bucharest Romania and Institute for Cultural Diplomacy Berlin, Germany. I am here to collect data about the effectiveness of national's strategies toward agro technology transfer and innovation in Tanzania. The focus of this interview is to collect data about the role your Institute played to enhance agricultural mechanization and technology in the country. This interview is undertaken as part of fulfillment of the requirements of PhD study and not otherwise. Therefore, you are assured; information collected will be kept strictly confidential. I will appreciate if you will be truthfully when you answer the questions. Thank you in advanced

1. What circumstance leads to the establishment of TIRDO? You can provide attachment to support your answer.

_____
_____
_____

2. What is the academic status of the current available researchers? Please provide details in the following table.

	Academic level	Quantity (Number)
1	Senior Professor	
2	Professor	
3	Assistance Professor	
4	Associate Professor	
5	Post Doctorate	
6	Dr. of Science	
7	PhD	
8	Master degree	
9	Bachelor degree	
10	Diploma	

3. Out of the total number of researchers available are there any foreign research fellows working with TIRDO? i. ☐ Yes ii. ☐ No. If yes, please provide their academic details in the following table.

	Academic level	Quantity (Number)
1	Senior Professor	
2	Professor	
3	Assistance Professor	
4	Associate Professor	
5	Post Doctorate	
6	Dr. of Science	
7	PhD	

8	Master degree	
9	Bachelor degree	
10	Diploma	

4. How many foreign is research fellows TIRDO has hosted in the previous three years.

	Academic level	Quantity (Number)	Years		
			2014	2015	2016
1.	Senior Professor				
2.	Professor				
3.	Assistance Professor				
4.	Master Degree				
5.	Undergraduate				

5. Does TIRDO researchers goes abroad to work as research fellows to the foreign research institutions?
i. ☐ Yes ii. ☐ No. If yes, please provide details about their research projects abroad in the following table for last year. (You can attached document to support your answer)

	Researcher's Academic Qualification	**Name of the Foreign Research institution**	**Project Name**	**Date (Month)**	
				From	**To**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

6. Did TIRDO have research corroboration or partnership agreements with other foreign research institutions? i. ☐ Yes ii. ☐ No. If yes, please provide details about the nature of the relationship in the following table.

	Foreign Research Institute		Core Research activities	Type of Relationship	Year of Agreement
	Name	Country			
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

7. Does TIRDO researchers have a regular access to professional development training? 1. ☐ Yes.
2. ☐ No. If yes, please outline the hosting countries and the name of the training provided in previous four years in the following table?

	Name and type of the Training	Country	Period Month &Year		Sponsor

			From	To	Name of Training Provider	
1						
2						
3						
4						
5						
6						
7						
8						
9						

8. Is technology and knowledge transfer among responsibility/function/objective of TIRDO?
i. ☐ Yes ii. ☐ No. If yes, please mentioned the legal and policy, which give your instrument a mandate to carry on the activities?
a._____

b._____
c._____

9. Is there any specialized department, section or directorate within TIRDO which deal with technology and knowledge transfer? Please outline the details. i. ☐ Yes ii. ☐ No. If yes, please name them.
_____
_____

10. Is there any partnership, support or assistance in relation with technology and knowledge transfer TIRDO receive/benefit from government? i. ☐ Yes ii. ☐ No. If yes, please tick appropriate support TIRDO normally receive from government among the following.

i. Innovation Information ☐
ii. Training ☐
iii. Breakthrough technology ☐
iv. Policy ☐

11. Is economic/competitive/industrial, business intelligence practice incorporated by TIRDO as one his competitive advantage strategy? i. ☐ Yes ii. ☐ No. If yes;

(a). what are the main objectives of incorporating intelligence approach? Please tick the right answer among the following.
i. Enhancement of technology transfer operations ☐
ii. Knowledge and skill empowerment ☐
iii. Market competitive advantage ☐
iv. Protection of economic interest against external threats ☐

(b). Is there any specific department/ section or unit within your organization which deal with intelligence activities? i. Yes ☐ ii. No. ☐ If yes, please mention the name ……..

12. What are the major achievements of TIRDO in term of agro technology innovation and technology transfer in the past two years? Please answer by filling the following tables. (You can provide attachment to support your answer).

	Nature and Name of achievement (machine/technology or knowledge)	Year	Nature of making		Capacity
			Innovated	transferred	
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

13. Does TIRDO received adequate financial resources to operate?

1		Yes	2		No

13.1 What is the trend of TIRDO budget for the past four years? Please answer by filling in the following table.

Year	Annual Budget (in Tsh)	Amount of Money Received and the source (in Tsh)		Deficit (in Tsh)	Name of the Financial Contributor (Other than Government)
		Government	Donner		
2013					
2014					
2015					
2016					

14. How does TIRDO link with agricultural stakeholders? Please provide details by filling in the following table. (You can provide an attachment to support your answer)

	Type of Stakeholders	Explanation
1	Small Scale Farmers	
2	Large Scale Farmers	
3	Smallholder enterprises	
4	Large Scale processing industries	
5	Government	
6	Agricultural Machines/Technology producers	
7	Ministry responsible for Foreign Affair	
8	Economic information gathering organs	
9	Global partners	
10	Regional Partners	
11	Ministry responsible for trade and Industries	
12	FDI	

16. How does TIRDO collect information about breakthrough strategies, policies and other advance technological information from advanced countries?

_____

_____

17. How does TIRDO share or access information regarding knowledge transfer, better policies and strategies from other foreign agricultural research institutions?

_____

_____

_____

Thank you very much for your participation in this interview. Your answers will be very useful for my research. Moreover, I promise to give your Institute a copy of my PhD thesis upon completion.

The End