Enhancing Higher Education Industry Linkage: The Contribution of Tanzania Commission for Science and Technology (COSTECH), Dar es Salaam, Tanzania

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ABSTRACT

The study was conducted to examine the contribution of Tanzania Commission for Science and Technology (COSTECH) to higher education - Industry linkage. The specific objectives of the study included; elaborating the effectiveness of COSTECH policies on promoting innovators activities from higher education institutions, understanding the role of COSTECH on moderating higher education industry linkage, and lastly assessing the efficiency of COSTECH on linking collaborative scientific research between universities and industry. Purposive sampling was used to obtain sample units for the study. The study managed to obtain twenty three (23) respondents who provided information needed to answer specific research questions. The study findings has indicated that, the effectiveness of COSTECH to enhance HIL was demonstrated by the frameworks institutionalized by COSTECH in making use of Science and Technology Policy of 1996 and the Research and Development Policy of 2010 to protect the IP and inventions of researchers. Also by the establishment of National Fund for the Advancement of Science and technology (NFAST) with an obligation to provide grants to (R&D) , awarding funds to (STI's) and technology transfer activities and also to provide support to technology transfer activities done by local scientists within the priorities that are pee-determined by the government. The study findings shows COSTECH execute its roles by ensuring that industry and higher learning institutions are involved in R&D conducted, through Technology and Innovation Support Centres (TISCs) and Technology Transfer Offices (TTOs), whereas the centers facilitates early engagement with industry stakeholders, aligning research with market needs. The TISCs and TTOs organize consultations, workshops, and collaborative research programs for continuous feedback. Furthermore the efficiency of COSTECH in enhancing HIL was demonstrated by its the ability to issue 45 patent applications, a successful commercialization of 15 intellectual properties and on top of that the awarding of 20 patent certificates, registration of 30 trademarks and 25 copyrights within the financial year 2023/2024. The study was concluded by mentioning that the mechanisms and foundation for HIL nourishment have been well established by COSTECH through different guidelines, frameworks and policies. Lastly The study recommendations suggested that HIL should be championed by state owned universities and firms as a starting point so as to attract other actors from the private sector.

Keywords: Higher Education, Higher Education - Industry Linkage, Intermediary Organizations

I. INTRODUCTION

Intermediaries are science and technology supporting organizations ranging from nonprofit, private, professional service providers, entrepreneur support organizations, and venture capitalists to public organizations that include universities incubators (Clayton et al., 2018). These organizations support academics in the commercialization process, however they are almost seen to operate behind the shadows and their effectiveness have not been fully realized (Szulczewska-Remi & Nowak-Mizgalska, 2023).

Intermediary organizations are also refereed to interface institutions or hybrid organizations also fourth pillar organization and are known to be major elements of the national system of innovation as such they are institutionalized for the main purpose of establishing linkages between firms, universities and other government agencies (Alexandre et al., 2022). Bailey (2015) documented on the different settings of the science funding agencies and further stipulated that funding activities in these organizations is based on the principle-agent theory, whereas in most cases the Ministry responsible for science, technology and Innovation is the principle. In such circumstance these organizations usually act as the agent.

Hakami et al. (2022) suggests that intermediary organizations can take different forms such as Technology, Transfer Offices (TTO's), University Technology Transfer Offices (UTTO's), Technology Licencing Offices (TLO's),

University Incubators (UI's) , Intellectual Property Headquarters (IPHQ's) and also university - industry research centers. These organizations are supposed to possess resources both human and non-human, to be able to manage the relationship by mediating culture and cognitive knowledge difference and allow both parts to understand each part individual needs.

Clayton et al. (2018) have argued that, the contribution of these organizations is treated as tangential to the science - based entrepreneurship studies despite of their historical role which they have played in sharing important information in respect of technological innovation. Nevertheless this condition is far much pronounced in the African context where technology transfer remains at the infancy stage and sparsely documented where the universities - industry joint efforts are looked upon in the hope of driving forward national and regional economic development (Fadeyi et al., 2019)

In African countries, government commissions or councils institutionalized to fund scientific and technological innovation and development include; Kenya National Innovation Agency, Research Council of Zimbabwe and Council for Scientific and Industrial Research (CSIR) in Nigeria (Bailey, 2019). Furthermore Bailey (2015) stipulates that, United Nations Commission on Science and Technology for Development (CSTD represent other councils or commission promoting science and technology in an international level. As for the East African Region, (COSTECH) The Tanzania Commission for Science and Technology stands as a sole Tanzanian government institution under the Ministry of Communication, Science and Technology Mandated to provide technical and financial supervision to entities that are focused on creating scientific and technical innovation such as higher education institutions and other business firms that conduct scientific research aiming at enhancing technological innovation (COSTECH, 2021).

COSTECH is tasked with the responsibility of developing and implementing various tools that safeguard and promote STI across the nation (COSTECH, 2021). COSTECH has several guidelines and frameworks such as the National Framework for Research Chairs COSTECH (2021); The national Postdoctoral Research Framework COSTECH (2020); Research and Innovation Grants Manual COSTECH (2019); National Research and Innovation Monitoring Framework COSTECH (2020); National Research Integrity Framework of Tanzania COSTECH (2020) and; National Research Priorities (2021/2022 - 2025/2026) COSTECH, (2021) which helps it to execute its roles.

That's being the case this study is geared towards unfolding the contribution of COSTECH to higher education - industry linkage, by focusing on three specific objectives, them being; first, elaborating the effectiveness of COSTECH policies on promoting innovators activities from higher education institutions, secondly, understanding the role of COSTECH on moderating higher education industry linkage and thirdly, assessing the efficiency of COSTECH on linking collaborative scientific research between universities and industry.

In Tanzania the National Science and Technology Policy (NSTP) 1996 (UNITED REPUBLIC OF TANZANIA, 1996) mentioned COSTECH to be a body that coordinate and harmonize effective technology transfer within the country. However the policy does not lay down clear frameworks on how COSTECH would enhance collaborative scientific research between higher education institutions and industry to foster technological innovation (Kaijage, 2010). In the case of Europe, between 1980's and 1990's the European Union developed and executed a policy to support technological and innovation infrastructure, the policy was developed to foster University - Industry Collaboration in R&D (Stander, 2017). However, challenges that face policy implementation in university-industry collaboration seem to be peculiar for specific university or institute Gashahun (2020) and thus depend on each specific university circumstances.

In the African context, Ibeme (2020) has documented that the non-existence of university Intellectual Property Right in countries such as Ethiopia constitutes one of the major challenges for universities to collaborate in scientific research and technological innovation with the industry. In that regard African countries need to learn from the developed countries such as United States of America and Canada on matters relating to the extent of Higher education - Industry collaboration in research and development cannot be overemphasized (Clayton et al., 2018).

The responsiveness of universities in linking with industrial firms can be measured (Bailey, 2015). To be able to measure the universities - industries technological transfer Fadeyi et al. (2019) used foreign nations' direct investment also cooperation between industry and universities to measure invention of technology and its commercialization as input and output of the linkage process. Furthermore Mwilongo (2021) noted that consultancy and research are the best measurement elements of higher education efficiency in technology transfer. Moreover other studies, such as Zhuoli (2023) mentioned that political environment, government support, university support and local industry dynamics plays a major role in the efficiency of knowledge transfer between higher education and industry. However such studies have not provided frameworks of measuring the efficiency of such collaborations.

1.1 Statement of the Problem

COSTECH has been operating in the environment that is characterized by the absence of formal agreement with universities and industries (Bailey, 2015). If such conditions if left unattended it results into the commission to be put in the constant need of negotiating it roles given various fluctuation arising from its external environment (Bailey,

2015). Previous scholars such as Lee, (2011); Fadeyi et al. (2019); Kaijage (2010) and Ranganathan and Gabreyohanns (2018) have documented on the role of intermediary organizations in enhancing higher education and industrial collaboration in scientific research and technological innovation.

In the developed world such as Japan advancements have been made by removing laws and policies that restricted national universities from Higher education - Industry partnership Lee (2011) yet the contribution of intermediary organizations in providing linkage is still obscured (Clayton et al., 2018) and still worse within the African context. In Tanzania, Kaijage (2010) noted that higher education institutions do have policies but do not have strategic guidelines that clearly provide framework that quantitatively measure the effectiveness and efficiency of higher education - industry technological transfer

Because of the above stated environment most of the African higher education institutions and specifically Tanzanian universities have been faced with ineffective scientific research outputs due to inefficient technological transfer frameworks (Mwilongo, 2021; Luhanga, 2018; Xing & Marwala, 2017). Therefore this study is geared to provide relevant theoretical solutions in addressing the role of the Commission of Science and Technology in enhancing Higher leaning and industrial linkage by viewing the relationship from the higher education angle.

1.2. Research objectives

i. To elaborate the effectiveness of COSTECH policies on promoting innovators activities from higher education institutions.
ii. To understand the role of COSTECH on moderating higher education industry linkage.
iii. To assess the efficiency of COSTECH on linking collaborative scientific research between universities and industry.

II. LITERATURE REVIEW

2.1 Theoretical Review

This study has opted to use the knowledge spillover theory of entrepreneurship as the theory resonates with the main goal of the study. The theory was first developed by David B. Audretsch in the year 1995. The theory points out the sources of entrepreneurial opportunities, new knowledge and ideas. The theory furthermore acknowledges that new knowledge can provide the missing link in recent growth models. The theory opined that ideas and knowledge can originate from organization context, it be; university research laboratory or firm's research and development unit and can sometimes be left commercialized due to uncertainties inherent in knowledge. Theretofore the theory underpin the study as it acknowledges the need for research and development outputs in formation of new entrepreneurial organization that can exploit and commercialize the abandoned knowledge.

2.2 Empirical Review

The Tanzania Commission for Science and Technology (2019) has outlined areas where it provide grants support to R&D and HLIs, such areas include grants to support strengthening and developing research facilities, grants to support scientific research and technological development and transfer, grants to support scientific publication, dissemination of scientific findings and technological information together with writing scientific textbooks and monographs, grants to support scientific expeditions within the country and abroad.

COSTECH (2019) through its client charter, has ascertained to provide infrastructure sponsorship to innovation and research within seven months after receiving of such requests, furthermore the commission through its client charter has promised to provide funds for research and innovation within seven months of publishing and receiving requests to conduct scientific studies. Through its national research and innovation monitoring framework, The Commission of Science and Technology, (2020) has pointed out eight dimensions that would be used in monitoring the framework. Among the eight dimensions mentioned, the intellectual property rights together with its measuring indicators were put into consideration.

The measurement indicators included, the number of filed number patent application, number of patent certificates granted, number of utility models or trade-mark registered, number of utility models or industrial design certificates applications filed, number of copyrights registered, number of breeder's rights filed or registered and a number of IPs commercialized. in China, Qin and Du (2017) used commercialization of research output as a metric to measure the outcome and efficiency of industry and higher education institutions linkage.

On the other hand, Alexandre (2022) studied firms that interact with universities directly against firms that interact with universities through intermediary organizations. The study pointed out that intermediary organizations are more successful in linking universities with small - sized firms than with large firms. Villani et al. (2017) pointed out that, medium -size firms tend to collaborate directly with universities than through intermediary organization. However Alexandre et al. (2022) stipulated that, most of the intermediary organization roles, have shown lack of clarity in identifying the specific types of firms that they support. Nerveless longitudinal observation of studies have

shown that intermediary organization support is mostly directed towards the small -sized firms, because these kind of firms faces high barriers when it comes to knowledge transfer between them and higher learning institutions. However Ibeme (2020) noted that many African firms are small and medium size while the large firms are mostly subsidiaries of transnational companies which draw from in-house R&D capabilities of the parent company. Alexandre et al. (2022) has the opinion that, small-sized firms can benefit significantly out of the linkages that can be created to allow technology transfer with higher learning institutions, while the same cannot be commented on the side of large firms.

Tezi (2019) studied the barrier that face knowledge transfer between the higher learning institutions and the aviation industry whereas the study pointed out that factors that impede university–industry collaborations include; the lack of understanding of each other's expectations, different interests and needs, limited of government funding, bureaucratic logistics in contacting industry actors. On the other hand Ibeme (2020) mentioned factors that limit commercialization of higher learning scientific researches which include absence of user involvement during defining the research agenda, irrelevance of some universities research, lack of enough competent researchers, weak research infrastructure, and inadequate funds for research and donor influence of research priorities.

Tezi (2019) openly mentioned that there is insufficient collaborative infrastructure between industry and higher learning institutions which are mainly caused by bureaucracy and lack of transparency in Higher learning institutions, and in most cases, firms' tend to develop a perception that, research output coming from their R&D is sufficient for innovation. In the same trajectory O'dwyer (2023) documented on the barriers and enablers in facilitating university-industry knowledge collaboration, whereas the study mentioned that strong fear of knowledge leakage, lack of strong trust between collaborators. Also rigidity of idea sharing during the embryonic phase which usually when matures it results into mistrust in intellectual property ownership during the engagement phase.

On top of that, on understanding the barriers that hinders knowledge transfer in HIL Wit-de Vries, Dolfsma, Van de Windt and Gerkema (2018) mentioned that culture differences between partnering organizations causes knowledge and goals differences and thus hinders collaboration between higher education and industry, the study went further and grouped the barriers into; into cognitive differences, institutional differences and social capital differences. On the other hand trust, communication, the use of intermediaries and experience were mentioned as some on the enhancing factors to enable HIL. Furthermore Rossoni et al. (2023) documented on the bottlenecks that higher education and industry are facing in conducting individual or collaborative R&D and stressed that these setbacks are highly pronounces in the less developed nations.

In providing solutions, Zhuoli (2023) argues that higher education and industry linkage can be optimized by enhancing the capacity and the skills of higher education students, so as to equip them with relevant competence needed in the industry without abandoning the fact that intermediary organization has a significant part to play in enhancing such expected outcomes. Zhuoli (2023) studied the effectiveness of intermediary organizations in facilitating HIL by viewing metrics such as; The existence of Technology Transfer Offices (TTO,s) and Collaborative Research Centres (CRC) that take charge in ensuring that explicit and codified knowledge is transferred through Intellectual property and licensing, seminars and workshops organized by centres. Alexandre et al. (2022) points out that Technology Transfer Offices have been exhibiting a well performance in the United states by working mostly with large firms than with the small-sized firms.

Hakim et al. (2022) Further points out that inter-mediation is a role that is practiced by intermediary organization, by standing in supporting the relationship between higher education institutions and firms, through leveraging funds in enhancing the collaborative innovative research and eliminating crosscutting barriers that exist between heterogeneous actors. Fadeyi et al. (2019) identified the production of four technological outputs from university that symbolizes efficiency in technological transfer between universities and industry, the output mentioned includes; number of invention disclosures, number of executed licenses, amount of licensing royalty income, and number of spin-offs created with university equity.

In line with this finding Fadeyi et al. (2019) also mentioned that, in South Africa significant advances have been reached by utilizing higher learning institutions research output in serving the public at different levels, such achievements have been attained by making sure that specific higher education institutions maintains patent rights guidelines, and in their absence the national Intellectual Property Right Act (IRP Act) made from the SA Public Financed Research and Development Act (Act 51, 2008) are used.

2.2. Conceptual Framework

The study conceptualizes that COSTECH policies, roles and efficiency (the independent variables) influence higher education industry linkage as presented in Figure 1.

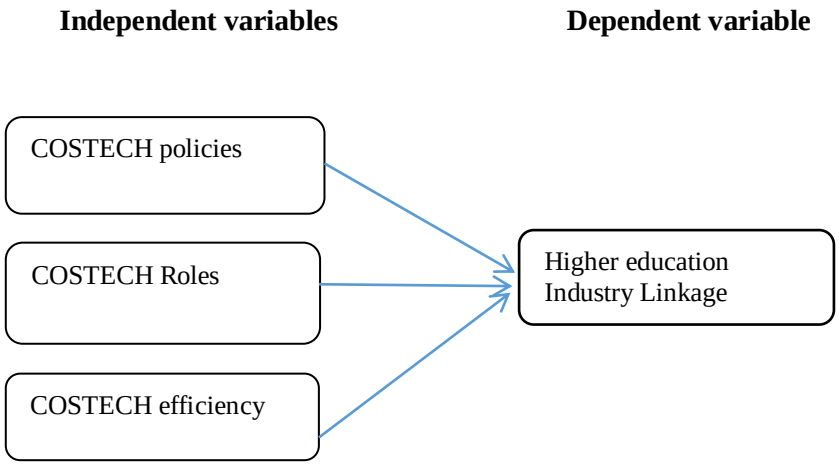

Figure 1
Conceptual Framework

III. METHODOLOGY

3.1 Research design

The study adopted a descriptive study design. The study was a descriptive one because it closely examined the current situation of higher learning and Industry collaboration in scientific R&D

3.2 Study location

The study was conducted at COSTECH located in Kinondoni municipality in Dar es Salaam region, Tanzania. This place was chosen because COSTECH is the only government owned intermediary that has been entrusted with the role of coordinating and promoting the development of science and technology within the country

3.3 Target population

The study population involved personnel's working at COSTECH who are the human capital working in the intermediary organization; this institution was chosen because it is the only government owned intermediary that has been entrusted with the role of coordinating and promoting the development of science and technology within the country.

3.4 Sample size and Sampling technique.

Purposive sampling was used in obtaining sampling units. Purposive sampling is a non-probability sampling, as such Rwegoshora (2014); Etikan and Babatope (2019) noted that purposive sampling is based on the knowledge and understanding of the researcher in selecting proper respondents. Because in this study qualitative information is what was needed it has been recommended that a minimum sample size of at least 12 respondents can reach data saturation (Clark & Braun, 2013; Guest, Bounce & Johnson, 2006). Therefore in this study a sample size of twenty three (23) respondents was required for primary data collection.

3.5. Data collection instruments

Primary data collection instruments and secondary data collection instruments were used to collect data for the study; structured interview guide was used for collecting primary data also document reviews was done to collect secondary data

IV. FINDINGS &DISCUSSION

4.1 Response Rate

The study managed to obtain twenty three (23) responses which imply 100% responses as compared to the sample size proposed.

Table 1
Response Rate

Sample	Responded	Response Rate
23	23	100.0%

4.2 Demographic Characteristics

The demographic characteristics of respondents were analyzed as follows; the sex distribution of respondents in this study was such that 47.8% of respondents which is equal to eleven (11) respondents were males, while 52.2% of respondents which is equal to twelve (12) respondents were females. Experience of respondents was such that, 4.3% of respondents which is equal to one (1) respondent have below 5 years of experience; 39.1% of respondents which is equal to nine (9) respondents, had 6-10 years of experience; 17.4% of respondents which is equal to four (4) respondents had 11-15 years of experience; 30.4% of respondents which is equal to seven (7) respondents had 16- 20 years of experience; and lastly 8.7% of respondents which is equal to two (2) respondents had the experience of above 20 years. The distribution of the education of respondents was such that, 13% of respondents which is equal to three (3) respondents had a certificate level education; 8.7% of respondents which is equal to two (2) respondents had a diploma level of education; 21.7% of respondents which is equal to five (5) respondents had a graduate level of education and 56.5% of respondents which is equal to thirteen (13) respondents had a postgraduate level of education.

Table 2

Demographic Characteristics

Category	Details	Number of Respondents	Percentage
Sex Distribution	Males	11	47.8%
	Females	12	52.2%
	Total	**23**	**100.0%**
Experience	Below 5 years	1	4.3%
	6–10 years	9	39.1%
	11–15 years	4	17.4%
	16–20 years	7	30.4%
	Above 20 years	2	8.7%
	Total	**23**	**100.00%**
Education Level	Certificate Level	3	13.0%
	Diploma Level	2	8.7%
	Graduate Level	5	21.7%
	Postgraduate Level	13	56.5%
	Total	**23**	**100.0%**

4.3 Effectiveness of COSTECH Policies on Promoting Innovation in Higher Education Institutions

In order to elaborate on the effectiveness of COSTECH policies on promoting innovative activities in higher education institutions; the study took interest to understand available policy provision at COSTECH that guide grants allocation to higher education institutions. Bailey (2015) suggested that intermediaries organizations should be equipped with policies that guide funding allocations to higher education institutions. The study findings have indicated that, COSTECH execute the Research and Innovation grant manual which provides directives that guide fund disbursement to accredited higher learning institutions so as to enhance innovative activities. To this end, a COSTECH Senior Officer said:

> *Eligible institutions for grants have to demonstrate strong research focus and submit proposals aligning with national development priorities and SDG's. Therefore priority is given to impact full projects especially those related to AI and IoT.* COSTECH Senior Officer 15-8-2024

This finding relates to Ranganathan and Gebreyohanns (2018) who considered that, higher education and industry link in Ethiopia is at an infant stage. The study was conducted to identify the government policies put in place to enhance the link between the higher education and industries. The study found that (8.44%) of respondent replied that national policy framework constitute one of the enabling factors in stimulating higher education - industry linkage. This study finding holds truths by the fact that, more spin-offs are likely to sprung out under a government intermediary policy condition that enforces, higher education institutions through TTO's to be tangent with industrial practitioners on frequent bases.

Furthermore another respondent from COSTECH who was a Senior Research Coordinator Officer II was quoted mentioning that:

> *"through part V of the Act No.7 of 1986 , the fund known as National Fund for the Advancement of Science and technology (NFAST) The fund has an obligation to provide grants to (R&D) , awarding funds to Science, technology and innovations (STI's) activities. Also the fund has a function to provide support to technology transfer activities done by local scientists within the priorities that are pre-determined by the government.* COSTECH: Senior Research Coordinator Officer II. 15-8-2024

Nevertheless majority of respondents mentioned different guidelines that are used as tools by COSTECH in enhancing HIL, the mentioned guidelines and frameworks include; Research and Innovation Grants Manual (2020), National Research Integrity Framework (2020), National Research and Innovation Monitoring Framework (2020), National Framework for Research Chairs, National Framework for Post-doctoral Research, National Framework for Mainstreaming Gender Equality and Equity in Research and Innovation 2024, National Framework for Linkages Between Higher Education, Research and development Institutions, and Industry (2024), National Framework for Scientific Competencies , National Framework for Data Sharing and innovation frameworks

In answering the same objective, the study aimed at unfolding current policies at COSTECH that protect inventions and intellectual property rights. In that regard findings have shown that, COSTECH make use of Science and Technology Policy of 1996 and the Research and Development Policy of 2010 to protect the IP and inventions of researchers. In line with this finding Fadeyi et al. (2019) also mentioned that, South Africa as a nation has made significant advances by utilizing higher learning institutions research output in serving the public at different levels, such achievements have been attained by making sure that specific higher education institutions maintains patent rights guidelines, and in their absence the national Intellectual Property Right Act (IRP Act) made from the SA Public Financed Research and Development Act (Act 51, 2008) are used. To further unfold the matter one respondent who holds a position of a Principle Research Coordinator officer I at COSTECH was quoted mentioned that:

> *"COSTECH collaborates with BRELA, the national IP office, PBRA and the IP office in Zanzibar for industrial property registration which also includes patents, utility models, trademarks, trade secrets, industrial designs, and geographical indications."* COSTECH; Principle Research Coordinator officer I , 17-8-2024.

Furthermore another respondent from the Managerial position at COSTECH was quoted mentioning that:

> *"COSTECH c "COSOTA manages copyrights and neighboring rights in mainland Tanzania, while COSOZA handles such matters in Zanzibar.* COSTECH: Manager, 15-8-2024

In responding to the same majority of respondent mentioned that, COSTECH in collaboration with BRELLA, usually coordinate time to time regular capacity building sessions on intellectual property rights and management. On top of that majority of respondents have unfolded that COSTECH usually signs an agreements with grantees including those from higher education institution, whereas such agreements allow management of intellectual properties by using policies of the higher education institution. However in absence of such policies in the higher education institution, the national policy is applied.

These findings underscore Ibeme (2020) who found that governments have a significant role in the whole process of selling and buying intellectual property, and therefore as to be beneficial, the study recommended that, specific enterprises have a duty to nature expertise on intellectual property management. Falling in line with the above argument Szulczewska (2013) argues that intellectual property right protection has been identified as a prominent indicator of research commercialization across institutions.

To provide further elaborations of the objective, the study aimed at obtaining the names of higher education institutions with policies and guidelines to oversee collaborative research. Results have shown that, majority of respondents are not aware of whether COSTECH maintains such a register.

This finding slightly concur with Fadeyi et al. (2019) who noted that countries in East Africa for instance Kenya, most of the higher education institutions have put in place rigid structures that do not allow smooth technology transfer to industry. The situation is do, despite the fact that the government puts in place policies to foster technology transfer ecosystem. Given such circumstances, the implementation of such policies encounters major challenges. However one respondent from Managerial position at COSTECH mentioned that:

> *"COSTECH maintains a register of higher education institutions with institutional IP policies, research policies, research integrity guidelines, and other relevant policies overseeing collaborative research and development with industry."* COSTECH: Manager, 15-8-2024

Some of the higher learning institutions in the register include: the University of Dar es Salaam (UDSM), Nelson Mandela African Institution of Science and Technology (NM-AIST), and Sokoine University of Agriculture (SUA). Also the mentioned higher education institutions have Technology and Innovation Supporting Centres (TISC's) focal point established in them. The focal points have the role to support research, innovation, industry partnerships together with enhancing technological development and collaboration across Tanzania.

As such in the same vein Kaijage (2010) mentioned that The University of Dar-es-salaam through the UCB (University Consultancy Bureau) guidance is provided to encourage individual academic staffs to take part in sponsored research, to provide more consultancy service and other services to the industry and firms, because such activities benefit individual staffs and the university at large.

4.4 Understanding the Role of COSTECH in Moderating Higher Education-Industry Linkages

So as to understand the role of COSTECH on moderating higher education industrial linkage, the study findings has identified that COSTECH uses several metrics to measure the responsiveness of higher education

institutions linking with industries. Such metrics include; commercialization rate of research outputs, a number of higher education - industry partnership, the effectiveness of Technology and Innovation Support Centres (TISC's) established in the higher education institutions and also through exhibitions. The finding of this study fall in line with Fadeyi et al. (2019); who stipulated that, in China, Qin and Du (2017) used commercialization of research output as a metric to measure the outcome and efficiency of industry and higher education institutions linkage.

Therefore the higher education faculties with high commercialization understanding were observed to be leading in knowledge transfer to industry. Having mentioned that, Zhuoli (2023) also outlined that, apart from teaching and research, higher education institutions can add another revenue stream arising from commercialization of its respective research outputs.

Furthermore in cementing the same, this study finding correlates with de Wit-de Vries et al. (2018) who documented that, intermediary organizations moderates HIL collaboration by facilitating partnerships which are based on knowledge sharing between individual and teams from higher education institutions and industry. Such partnerships aim at producing common outputs and can take form of research partnership, collaborative research, contract research and consultation. The study further expounded that intermediary organizations mostly has a role to resolve cognitive differences among partners together with resolving goals differences among or between partners.

As such, in an interview with personnel holding a Managerial position at COSTECH, the interviewee was quoted mentioning that:

> *"In ensuring that COSTECH plays a fundamental role in linking higher learning with industry, a National Framework for Linkages Between Higher Education , Research and development Institutions, and Industry (2024) has been developed and has started to be implemented from year 2024"* COSTECH; Manager, 16th -Aug-2024

On top of that, the study by Kaijage (2010) falls in line with this study findings., as the study has mentioned that University and Industry collaborations has been continuously heighten by intermediary organization efforts to influence the public policy in education, to adjusts the curriculum of higher learning institutions to respond to the needs of the industry, furthermore strategic steps are taken by intermediary organizations to persuade and support academicians in securing positions in firms as board members and in academic institutions as members of faculty boards , as it is assumed them being on both parties heighten the possibilities of forming linkages in knowledge transfer.

In an interview with one employee who is in the Managerial position, the respondent was quoted mentioning that:

> *"COSTECH has taken gradual measures which we consider them very strategic in ensuring Higher education and Industry linkage, which has been achieved day after day. As of today COSTECH has used its advantageous position within the ministry of education to ensure that curriculum's of Higher learning institutions are aligned to the industrial needs."* COSTECH; Manager; 15th - Aug-2024

Nevertheless the findings of this study resonates with Ibeme (2020) who expounded that together with other forms of partnerships such as sponsored research, joint research, professional courses and joint curriculum development, students placements; plays a significant role in strengthening knowledge transfer in HIL.

In responding to the same one Principle Research Coordinator officer I was noted mentioning that COSTECH moderates higher education institutions - Industry linkage through different operations such as:

> *Participating in the activity of the industry advisory boards, also Participating in national platforms such as Tanzania Innovation Week, Dar es Salaam Trade Fair, and Nane Nane exhibitions, also feedback from industry partners and joint publications helps to enhance alignment of institutions with industry needs so as to fostering socioeconomic development.* COSTECH; Principle Research Coordinator officer I

Apart from moderating the HIL, the study has made inquiry to understand whether COSTECH moderates and ensure that higher learning institutions provide consultancy services to industrial firms. The results of the study were such that. COSTECH provides guidance and mechanisms for collaboration, such as 'Monitoring Framework and Linkages Framework' also through Technology and Innovation Support Centres (TISCs) and Technology Transfer Offices that are established in higher education institutions. Furthermore COSTECH uses the innovative cluster model within the triple helix framework to support collaboration between higher education institutions, industry, and government by monitoring and evaluating consultancy effectiveness and gathering industry feedback, following the consultation provided.

To be more specific, the study intended to identify HIL in terms of collaborative R&D and innovation projects between higher education institutions and industry that have been moderated by COSTECH within the two financial years (2022/2023 and 2023/2024). In response to that, one respondent from COSTECH with a position of Senior Research Coordinator Officer mentioned that, within the two financial years2022/2023 and 2023/2024 , COSTECH took charge to moderate several collaborative R&D and innovation projects between higher education institutions and industry, whereas notable projects include the Prepaid Water Meter Project with DTBi and RUWASA,

the Smart Agriculture Initiative with Sokoine University of Agriculture (SUA) and agricultural firms, and Renewable Energy Solutions with the University of Dar es Salaam (UDSM) and local energy companies.

Also other respondents listed several other projects which include: the Assessment and Development of Mechanization Technology in Sunflower Harvesting, Threshing and Improvement of Oil Processing for Small Scale Producers-UDSM and Intermech Engineering Limited, and Dar es Salaam Stayfit Nutrisupplies Co. LTD, Dar es Salaam, on one hand, and the development of Gypsum Processing Technologies for Small-Scale Industries-UDOM and Ng'hami Industry Company LTD, Maswa.

On the other hand, the mentioned projects are said to have leveraged the triple helix model that fosters innovation and strengthening higher education institutions - industry linkage. All the above mentioned projects are a result of the application of different guidelines and frameworks developed by COSTECH to enhance conjoint R&D and innovation between higher education institutions and industry.

4.5 Assessing the Efficiency of COSTECH in Facilitating Collaborative Scientific Research Between Universities and Industry

In order to assess the efficiency of COSTECH on linking collaborative scientific research between universities and industry; implicitly the study inquired metrics which indicated the output of the tasks executed by COSTECH. To identify such outputs the study considered a number of metrics them being; number of patent application filled, Number of patent certificates granted, number of trademark registered, number of copyright registered, number of intellectual property commercialized.

In responding to these indicators, one employee in the managerial position at COSTECH mentioned that, in average within the financial year 2023/2024 COSTECH had Forty five (45) filed patent applications. Additionally, fifteen (15) intellectual properties were successfully commercialized from higher education institutions.

The study results are concordant with de Wit-de Vries et al. (2018); Hakami et al. (2022) who pointed out that, explicit knowledge can be transferred through contractual agreements such as patenting or licensing. As such Szulczewska-Remi and Nowak-Mizgalska (2023) documented that patent awards symbolizes scientists decisions on research commercialization and research output entrepreneurship.

Furthermore this study results records that COSTECH awarded twenty (20) patent certificates, registered thirty (30) trademarks and twenty five (25) copyrights from higher education institutions and other actors. These results are contrary to Kaijage (2010) who pointed out that, university didn't recognize the acquisition of licence, copyright, intellectual property rights, purchase of prototypes and spin-offs; as areas that foster knowledge commercialization and make impact through HIL.

The study results have further indicated that, the special window for supporting and up-scaling the commercialization of research output has been executed through NFAST. Also through establishing Technology and Innovation Support Centres (TISCs) and Technology Transfer Offices

In the same trajectory the study aimed at understanding the process which is upheld by COSTECH to ensure that firms and industry are involved before the actual conduct of experimental R&D so as to ensure relevance, application and commercialization of technological invention. The study results indicate that COSTECH ensures industry and higher learning institutions are involved in R&D conducted, through Technology and Innovation Support Centres (TISCs) and Technology Transfer Offices (TTOs). In line with this finding Zhuoli (2023) argues that Technology Transfer Offices (TTO) have a task to transfer knowledge to from higher education to small medium entreprises (SME's) that have lower knowledge capability and lower physical proximity. This role helps TTO to desseminate knowledge in a wider range and thus enhancing regional economic growth.

In an interview with one respondent from a Managerial position it was mentioned that:

> *"Support centers facilitate early engagement with industry stakeholders; they also provide a quick alignment of research output with market needs. TISCs and TTOs organize consultations, workshops, and collaborative research programs for continuous feedback"* COSTECH; Manager; 16th - Aug. 2024

In line with this study finding Zhuoli (2023) mention that Collective Research Centres (CRC's) like TTO's participate in enhancing higher education and industry linkage by organizing workshops and seminars. Furthermore Villani et al. (2017) also documented that, in Italy, a policy was passed

Another respondent who was a Senior Research Coordinator Officer was quoted mentioning that:

> *"These centers support market research and feasibility studies to ensure commercial viability. Research proposals must include industry relevance and potential applications. Additionally, TISCs and TTOs use Technology Readiness Levels (TRL) assessments to evaluate the maturity and readiness of technologies for commercialization, enhancing the usability and market potential of technological inventions*. COSTECH. Research Coordinator Officer, 18Th -Aug-2024

V. CONCLUSIONS & RECOMMENDATIONS

5.1 Conclusion

The mechanisms and foundation for HIL nourishment have been well established by COSTECH through different guidelines, frameworks and policies. However the study views commercialization of knowledge as a very important move especially at the current stage where the world is experiencing the wave of the fourth phase industrial revolution. Given the nature of the developing economy of Tanzania, the study argues HIL to be championed by state owned universities and firms. As such, the resultant success will attract more actors from the private sector of the economy, and the potential versioned for science and technology nourishment in Tanzania will be achieved spontaneously.

5.2 Recommendations

Provided that guidelines and frameworks for HIL have been developed and executed by COSTECH, the study recommends sharing of these valuable documents to universities and firms, whereas priority should be given to state owned firms and university. Also capacity building activities should be conducted on the potential actors by involving them in seminars and workshops. Making the actors conversant with the guidelines and frameworks will attract strong linkages as required.

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