A STUDY AND ANALYSIS OF THE SCIENCE TECHNOLOGY AND INNOVATION (STI) ECOSYSTEM OF GHANA (FINAL DRAFT REPORT)

MINISTRY OF ENVIRONMENT, SCIENCE, TECHNOLOGY AND INNOVATION (MESTI)

PREPARED BY

SCIENCE AND TECHNOLOGY POLICY RESEARCH INSTITUTE

(CSIR-STEPRI)

Table of Content

EXECUTIVE SUMMARY

The Science and Technology Policy Research Institute of the Council for Scientific and Industrial Research (CSIR-STEPRI) was commissioned by the Ministry of Environment, Science, Technology, and Innovation (MESTI) to conduct a study and analysis of the science, technology, and innovation (STI) ecosystem in Ghana with support from the Science Granting Councils Initiative (SGCI). The rationale behind the study was as a result of the pursuit of the Government of Ghana to build a strong technologically-driven economy that drives the Ghana Beyond Aid Agenda by ensuring that research and development activities are harnessed for development. Therefore, Ghana Innovation Research Commercialization (GIRC) Centre was suggested for establishment to support the harmonization of innovations and research activities in Ghana with the ultimate aim of commercializing them for national development.

To help achieve the goal, an objective for the study was set to assist MESTI to conduct an innovation ecosystem analysis that will form the foundation for a Master Implementation Framework for the GIRC-Centre. The preparation for the study begun with the development of an inception report which detailed the activities carried out from the negotiation stage to the signing of the contract and to the undertaking of the assignment.

The methodology for the study employed a mix-method to elicit information in order to address the tasks which included desk research to review reports and literature in the areas of STI Ecosystem Studies. The review of literature was done to get a better understanding of the innovation systems and their relationship with the Ghana Science Technology and Innovation Ecosystem. This informed the approach to the data collection on the ground by means of census surveys and mapping the various stakeholders to identify the research and innovation actors. The mapping of the actors was categorized into research and commercial categories of innovation actors and a third category comprising the start-up companies. Questionnaires were administered for each of the categories and in-depth interviews conducted. The post data collection was tasked with analysis of data using SPSS and Excel statistical tools and converting all relevant information into figures for presentation.

The results of the study highlighted key findings that have ramifications for policymaking and the implementation of the GIRC-Centre and the way forward by providing recommendations. The study found that there is a gender disparity in the Ghana's STI ecosystem which reflected

in male dominance of the appointment of focal persons by organisations in three main categories of respondents-innovation and research, policymaking, and the commercial categories. The distribution of respondents indicates that almost two-thirds of the organisations in the Research Category interviewed belonged to higher education and incubations hubs and the rest fall within public research and development, technology transfer; public-private-partnership arrangement among others. More than half (58%) of respondents in the commercial category was government organisations and 28% was financial institutions, the remainder were non-classifiable group and the private sector. As regards the distribution, it emerged that the respondents were not evenly spread geographically across Ghana with more than half of the respondents (54.3%) located in Greater Accra (Accra) and Ashanti (Kumasi) Regions. The remainder of the respondents were distributed across nine other regions in Ghana.

The study identified the existence of interactions and linkages among actors in the innovation ecosystem of Ghana, such as linkages to government organisations and institutions and also with the private sector including the financial institutions. This confirms that linkages through interactions are very key for the functioning of the STI ecosystem. Several facilitators were identified as helping in the provision of conducive environment for linkages and interactions among the actors and one of such facilitators is policy. Some policies provisions support research and innovations but do not necessarily have provisions that facilitate commercialisation. Worthy of highlighting, among the list of policies, include the One District One Factory (1D1F) Programme and the Planting for Food and Jobs, Local Content Policy (Petroleum Downstream), Ghana Investment Promotion Centre Act (Act 865) which are policies of the Government of Ghana.

The report further presents some analyses of strengths, weaknesses, opportunities, and threats (SWOT) of the ecosystem, for the higher education and research, public research and development, and the incubation and innovation hubs. The major threat identified was inadequacy of funding and the capacity of human capital, infrastructure, among others. In order to appreciate the issues better including the successes and the challenges, the study developed case studies of different types of hubs on the basis of their thematic areas of focus which were highlighted.

The study concluded that women's participation at the top level of the innovation ecosystem is low; top level management of actors in the innovation ecosystem favour the participation of

men. Notwithstanding, the study found that there are attempts to improve the participation of women in the innovation ecosystem through specific programmes and projects. The goal is to empower young women to enter the fields of Science, Technology, Engineering, and Mathematics (STEM). The concentration of the ecosystem actors in the major cities of Accra and Kumasi does not auger well for national development. As a result, the study recommends that deliberate strategies should be developed to targets the spreading of innovation ecosystem of actors, especially hubs across the country.

There is the need for proper coordination of programmes, projects, and interventions among the key actors of organisations to provide support for enhanced commercialisation of research and innovations in Ghana, particularly the development of start-ups and growing entrepreneurs. It was strongly recommended that the ecosystem be diversified through support for the commercialization of traditional R&D outputs that are sitting on the shelves of the various research institutions and universities in Ghana. In this light, research organisations have to adopt the appropriate means to communicate their research findings with bankable outputs and innovations for commercialisation to the banks for support.

The last but not the least, the study recommendation employs MESTI to develop a strategic paper or roadmap to cater for commercialisation of research and innovations and also engage with the development partners such as the British Council, GIZ, European Commission and the World Bank. The idea is to ensure that activities in the innovation ecosystem and of the development partners are addressing national development priorities as determined by the nation. With this in mind, the Ghana Innovation and Research Commercialisation Centre (GIRC-Centre) should be established with careful thought and clear plans to provide it with sustainable model of funding, which will in turn enable the Centre to support actors in the innovation ecosystem with timely and adequate funding.

1.0. Introduction

1.1. Background

The Science and Technology Policy Research Institute of the Council for Scientific and Industrial Research (CSIR-STEPRI) has been appointed consultant by the Ministry of Environment, Science, Technology, and Innovation (MESTI) to conduct a study and analysis of the science, technology, and innovation (STI) ecosystem in Ghana with the support of the Science Granting Councils Initiative (SGCI).

The warrant for this assignment derives from Government of Ghana's pursuit to build a strong technologically-driven economy that drives the Ghana Beyond Aid agenda by ensuring that research and development activities in public research entities are harnessed for socio-economic development. To achieve this requires the establishment of an entity that would harmonize innovations and research activities in Ghana, and to commercialize these research and innovations. Thus, the Ghana Innovation and Research Commercialization Centre (GIRC-Centre) has been suggested.

1.2. Objective and tasks of Study

The objective of this assignment is to assist MESTI conduct an innovation ecosystem analysis that will form the foundation for a Master Implementation Framework for the GIRC-Centre To this end, the study comprised the following specific tasks[1]:

- Conduct a survey to identify existing research and innovation actors
- Conduct an STI Stakeholder mapping of the innovation actors with focus on their strengths and functions.
- Conduct analysis of the Strengths, Weaknesses, Opportunities, and Threats (SWOT) of the
- In-depth Interviews/Case Studies of Selected actors
- Make recommendations on Scope and Support Services of the GIRC-Center

[1] See Appendix 1 for terms of reference of the assignment

2.0. Literature Review

2.1. System of Innovation Versus Innovation Ecosystem

It is important to underscore the fact that there have been studies about Ghana's national system of innovation and therefore, it would appear as though the innovation ecosystem is synonymous with the national system of innovation. Of course, there are areas of overlaps between these two concepts and frameworks that may include principal actors. Indeed, it has been noted that the concept of innovation ecosystem has remarkably enriched the concept of system of innovation (Smorodinskaya, Russell, Katukov, & Still, 2017). But it should be pointed out that the innovation ecosystem is not the same as the national system of innovation[2]. Given this, it is important to put into context what this report takes to mean innovation ecosystem.

2.2. Ghana's National System of Innovation

There are several definitions for innovation in the literature. However, a popular one is that of the Organisation for Economic Cooperation and Development (OECD). According to the OECD, an innovation is "a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" (OECD/Eurostat, 2018, p. 20). Tidd, Bessant, & Pavitt (2005, p. 66) summarise this definition of innovation simply as "a process of turning opportunity into new ideas and of putting these into widely used practice." Thus, an innovation goes beyond a new invention or idea to include its implementation by being actively used or made available for others to use.

From the definition of innovation above, the system of innovation can be considered as a fluid conceptual frame for coordinating relationships among organizations where "knowledge is the currency of exchange" (Bartels, Voss, Lederer, & Bachtro, 2012, p. 4; Edquist & Johnson, 1997; Lundvall, 2010). However, as with innovation, several definitions exist in the literature about the national system of innovation (NSI) (cf. OECD, 1997, p. 10). Among these definitions, we adopt the definition by Lundvall (2010) which states that the NSI comprises "elements and relationships which interact in the production, diffusion and use of new, and economically useful, knowledge and that a national system encompasses elements and relationships, either located within or rooted inside the borders of a nation state" (p. 4). Hence,

[2] There are dissenting views on this score. Cf. for instance Oh et al., (2016).

since the NSI is a framework that encapsulates research and development (R&D) activities in a given geographic space, Ghana's National System of Innovation (GNSI) comprises several identifiable institutions and organizations that form a complex adaptive system. This system shows "emergent behavior" (sic) as a result of interactions among elements of its components (UNIDO, 2012, p. 15).

Very often the triple helix model has been used to visualize the NSI frame (see Figure 1). The core pillars of this model include actors from the government sector, actors from industry, and actors from the knowledge-based institutions (KBIs). However, in a report by the United Nations Industrial Development Organization (UNIDO) on the GNSI, the triple helix framing was modified to include arbitrageurs. Accordingly, when mapping the GNSI, one would find:

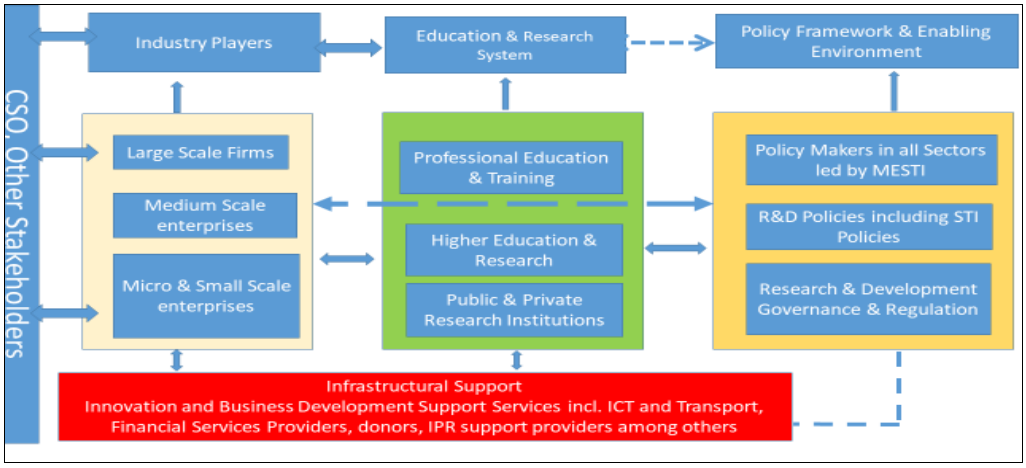
(i) Within the government pillar of the triple helix structure, the GNSI comprises the Executive arm of government that includes the office of the president, ministries that have policymaking powers, departments, commissions, and agencies, (some of whom have policymaking powers, but that are mostly implementing arms of the ministries). Also included in the pillar representing government are local government authorities.

(ii) The Industry pillar refers to Ghana's private sector including small, medium and large enterprises and high technology industry.

(iii) KBIs pillar encompasses research institutions (public, private, and international), universities, and colleges in Ghana.

(iv) The arbitrageurs in Ghana will include technology transfer centres, venture capitalists, the investment promotion centre, and the Registrar General's Department.

Figure 1: A pictorial presentation of actors and institutions in the Ghana's National Innovation System



Source: Quaye, Akon-Yamga, Daniels, Ting, & Asante (2019)

2.3. The Innovation Ecosystem

Unlike the system of innovation, the innovation ecosystem has been a relatively recent concept, and is receiving increasing attention (Xu, Wu, Minshall, & Zhou, 2018). In the academic literature, scholars have recently focused their interests on the network of actors involved in developing and in commercializing innovations. This phenomenon has been given different nomenclature (Gomes, Facin, Salerno, & Ikenami, 2018). For instance, Chesbrough (2003) calls it open innovation while Lee, Nam, & Son, (2015) call it innovation networks.

The idea is, in a complex system of innovation, a number of actors are usually involved, which calls for changes that are not limited to only the supply networks, but which also may impact other actors, as in for instance, regulators (Adner & Kapoor, 2010). Therefore, in order to cater for this means of collaborative creation of value, the concept of innovations ecosystem has been developed (Gomes et al., 2018). Although "innovation ecosystem" has rapidly gained grounds (Oh, Phillips, Park, & Lee, 2016) in strategy, innovation, and entrepreneurship literature, the literature does not provide a "robust definition of what an innovation ecosystem is. Thus, a lack of theoretical consistency concerning innovation ecosystem terminology may intensify the fuzzy landscape of research" (Gomes et al., 2018, p. 30). The many definitions vary in vision, scope and detail (Rabelo & Bernus, 2015).

Notwithstanding the lack of robust definition, we adopt a definition of "innovation ecosystem" as:

> [T]he complex relationships that are formed between actors or entities whose functional goal is to enable technology development and innovation [….] The actors would include the material

> resources (funds, equipment, facilities, etc.) and the human capital (students, faculty, staff, industry researchers, industry representatives, etc.) that make up the institutional entities participating in the ecosystem.
>
> (Jackson, 2011, p. 2)

In the literature of the innovation ecosystem, there is emphasis that the ecosystem essentially depends on collaboration among distinct and independent actors who form a network-like structure (Rabelo & Bernus, 2015) towards technology development and innovation.

Going by this definition, Jackson (2011) argues that the innovation ecosystem is made up of two separate economies that are weakly coupled—"the research economy, which is driven by fundamental research, and the commercial economy, which is driven by the marketplace." We add that since Jackson (2011) puts government organizations that consume research and that are not research institutions into the commercial market category, this category can sometimes be driven by political decisions as well.

2.4. Innovation Ecosystem in Ghana

On the basis of Jackson's definition of the innovation ecosystem, we identify an innovation ecosystem in Ghana's national system of innovation (GNSI) to include a complex and active relationship that exists among actors whose functional goal is to enable science and technology development, and innovation. The emphasis on such a complex relationship is on the fact that it is active and does not only exist in a potential with latent channels for interaction. By this definition, we visualize the innovation ecosystem to lie within the overarching framework of the national system of innovation. This is because, whereas the GNSI is a framework looking at the overall interconnectedness of actors in the national economy (whether their purpose is to enable technology development and innovation or otherwise [see Figure 1]), the Ghana innovation ecosystem framework comprises actors in the economy whose purpose and interconnectedness enable technology development and innovation. Nonetheless, the possibility that actors in the two systems overlap is high.

For this study, we define three categories of actors of the innovation ecosystem in Ghana, namely the innovation and research category, the policymaking category, and the commercial category. The innovation and research category include the innovation hubs, research organisations, and higher education institutions. The policymaking category includes

government entities in charge of policymaking such as ministries and the legislature. Last but not the least, the commercial category here includes organisations that benefit from output of research and innovation and who may fund such research and innovation activities. Appendix 2 presents a list of actors we have identified as being principal to the innovation ecosystem. We categorize the list into the three major categories. It is important to underscore the fact that the table does not contain all actors. Hence, the research team undertook two rounds of surveys to update this list.

3.0. Methodology

The STI ecosystem study employed a mix-method approach to elicit information in order to address the specific tasks of the study. This mix-method approach included desk research to review reports and literature in the areas of STI Ecosystem Studies, which then informed our approach to data collection on the ground by means of census surveys.

3.1. Desk Research

On the basis of the literature review and limited reconnaissance surveys the research team undertook, a list was generated representing principal actors in Ghana's innovation ecosystem. The list was organised according to the categories of actors of the innovation ecosystem defined earlier, *vis-à-vis* innovation and research category, policymaking category, and commercial category. See Appendix 2 for the full list of organisations.

3.2. Fieldwork for Surveys

The list generated from the desk research was used as the basis for fieldwork conducted by the research team from July to October 2019. The approach was to contact all the organisations listed for interview in a first round of survey. Hence, the Ministry of Environment Science Technology and Innovation (MESTI) wrote letters of introduction to all organisations on the list. The purpose of the letter was to introduce researchers from STEPRI to the organisations and to request the organisations to designate focal persons to be interviewed by the researchers.

Given that a substantial number of organisations did not respond to the letter from MESTI, a considerable amount of time of the fieldwork was spent following up on the letter. A total of

70 organisations were interviewed across board in the two rounds of the survey. Besides, up to three start-ups per innovation and incubation hub were interviewed to gather qualitative data. In total, 30 start-ups were interviewed.

3.3. Instruments for Surveys

Three instruments were used to cater for three different groups of respondents. One questionnaire was used to elicit responses from the innovation and research category and another questionnaire for the policymaking, and commercial categories. An interview guide was the third instrument used to elicit responses from start-up companies that had been supported by organisations in the innovation and research category. Although the instruments for the innovation and research, the policymaking, and the commercial categories were questionnaires comprising a mix of close and open-ended questions, the instrument for the start-ups was a checklist that served as interview guide for discussions. In addition, in-depth interviews were conducted with organisations identified as incubation and innovation hubs.

3.4. Data Analysis

The filled questionnaires were entered separately for the three categories of the innovation ecosystem defined earlier. The data was, managed and analysed with SPSS for MacOS Version 23. In addition, processed and analysed data was exported from SPSS into MS Excel for further analyses and conversion into figures for presentation.

4.0. Results

This section presents results of the study, highlighting key findings that have ramifications for policymaking and the implementation of the GIRC-Centre. This section begins with a presentation of the characteristics of the organisations that were interviewed, followed by a mapping of the STI stakeholders where we identify research and innovation actors in Ghana's innovation ecosystem, conduct a stakeholder analysis, and identify principal actors. Next, we present a SWOT analysis of the STI ecosystem looking at current trends and future priorities.

4.1. Characteristics of Respondents

4.1.1. Gender Dimension of Respondents

There is gender disparity in Ghana's STI ecosystem. This is reflected in the percentage of male (85%) and women (15%) focal persons appointed by organisations in the Research Category of respondents (Figure 2). The story was not quite different for the policymaking category where all respondents were male and for the commercial category where 85% of respondents was male and 15% was female.

Figure 2: Gender Distribution of Respondents (Innovation and Research Category)

4.1.2. Distribution of Respondents Among Categories of the Innovation Ecosystem

More than two-thirds of organisations in the innovation and research category interviewed belonged to higher education and incubations hubs (see Table 1a). Thus, 44.1% of respondents was from innovation and incubation hubs; 23.5% from higher education and research institutions; while the remainder was spread among public research and development; technology transfer; public-private-partnership arrangement; private research and development organisations; and a project. It is important to point out that some of those categorised as higher education and research were performing roles that incubation and innovation hubs did; however, they preferred to be identified as higher education organisations. For the policymaking category, all respondents were from ministries. For the commercial category, majority of the respondents were financial institutions (44%). The rest included government departments and agencies (39%), limited liability companies (13%), and government initiative on entrepreneurship (4%). See Table 1b.

Table 1: Types of organisations in Categories

(a) Innovation and Research Category

Type of Organisation	Frequency	Percent

Higher education and research	8	23.5
Public research and development	6	17.6
Public-private-partnership arrangement	1	2.9
Technology transfer	2	5.9
Innovation and Incubation Hub	15	44.1
Private Research and Development	1	2.9
Project	1	2.9
Total	34	100.0

(b) Commercial Category

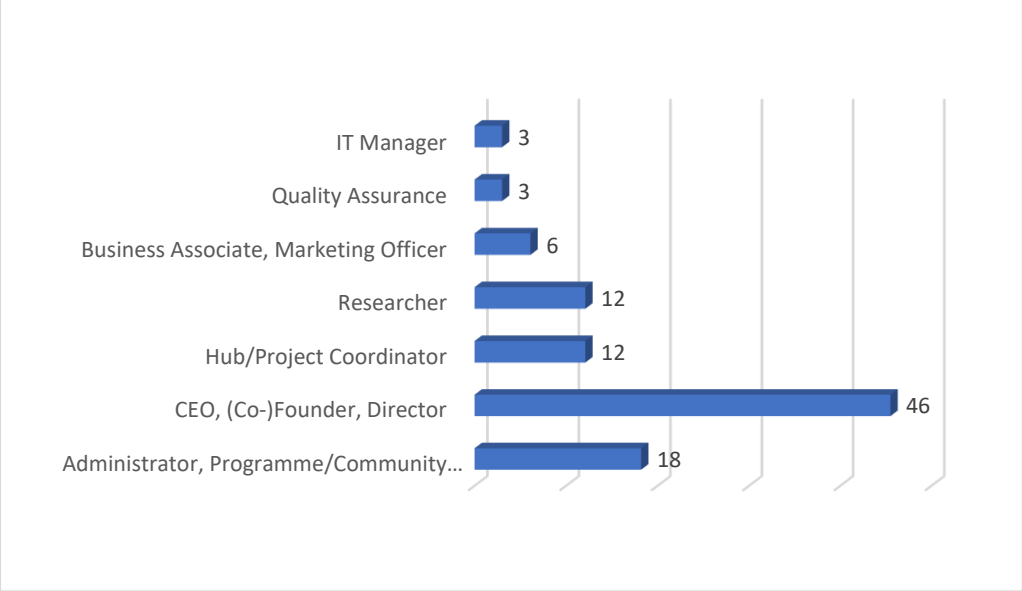
Type of Organisation	Frequency	Percent
Government department or agency	9	39.1
Limited liability company	3	13.0
Financial institution	10	43.5
Government Initiative on Entrepreneurship	1	4.3
Total	23	100.0

Source: Fieldwork (2019)

4.1.3. Designation of Respondents

In the innovation and research category, 46% of the respondents was top level management. That included directors, CEOs, founders and co-founders of organisations. Other designations included administrators, programme and community managers comprising 18% of the respondents, project coordinators (12%), researchers (12%), business associates and marketing officers (6%), quality assurance (3%), and IT manager (3%). See Figure 3.

Figure 3: Designation of Respondents in Innovation and Research Category (%)



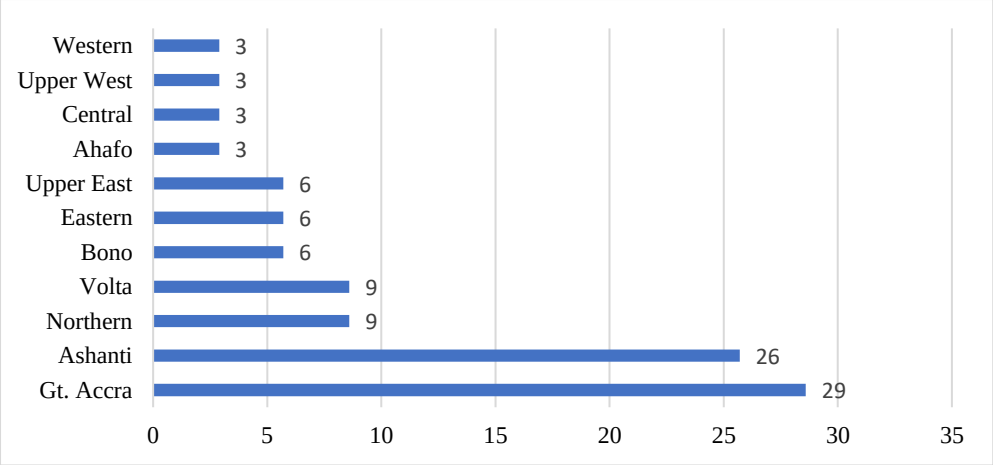
Source: Fieldwork (2019)

The gender disparity observed earlier was not only reflected in the overall number of focal persons interviewed; but it was also reflected in the designations of the persons interviewed for each organization. For instance, whereas almost half of the respondents (46%) was from top level management designation (CEOs, founders, co-founders, directors, etc.) of the organizations, none of the female respondents was from top level management. However, only respondents within the group comprising administrators, programme/community manager, achieved male-female parity of 50% each.

4.1.4. Geographical Distribution of Respondents

Respondents were not evenly spread geographically across Ghana. Unsurprisingly, more than half of the respondents (55%) were spread between Gt. Accra and Ashanti Regions. Indeed, they were in the major cities of Accra and Kumasi in the two regions respectively. The remainder of the respondents were distributed across nine other regions in Ghana (see Figure 4). The geographical concentration of innovation ecosystems is one of their characteristics (Jackson, 2011) for strengthened collaborations, interactions and linkages. However, the downside of this is that other parts of the country stand to lose from this spatial clustering.

Figure 4: Geographical Distribution of Respondents in Innovation and Research Category (%)



Source: Fieldwork (2019)

Concentration of the hubs in the major cities could be attributed to the fact that calls for project proposals were usually targeted at the major cities such as Accra, Kumasi, Takoradi and Tamale. This is because projects or grant designs already predetermine where the project should be located before it was granted. This therefore cuts out or eliminates other hubs in the small cities from also competing for projects. The challenge with the concentration of projects in the bigger cities could be contributing to migration of entrepreneurs to the cities which does not auger well for the development of the small cities. It also creates an over-saturation of entrepreneurs and SMEs in the bigger cities.

In spite of the uneven distribution of organisations across the country, it is refreshing to note that there was, at least, one organisation for almost all of the ten older regions of Ghana. Given that there are now sixteen regions, there was no respondent from five regions.

Overall, the innovation and research category of respondents was relatively more diverse (gender-wise and spatially) than the commercial category. For the commercial category of respondents, whereas for gender 92% of respondents was male and 8% female; the spatial distribution of respondents was skewered towards the Capital City—Accra—where 97% of respondents were located.

4.2. Mapping Innovation Ecosystem Stakeholders

An important task for this assignment, a study and analysis of the STI ecosystem, is to map various stakeholders in the ecosystem by identifying research and innovation actors, conducting a stakeholder analysis, and identifying principal actors in the ecosystem. This

section addresses the task at hand and presents a mapping of stakeholders in the innovation ecosystem in Ghana. Following from the earlier definition of three categories of actors on innovation ecosystem of Ghana, this section identifies the actors in ecosystem along the lines of innovation and research category, policymaking category, and commercial category.

4.2.1. Innovation and Research Actors in Ghana's Innovation Ecosystem

Under the innovation and research category, the actors have been further classified into two sub-categories: (i) Innovation and Incubation Hubs; and (ii) Higher Education and Public Research Organisations. See Appendix 3 for a full list of the organisations identified.

Actors in the Innovation and Incubation Hubs sub-category are organisations with diverse portfolio of mandates, activities, and programmes; yet they all have the very important goal to promote entrepreneurship through direct and indirect support for the development of ideas to products or services (innovation). Hubs are an expression of the growing local information technology and creative industries and are designed to drive development in several sectors by creating a platform that promotes a technology-based economy that will promote the culture of innovation and competitiveness. Innovation hubs help SMEs to connect, communicate and collaborate with independent inventors and other parties to boost innovation practices (Vrgovic, Vidicki, Glassman, & Walton, 2012).

Key differences among the actors in this sub-category lie in the manner in which they support SMEs (or entrepreneurs), their areas of focus (e.g. digital technology, agriculture, etc..), and sources of funding/funding mechanisms. Under the sub-category of Innovation and Incubation Hubs, actors further cluster under public-private partnerships, business incubation, digital innovation, co-working space, private research (consultancy), and projects. Table 2 presents brief profiles of organisations which were interviewed from this sub-category.

Actors in the second sub-category—Higher Education and Public Research Organisations—include universities (private and public) and public research and development organisations. Universities that responded favourably to the study included a mixture of traditional and technical universities and were spread across the northern, middle and southern belts of Ghana. See Table 3 for the list of organisations under this sub-category. This category of actors is very important in the quest for commercialising innovation and research in Ghana because, very often, the actors in this category produce the knowledge base for innovation. It has become

common to hear that universities and research organisations in Ghana have research outputs or knowledge/technologies sitting on their shelves that require commercialisation. Indeed, it is for this same reason that the GIRC-Centre is being established. Hence, the actors in this sub-category are an indispensable cog in any interventions to commercialise innovation and research in Ghana because of the need for scientific knowledge.

Table 2: Profiles of Incubation and Innovation Hubs Reached

Organisation	Website	Main Functions		Organisation	Website	Main Functions
Incubation and Innovation Hubs				**Incubation and Innovation Hubs**		
Agribusiness Innovation Hub (iHub)	www.savanet-gh.org	Promote innovation and technology transfer for agribusiness development; bridging the gap for access and adoption of modern technology in agriculture for agribusiness development		Impact Hub	www.accra.impacthub.net	Support early-stage innovator-ideas to market
Centre for Social Innovations	www.csighana.org	Support for social and educational innovation, and community innovation and entrepreneurship		iSpace	www.ispacegh.com	To provide training, mentorship, access to funding and entrepreneurship
Dansyn Ghana Limited	www.dansynghana.com	To provide professional services to organizations, individuals and groups through training and skills development, capacity building, mentoring, coaching, and other growth support initiatives		Kosmos Innovation Centre	kosmosinnovationcenter.com	Working with entrepreneurs into incubation and SMEs, growing start-ups and accelerating SMEs
Enablis Entrepreneurial Network Ghana	www.ghana.enablis.org	Identify budding entrepreneurs and empower them to succeed		Kumasi Hive	www.kumasihive.com	Support local innovation technology development, incubation, business development, co-working space and business capacity building
Eqwip Hubs	www.eqwiphubs.org	Provision of innovation spaces that transform the youth through market-driven work skills and entrepreneurship incubators		MEST (Melwater School of Entrepreneurship and Technology)	www.meltwater.org	entrepreneurial training program, seed fund and incubator for Africa's next leading software entrepreneurs
Grassroots Hub	www.grassrootshubgh.net	Educate, innovate, and incubate eco-preneurship and SDG innovations		No Business as Usual (NBU)	www.nbuhub.com	Provide training in entrepreneurship and employable skills targeting 500 youth within the Asokre Mampong Municipality
Hapaspace	www.hapaspace.com	Supports start-ups to move from just idea to full fledge business, provide co-working space, event space and		Sun City Hub	www.suncityhubgh.com	Train entrepreneurs, incubate, business plan development, and empower women through capacity building
Ho Node	honode.org	Empowering young people with digital skills and innovation culture to build successful start-ups, create sustainable jobs and prepare for future jobs		Tentmaker Ghana	https://www.tentmakergh.com	Innovation hub that provides business Incubation, co-working space and support services to entrepreneurs and/or start-ups for sustainability and scale.
Hopin Academy	www.hopinacademy.org	Providing training in ICT, communication, and marketing for professionals and entrepreneurs		Workshed Africa Ltd.	www.ourworkshed.com www.worksh edafrica.com	To help businesses attain success faster
i.Code	www.icodegh.com	Provide training in entrepreneurship and technology		Yison Technology Hub	www.yisontechhub.com	Empower youth in the area of innovation activity and technology

Source: Fieldwork (2019)

Table 3: Profiles of Higher Education and Research Organisations Reached

Organisation	Website	Main Functions		Organisation	Website	Main Functions
Higher Education Institutions and Public Research Organisations				**Higher Education Institutions and Public Research Organisations**		
Business Innovations and Incubation Centre, UDS	None	Contribute to the growth of SME sub-sector in Ghana by offering solutions		CSIR-Head Office	www.csir.org	Pursue implementation of government policies on scientific research and development
Centre for Plant Medicine Research	www.cpmr.org.gh	Research into plant medicine for promotion, encouragement, extension, transfer and application of scientific research knowledge and development in field of plant medicine		CSIR-SRI	none	Undertake research to generate technologies, commercialise these technologies and build capacity in sustainable management of Ghana's soil resources
Centre for Entrepreneurship and Innovation Development (KTU)	https:\\ceid.ktu.edu.gh/contact-us	Help students acquire entrepreneurial skills so as to establish their own business		GIMPA	www.gimpa.edu.gh	To provide higher and tertiary education, consultancy, and research and education
Centre for Business Development, KNUST	ki-hub.com	Industrial and academic relation office to promote spin-off from departmental levels		Ho Technical University	www.htu.edu.gh	Train students, conduct practical or applied research
CSIR-BRRI	www.brri.org	Undertake research into all aspects of building and road design and construction, to develop construction materials from local sources to reduce construction costs and make housing affordable		Sunyani Technical University	www.stu.edu.gh	Teaching (Provide higher education in engineering science and technology-based disciplines, technical and vocational education and training, applied arts and related disciplines)
CSIR-CRI	www.cropsresearch.org	Undertake research to generate technologies in food crops (cereals, legumes/seeds, roots/tubers) horticultural crops, and industrial crops		UCC BI (University of Cape Coast Business Incubator)	www.cesed.ucc.edu.gh	Produce leaders in entrepreneurship and small enterprise development in Ghana and beyond
CSIR-FORIG	www.csir-forig.org	Undertake forest, forest products and related research, disseminate, and commercialise research outputs and services		University of Professional Studies (UPSA)	www.udsa.edu.gh	Teaching and research

Source: Fieldwork (2019)

4.2.2. Policymaking Actors in Ghana's Innovation Ecosystem

The Executive arm of government in Ghana, represented by the Office of the President and Ministries, has been mandated by Ghana's constitution to initiate policies (Akon-yamga, 2018). The Executive is nonetheless assisted by the Legislative arm to make such policies. Various sector ministries make policies for their specific sectors and these policies have ramifications for the innovation ecosystem. Thus, to be able to execute the objective of innovation and research commercialisation, it is important to understand ways in which sector ministries' policies affect actors in the innovation ecosystem. In addition, an understanding of the policies of sector ministries is important for determining channels by which innovation and research commercialisation could be realised. Table 4 presents a list of sector ministries that were reached during this study.

The role of ministries in the innovation ecosystem cannot be limited to the policy process alone. Ministries are major implementers of government programmes, through and, in collaboration with sector agencies and departments. Through the implementation process, there are consumptions of goods and services, and use of expertise. Hence, there is a unique role for ministries in the innovation ecosystem in which they can significantly influence the innovation ecosystem activities by way of the priorities they set for the country.

Table 4: Profiles of Policymaking Institutions Reached

Organisation	Website	Main Functions		Organisation	Website	Main Functions
Ministries				**Ministries**		
Ministry of Aviation	http://moa.gov.gh	Formulate aviation policies for the development of the aviation industry		Ministry of Roads and Highways	www.mrh.gov.gh	Formulate policies, coordinate sector performance, monitor and evaluate road infrastructure development and maintenance, and road maintenance financing
Ministry of Employment and Labour Relations	www.melr.gov.gh	Lead policy adviser to government on employment and labour related issues		Ministry of the Interior	www.mint.gov.gh	Ensure internal security, maintain law and order in the country
Ministry of Energy	www.energymin.gov.gh	Formulation and implementation of energy policy, monitoring and evaluation of activities in the energy sector		Ministry of Trade and Industry	www.moti.gov.gh	Lead policy advisor to government on trade, industry and private sector development
Ministry of Food and Agriculture	www.mofa.gov.gh	Formulate policy relating to agriculture and backstopping in the decentralised department and monitoring and evaluation		Ministry of Works and Housing	www.mwh.gov.gh	Formulate housing and works policies, sustainably manage development of infrastructure, improve access to safe, secure and decent accommodation
Ministry of Health	www.moh.gov.gh	Formulate policies and regulatory frameworks to guide health service delivery in Ghana, Mobilize and allocate resources for health service development, and Train, deploy, and retain health professionals		Ministry of Youth and Sports	www.moys.gov.gh	Promote youth and sports development
Ministry of Information	http://moi.gov.gh	To disseminate government information		Ministry of Finance	www.mofep.gov.gh	Formulating and implementing sound fiscal and financial policies of government, and managing the economy
Ministry of Local Government and Rural Development	www.mlgrd.gov.gh	Ensure good governance of MMDAs through the formulation of policies on decentralisation and rural and urban development		National Development Planning Commission	www.ndpc.gov.gh	To advice the President of Ghana and Parliament on development planning, policy, and strategy

Source: Fieldwork (2019)

4.2.3. Commercial Actors in Ghana's Innovation Ecosystem

The third category of the innovation ecosystem—the Commercial Category—is driven by the market. Mostly, this category consumes products of the innovation and research category. In addition, the commercial category funds, supports, and facilitates activities of the innovation and research category. The commercial category was identified to include actors such as financial institutions, the private sector, and public agencies and corporations (Table 5).

Table 5: Profiles of Commercial Category of Organisations Reached

Organisation	Website	Main Functions		Organisation	Website	Main Functions
Financial Institutions				**Financial Institutions**		
Agricultural Development Bank	www.agricbank.com	Provide banking and financial services		Ghana International Bank Plc.	ghanabank.co.uk	Providing correspondent banking services to financial institutions as well as financing solutions to selected corporate financial institutions and individuals. Ghana office is only a representative off
Barclays Bank Ghana	https://www.gh.barclaysafrica.com/personal/	Financial intermediation		National Investment Bank	www.nib-ghana.com	Financial services
Ecobank	www.ecobank.com	Financial intermediation, economic development of Ghana, and value creation for shareholders		Stanbic Bank Ghana Limited	www.stanbicbank.com.gh	Drive growth in Africa by offering superior financial products using our insights and experience to unlock opportunities and mitigate risk for our broad range of clients
First Atlantic Bank	www.firstatlanticbank.com.gh	Financial service/Commercial bank		United Bank for Africa Ghana Limited	www.ubaghana.com	Commercial Bank
GCB Bank Limited	www.gcbbank.com.gh	Making banking services available to all		Zenith Bank Ghana Ltd.	www.zenithbank.com.gh	Banking
Public Agencies and Corporations				**Public Agencies and Corporations**		
Forestry Commission	www.fcghana.org	Regulate the utilisation of timber resources; manages the nation's forest resources and protected areas; assist the private sector and other bodies with the implementation of forest and wildlife policies		National Entrepreneurship and Innovation Programme	www.neip.gov.gh	Create entrepreneurship
Forestry Commission (Forest Services Division)	www.fcghana.org	Protection, development, and management of Ghana's forest resources		National Petroleum Authority	www.npa.org.gh	Regulate, oversee, and monitor activities in the petroleum downstream industry
Ghana Export Promotion Authority	www.gepaghana.org	Develop and promote exports		Private Enterprise Foundation	www.pef.org.gh	Advocacy on behalf of companies and train members to improve technical and management skills
Ghana Investment Promotion Centre	www.gipc.gov.gh	Promote investment in and outside of Ghana (ACT 865) 2013		Tema Oil Refiner	www.torghana.com	Refining crude oil for Ghana and exports
Goil Company Limited	www.goil.com.gh	Market quality petroleum and other energy products and services		Venture Capital Trust Fund	www.venturecapitalghana.com.gh	To provide long-term financing to SMEs through venture capital financing companies, and to develop the venture capital industry
National Board for Small Scale Industry	www.nbssi.gov.gh	To play a leading role in the promotion and development of MSMEs in Ghana (ACT 434)		Wildlife Division of Forestry Commission	none	Manages Ghana's protected areas, regulates the utilisation of wildlife resources, promotes public awareness, and support for wildlife conservation

Source: Fieldwork (2019)

Tables 2, 3,4, and 5 showcase profiles of actors in the innovation ecosystem covered during the field work. However, a mapping of actors in the innovation ecosystem cannot end in a listing of entities with their profiles. A proper mapping of actors must also include analysis of

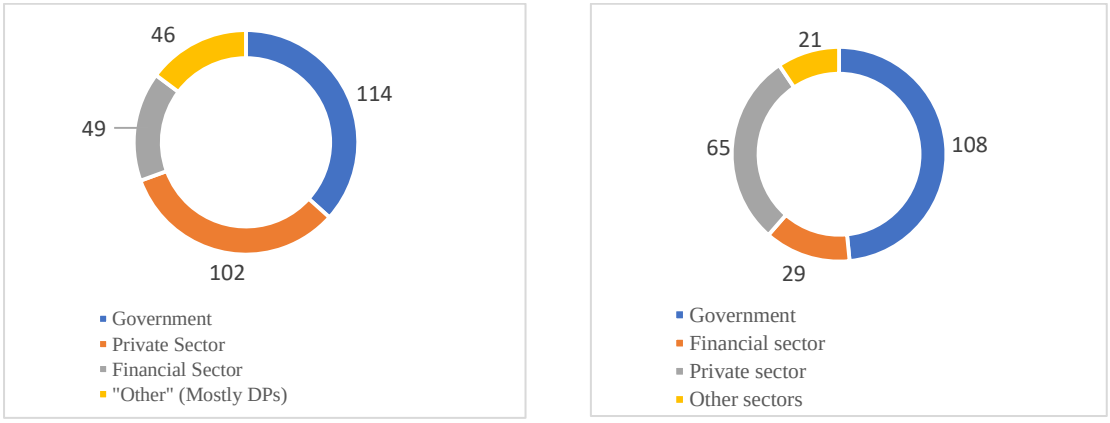
the actors' interactions with stakeholders of the innovation ecosystem. This is important because the innovation ecosystem embodies real-time complex relationships among stakeholders with the functional aim of enabling technology development and innovation. Thus, in what follows attention is devoted to showing the interactions between, on one hand, actors in the ecosystem that were interviewed and, on the other hand, actors/stakeholders in the innovation ecosystem in general.

4.2.4. Ecosystem Stakeholder Analysis

The study sought to identify and present (in a simplified manner) the nature of interactions and linkages among actors in the innovation ecosystem of Ghana. Consequently, the study found that the innovation and research category interacted most of the time with government organisations followed closely by interactions with the private sector. The financial sector organisations edged the non-classified group labelled "other" organisations (which was dominated by donor agencies and organisations) for the third most important sector to the innovation and research category of the innovation ecosystem (Figure 5 a).

Figure 5: Most Connected Sectors to Categories of the Innovation Ecosystem (Frequency)

(a) Innovation and Research Category **(b) Policymaking and Commercial Categories (Combined)**



Source: Fieldwork (2019)

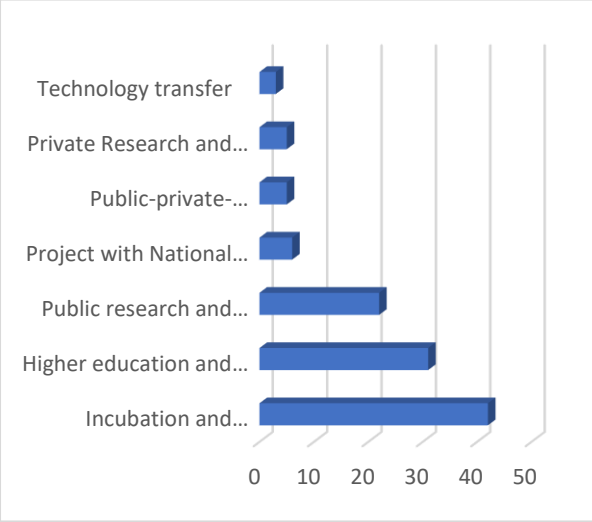
For the combined categories or policymaking and commercial actors, linkages to government organisations and institutions was also important. This was followed by interactions with the private sector, financial, and then the non-classified group "other" (Figure 5b). As illustrated by Figure 5, it is clear that the public sector is very key for the functioning of the innovation ecosystem. Among others, the public sector is the largest consumer of goods and services in

the economy, and the sector includes the government which makes policies and regulations that govern the innovation ecosystem.

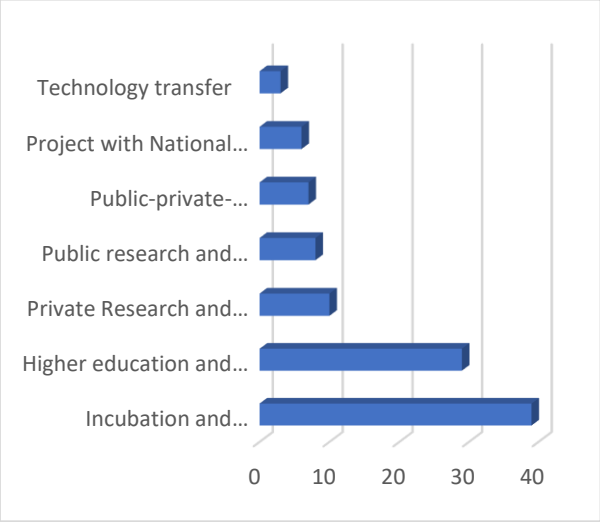
Considering the sector with the most interactions (government), it came to light that organisations in the innovation and incubation sub-category did the most interactions with government organisations (Figure 6a). Innovation and incubation hubs were followed by higher education institutions; private research institutions, and public research institutions. In Figure 6b, the story is similar. The innovation and incubation hubs led in terms of interactions with the private sector, followed by higher education institutions, private and public research institutions. The same scenario is repeated for interactions with the "other" sectors of organisations (Figure 6c). From the presentation in Figure 6, it is fair to observe that the innovation and incubation hubs have been busy interacting with a number of organisations in Ghana and abroad. Table 5 present lists of top ten organisations per sector that the various sub-category of organisations interacted with.

Figure 6: Sector Connections to Sub-Categories of Innovation and Research

(a) Government Sector

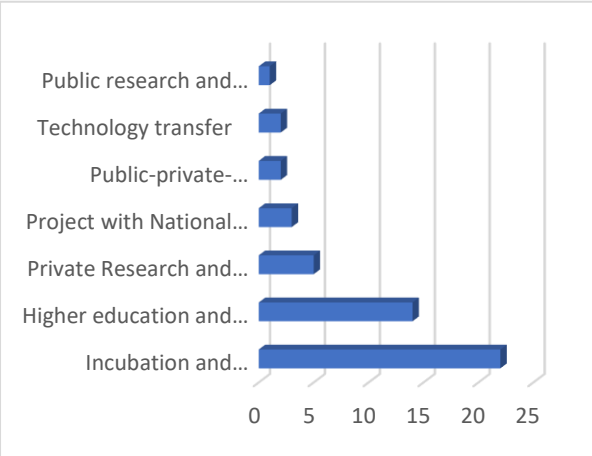


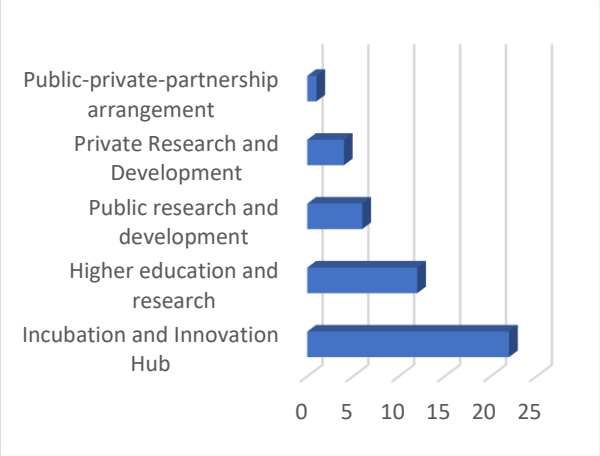
(b) Private Sector



(c) Financial Sector

(d) "Other" Sector





The study sought to identify and generate a list of top ten organisations that interacted the most with the innovation and research category of the innovation ecosystem. From Table 6, the top-most government organisations[3] that interacted with the organisations under the innovation and research category of the innovation system include the Secretariat of National Entrepreneurship and Innovation Programme (NEIP), Ministry of Business Development (MoBD), Ministry of Environment Science Technology and Innovation (MESTI), Ministry of Trade and Industry (MoTI), National Youth Authority (NYA), National Board for Small Scale Industries (NBSSI), Ghana Standards Authority (GSA), Food and Drugs Authority (FDA), and the Youth Employment Agency (YEA). This list is a mixture of policymaking organisations (MESTI, MoBD, and MoTI), implementing agencies (NEIP, NYA, NBSSI, and YEA), and regulatory organisations (GSA and FDA).

The list of top private sector organisations that interacted with organisations under the innovation and research category includes Ghana Technology Lab, MTN, Vodafone, Ghana Hubs Network, Association of Ghana Industries (AGI), Business and Financial Times (B&FT), Ghana Innovation Hub, Impact Hub, and Kumasi Hive. The organisations in this list reflect the dominance or strength of the interactions from innovation and incubation hubs.

For the list of top organisations in the Financial Sector, the study identified, in order of importance, Agricultural Development Bank (ADB), Stanbic Bank, Ecobank, Cal Bank, National Investment Bank, Universal Merchant Bank (UMB), Credit Union Training Centre, GN Bank[1], and the Angel Investors as the ones respondents interacted with the most. It is

[3] The organisations are listed in order of importance based on the frequencies of responses
[1] This bank is currently in distress (see https://www.myjoyonline.com/business/2019/August-16th/why-gn-savings-and-loans-company-ltd-was-closed-down.php.)

important to note that this list includes a mix of agricultural, development, and commercial banks.

The innovation and research category organisations did interact with development partners (DPs), civil society organisations (CSOs), and non-governmental organisations (NGOs). As shown in Table 5, the list of top ten DPs/CSOs/NGOs mentioned by respondents includes GIZ, British Council, the Delegation of German Industry and Commerce in Ghana (AHK), Canadian Embassy, German Academic Exchange Service (DAAD), European Commission, Ghana-Oracle Digital Enterprise Programme (GODEP), Wadhwani Foundation, the World Bank, and Afrilabs.

Table 6: Top Ten Organisations for Innovation and Research Category

Top Government Organisations				**Top Private Sector Organisations**		
Organisation	**Frequency**	**Percent**		**Organisation**	**Frequency**	**Percent**
NEIP	18	28		Ghana Tech Lab	5	14
MoBD	13	20		MTN	5	14
MESTI	6	9		Vodafone	5	14
MoTI	5	8		Ghana Hubs Network	4	11
NYA	4	6		AGI	3	8
NBSSI	4	6		B&FT	3	8
GSA	4	6		Ghana Innovation Hub	3	8
FDA	4	6		Impact Hub	3	8
YEA	3	5		Kumasi Hive	3	8
MoC	3	5		AGEA	2	6
Total	64	100		**Total**	36	100
Top Financial Organisations				**Top DPs, CSOs, and NGOs**		
Organisation	**Frequency**	**Percent**		**Organisation**	**Frequency**	**Percent**
ADB	5	16		GIZ	9	31
Stanbic	5	16		British Council	5	17
Ecobank	4	13		AHK	2	7
Cal Bank	3	10		Canadian Embassy	2	7

Commercial Banks	3	10		DAAD	2	7
NIB	3	10		European Commission	2	7
UMB	3	10		GODEP	2	7
Credit Union Training Centre	2	6		Wadhwani Foundation	2	7
GN Bank	2	6		World Bank	2	7
Angel Investors	1	3		Afrilabs	1	3
Total	31	100		**Total**	29	100

Source: Fieldwork (2019)

It is important to underscore the fact that in the innovation ecosystem, there are several facilitators of interactions among the actors, including policies, programmes, and laws. In this regard, respondents were asked to mention some that facilitated their operations. Table 7 provides a summary. Worthy of highlighting, among the list in the table is the One District One Factory (1D1F) Programme. The 1D1F is a government programme that has the main goal of establishing at least one factory in each of the districts in Ghana. The programme has been envisaged to be led by the private sector with the government's facilitation.

One policy mentioned was the mandates of universities as contained in the Acts establishing the universities. Public universities' mandate includes the need to engage and foster relationships with bodies outside the universities. For instance, the Act establishing the University of Ghana states

> Research will be undertaken in the subjects which are taught in the University, but with special attention to subjects that relate to the social, cultural, economic, scientific, technological and any other problems which exist in Ghana or elsewhere in Africa… the University will develop close relationships with the people of this country and with any other institutions, whether within the country or outside
>
> (Republic of Ghana, 2010, p. 5,6)

Hence, the public universities are motivated by their mandate to interact with organisations across all sectors for the purpose of disseminating their research findings and developing innovations. Consequently, there has been renewed urgency among public universities in Ghana to establish and strengthen relationships with the private sector.

The Planting for Food and Jobs is a programme of the Government of Ghana, which equally received same mention as the previously discussed policies. It is aimed at promoting growth in food production and to create jobs across the country. This Programme is being implemented by the Ministry of Food and Agriculture and has five pillars: (i) Seed access and development; (ii) fertilizer access and fertilizer systems development; (iii) extension services; (iv) marketing; and (v) e-agriculture. Notwithstanding the benefits of this programme, according to some of the agri-based hubs, they have only benefited from one of the pillars of the PFJ, which is the fertilizer access pillar.

Other policies mentioned include the National Youth Policy; The Act establishing the Council for Scientific and Industrial Research (Act 521); the National Education Policy; private-public participation policies; Data Protection Act (Act 843); Corporate Social Responsibility Policies of corporations; Ghana Beyond Aid; local government bylaws; the National Climate Change Policy; the Ministry of Business Development' policy of 5-year tax-free for start-ups and SMEs; Private Sector Engagement Strategy Document, and the Private Sector Development Plan (Table 7)

Table 7: Policies that Facilitate Organisations' Activities

Policies	Frequency	Percent
One District one Factory (1D1F)	2	11
Universities' Mandate from Establishing Acts (KNUST, UDS)	2	11
Planting for Food and Jobs	2	11
National Youth Policy	1	5
CSIR Act (Act 521)	1	5
National Education Policy	1	5
PPP Policies	1	5
Data Protection Law	1	5
CSRP of Corporations (Newmont)	1	5
Ghana Beyond Aid	1	5
Universities' IP Policy (KNUST)	1	5

Local Assembly Bylaws	1	5
National Climate Change Policy	1	5
Policy of 3-year tax-free for start-ups and SMEs	1	5
Private Sector Engagement Strategy Document	1	5
Private Sector Development Plan	1	5
Total	19	100

Source: Fieldwork (2019)

Table 8 list summarises top ten organisations for the combined respondents the policymaking and commercial categories. The list of top ten government organisations for these categories of respondents interacted with includes the Bank of Ghana (BoG), Council for Scientific and Industrial Research (CSIR), Ministry of Trade and Industry, the Ghana Interbank Payment and Settlement Systems (GhIPSS), Ghana Standards Authority (GSA), Ministry of Environment Science Technology and Innovation (MESTI), the Environmental Protection Agency (EPA), Ministry of Finance (MoF), Ministry of Food nd Agriculture (MoFA) and the Food and Drugs Authority (FDA).

The top ten financial sector organisations for the two categories include Commercial Banks in general, and specifically, Agricultural Development Bank (ADB), Access Bank, Airtel Money, Corenett, Ecobank, Exim Bank, Ghana Commercial Bank (GCB), and GH Bank. For the private sector, the two categories interacted with the Association of Ghana Industry (AGI), Airtel-Tigo, MTN, Vodafone, Ghana National Chamber of Commerce and Industry (GNCCI), the Chamber of Bulk Oil Distribution (CBOD), Federation of Associations of Ghanaian Exporters (FAGE), NCR Ghana Limited, and Private Enterprise Foundation (PEF).

In the among the development partners, civil society and non-governmental organisations, among others, the specific organisations that the two categories (policymaking and commercial) interacted with include the World Bank, China Europe International Business School (CEIBS), Civil Society Organisations (CSOs) in general, the Department for International Development (DFID) of the United Kingdom, E-transact, the European Commission, GIZ, Integrated Community Centre for Employable Skills (ICCES), and Interswitch (Table 8).

Table 8: Top Ten Critical Organisation to Commercial Category Respondents

Government		
Organisation	**Frequency**	**Percent**
Bank of Ghana	6	13
CSIR	6	13
MoTI	6	13
GhIPSS	5	10
GSA	5	10
MESTI	5	10
EPA	4	8
MoF	4	8
MoFA	4	8
FDA	3	6
Total	48	100

Financial		
Organisation	**Frequency**	**Percent**
Commercial Banks	5	33
ADB	2	13
Access Bank	1	7
Airtel Money	1	7
Corenett,	1	7
Ecobank	1	7
Exim Bank	1	7
Express pay	1	7
GCB	1	7
GH Bank	1	7
Total	15	100

Private Sector		
Organisation	**Frequency**	**Percent**
AGI	5	17
Airtel- Tigo	4	13
MTN	4	13
Vodafone	4	13
GNCCI	3	10
CBOD	2	7
FAGE	2	7
Imani Ghana	2	7
NCR	2	7
PEF	2	7
Total	30	100

DPs, CSOs, NGOs, and Other		
Organisation	**Frequency**	**Percent**
CEIBS	1	9
CSOs	1	9
British Council	1	9
DFID	1	9
E-transact,	1	9
EU	1	9
GIZ	1	9
ICCES	1	9
Interswitch	1	9
World Bank	2	18
Total	11	100

Source: Fieldwork (2019)

A number of existing conditions were identified by as contributing to making the environment conducive for interactions. See Appendix 4 for the full list of conditions by respondents. Notwithstanding, is worthy of highlighting here that conditions created by government of Ghana's policies were mentioned. For instance, the one district one factory (1D1F) has created a sense of developing local businesses. Existence of market opportunities was another cluster of conditions. Under this, the increasing demand for exportable goods from Ghana was one, tremendous need for capital among SMEs for which banks are taking advantage to develop products for SMEs. There is also the condition of available structures to incubate entrepreneurs, such as proliferation of ICT, pursuit of the digital transformation in Ghana.

In addition to identifying existing conditions, Commercial Category of actors identified non-existing conditions that, if existed, could facilitate interactions even further. Table 9 lists some of these conditions.

Table 9: Non-Existing Conditions that Could Facilitate Interactions

Conditions	Frequency	Percent
Adequate funding for R&D institutions	8	16
Better collaborations with R&D institutions, and efficient and effective timber resources utilisation, effective stakeholders' engagement platforms, institutionalised linkages	7	14
Capacity development opportunities	5	10
Regulatory regime for the commercialisation of R&D, mandate of the organisation to not directly engage in commercial activities	4	8
Better road infrastructure, Cost of electricity power	3	6
Access to R&D reports/data and awareness of STI and the outputs of R&D	3	6
National quality policy, open standards to drive best practices, crystallisation of the regulatory environment as a quality barometer	3	6
Information about individuals willing to take challenges of commercialising research outputs	2	4

Lack of research on the contributions of commercialisation to GDP	2	4
Support from the private sector and donor institutions for commercialisation	2	4
Tax incentives for funding STI	2	4
Funds to support start-ups	2	4
Harmonising R&D priorities among stakeholders, non-existing policy direction on R&D	2	4
Drone for fast delivery of materials for testing to the laboratory	1	2
Political will	1	2
One-stop-shop for business registration	1	2
Support from R&D institutions with bankable research output	1	2
Total	**49**	**100**

Source: Fieldwork (2019)

Furthermore, the conditions listed above were most likely created or facilitated by policies and legislative frameworks. A number of such specific policies and legislative frameworks were identified to be critical for the innovation ecosystem. Among the policies and laws mentioned include:

- Energy Policy
- Local Content Policy (Petroleum Downstream)
- Ghana Investment Promotion Centre Act (Act 865)
- Circulars from the Bank of Ghana
- Corporate Social Responsibility
- Exim Bank Act (ACT911)
- FASDEP II, objective 4
- Forest and Wildlife Policy 2012
- Import substitution policy of government
- National Health Policy, Supply Chain Master Plan
- The National Health Insurance Scheme NHIS (The Law)
- National CHPS Policy
- National Youth Policy
- Policy on promoting alternative means of housing construction as enshrined in the national housing policy

- PPP Policy (bill), considering the private sector as the engine of growth
- Security and Exchange Commission's Regulations
- National Science Technology and Innovation Policy

4.3. SWOT of the STI Ecosystem

So far, this report has presented a mapping of key actors and policies at play in the innovation ecosystem of Ghana, on the basis of interviews. In this section, the report presents some analyses of strengths, weaknesses, opportunities, and threats (SWOT) of the sub-categories of the innovation and research category of the innovation ecosystem.

SWOT of Innovation and Research Category

For the purpose of the SWOT analyses, the innovation and research category of respondents will be discussed under three sub-categories, namely: (i) Higher education and research; (ii) Public research and development; and (iii) Incubation and Innovation Hub. See Appendix 5 for the full list of SWOT responses.

Strengths

The strengths of higher education institutions were listed to include greater human resources capacity for education and training in several areas such as engineering, governance, entrepreneurship, and technology development. In addition, the higher education institutions had strengths for research and technology development; available infrastructure in the form of office space, laboratories, and ICT facilities; and their locations and market (usually students and public) too were a form of strength they boasted about. Furthermore, among the areas of strengths they identified included the wide array of professional expertise they could rely on from the university-wide pool of expertise.

Among the public research sub-category, their greatest strength lies in research and development across various sectors of the national economy. There is, however, stronger emphasis on agricultural research, technologies development, and innovations, with specific areas such as agronomy, plant breeding, and soil fertility management techniques. Some of the research organisations have capacities for products commercialisation, e.g., *prekese* syrup (CSIR-FORIG), solar drying (CSIR-ARI), and cassava flour (CSIR-FRI). In addition to the emphasis of agricultural research and development, the public research institutions have strengths in industrial research and development as well; they are a repository and sources of

information on research output/results that have potential for innovation and commercialisation—a very important strength.

The main strength of incubation and innovation hubs lies in their capacities to incubate entrepreneurs and small businesses from the stage of idea to market. That is, they are strong in start-up development. In so doing, the hubs provide tailor-designed trainings to the incubatees (entrepreneurs and small businesses) to help them develop their ideas into products and services, and to start and grow their businesses. Hubs provide entrepreneurship training, digital technology and skills training, approaches to fundraising, and training in financial management to incubates. Alongside the training provided, incubation and innovation hubs do provide mentorship and coaching to the incubatees and eventual start-ups; some of the hubs are sponsored by their parent companies and therefore provide their services for free in addition to providing funding to start-ups to run. For instance, MEST and Kosmos Innovation Centre are two hubs that were interviewed that provide funding to start-ups with backing from their parent companies. It goes without saying, however, that most of the hubs provide their services for free to incubatees that are being sponsored by the National Entrepreneurship and Innovation Programme.

Furthermore, incubation and innovation hubs have strengths in the form of maker spaces where they help start-ups produce prototypes of their products for testing and trial prior to commercial production. It must be added, however, that not all the hubs have this capability; only the well-established hubs such as Kumasi Hive have such capabilities. Therefore, it would be important to find means by which hubs could be supported to have or access makerspaces to then support their incubatees to produce prototypes of their innovations.

Hubs by the nature of their organisations consider themselves as a "community" and therefore are able to give to each other and their incubatees community support, which exists internally and externally. The internal community support is important because it enhances the sharing of ideas with a diversity of persons, organisations, and expertise, which promote the generation of ideas. The external community also provides the same benefits as the internal community with the added advantage of broadening the network of organisation, person, and expertise that incubatees and small businesses can tap into. For example, the EQWIP Hub in Tamale gets its financial strength from an external source which is the Global Affairs of Canada. This provides funds to ensure that trainings for incubatees are done free of charge with the ultimate goal of

impacting on lives and the community. In addition to this fund, individual volunteers from Canada fundraise $3,500.00 each to qualify in participating as a volunteer on the EQWIP Hub Project. The money raised is put in a Youth Innovation Fund which provides seed capital for start-ups business acceleration. With this scenario, it is a fact that some start-ups get external support in order to sustain operations.

Incubation and innovation hubs have the added strength of being able to support innovations and entrepreneurship at the local level. One of the services provided by hubs is co-working space where small businesses and entrepreneurs have space and facilities to run their businesses from. The co-working space concept is a means of generating revenue internally to support the hub operations since the user of the co-working space is charged monthly rent. It is important to point out that there are organisations providing co-working space services that are not necessarily incubation hubs. One of such organisations interviewed during the study is Workshed.

Weaknesses

Among the higher education organisations, two weaknesses were paramount namely weak linkages to the private sector and inability to secure funding for research and development activities. The issue of weak linkage between the academia and private sector in Ghana has been a major problem militating against the successful transformation of research output and technology in the academia to products and services. Consequently, novel approaches are required to circumvent this problem and hereby result in the establishment and strengthening of linkages between academia and the private sector. Already, higher education and research organisation have begun establishing technology transfer centres and incubation hubs. There is value in doing so, however, strategies are needed at the national or sectoral level to harmonise these efforts.

The second major weakness of higher education organisations—ability to obtain funding for R&D—partly follows from the weak linkage existing between the academia and private sector. The other part stems from the fact that until recently, there was no national fund solely dedicated to financing research, technology development, and innovation activities in Ghana. With most of the higher education organisations relying on the national public purse, there has been inadequate financing or R&D activities in these institutions. Apparently, government priority on local R&D is not high enough to stimulate government funding of the R&D. At the

same time, looking for and obtaining funding has become extremely competitive and requiring staff and researchers of high calibre to attract research funding. The absence of funding for higher education institutions does not only affect the R&D activities of the organisations, but it does also affect their ability to support and fund start-ups (for those that have established incubation hubs). In the absence of funding, some of the hubs in the higher education charge each student to raise some funds to acquire some resources for training.

Although higher education institutions reported the availability of infrastructure as a source of strength, there is more room for improvement in that area with respect to specific infrastructures for research and development. There are buildings for use as office and other spaces; however, furnishing in such building is a major challenge. Even those with spaces for start-ups are inadequate to accommodate the increasing numbers. As a result of the limited spaces some of the hubs improvise by conducting community outreaches where they go into the communities and train some people who could not get enrolled in the hubs. Moreover, the equipment for research and development have become old and require replacement to ensure that they are internationally competitive. Maintenance of infrastructure and equipment is inadequate. Higher education institutions have ICT and laboratory facilities, but the challenge is that some of the software are not updated as frequently as they should be and internet speed and reliability outside the major cities is a bigger challenge. Some laboratory equipment needed for testing of samples is not available or broken down or obsolete which negatively affect testing of materials required for FDA certification (especially for edibles).

Public research organisations share similar weaknesses as the higher education organisations. Especially on issues of linkages and interactions with the private sector and on funding of R&D activities. Added to these, public research organisations have low visibility as a weakness. In other words, there is low recognition among the general public in Ghana about the abilities and achievements of public research organisations. Indeed, anecdotally, it has been erroneously observed that public research organisations are a drain on government funding. Meanwhile, these organisations produce very important technologies for the agricultural and industrial sectors of Ghana's economy and thus contribute significantly to national gross domestic product (GDP). The disconnect here is that public research organisations do not invest in and are not aggressive about self-marketing in spite of their deliverables.

In addition to the above, public research organisations, especially those that were already into commercialisation of their products, identified absence of mechanised production systems to ensure increased production as a weakness. This affected the levels of their internally generated funds. Furthermore, the overall rate of commercialisation was lower than they expected, an outcome of the low production capacity and inadequate funding. Above all else, attracting and retaining young researchers and staff was a weakness identified by public research organisations. Even when they were successful, the recruits did not last long, but found other offers elsewhere. For the public research organisations that were in production, their weakness in obtaining funding affected their working capital as well.

In identifying weaknesses, incubation and innovation hubs were not spared. Securing funding support for start-ups was one of their weaknesses. With the exception of hubs that had funding from their parent companies, which made it possible for them to provide funding to their start-ups, all other hubs were weak in funding their start-ups. As reported to have happened very often, hubs would incubate entrepreneurs and start-ups to a point where they needed to scaleup and out, but due to lack of funding support, many of such start-ups ended up folding or not growing at the rate they should. Even if funding is provided, the amount given for acceleration is usually not sufficient for some specific type of business start-ups because of their capital intensiveness. A quote from an interview with the CEO of Dansyn Hub stated, "I am operating the hub because of passion but not because of money, if I was following money, I would have folded up long time ago." This further goes to affirm the financial challenges faced by the hubs.

In addition, the rate at which hubs enrolled and graduated incubatees resulted in mass production of entrepreneurs with limited support systems around the small businesses that would ensure their survival and growth. The issue of mass production of entrepreneurs does not end with the numbers, but there are other related problems. Challenges such as the hubs not being able to communicate effectively with all the start-ups and or be able to manage logistics among them are also prevalent. In order words, the number of incubatees and start-ups was outgrowing the capacities of the hubs to be able to provide them the needed support. There are instances where hubs lack logistics such as vehicles to carryout monitoring and evaluation of the performance of start-ups and help correct challenges if any, of the start-ups in their various operational areas. Even though, there is some level of monitoring, those start-ups covered are few and those not covered are those liable for failure.

Since incubation and innovation hubs are not research organisations themselves, they identified a weakness in data analysis. By the nature of operations of hubs, they do not often have all expertise in-house. They hire experts as consultants as and when the need arises, but the need for researchers and data analysts is an area that the hubs require in-house expertise. However, since most of the hubs do not charge for their services and do not have core funding support, they are unable to hire and retain researchers in-house. This weakness also affects other categories of staff they have in-house for running their trainings. Hubs identified that most of the staff for training need to improve their capacities in order to be able to provide higher quality training to the incubatees.

Opportunities

A number of opportunities were identified by the higher education institutions. The development of agribusiness is one of such. This is particularly important given the present government's policy *Agenda for Jobs* giving direct impetus to various programmes such *Planting for Food and Jobs*. Thus, the opportunity to design programmes at higher education institutions for agribusiness would go a long way to ensure the transformation of the agricultural sector from predominantly subsistence to commercial for increased productivity and income for farmers.

Furthermore, the specific opportunity to develop agribusiness falls within a broader opportunity of promoting entrepreneurship among higher educational institutions. Traditionally, this has not been the case. In the past the focus of higher education institutions was on producing human capital to be hired by businesses. However, in recent times, the focus has shifted a lot more to imparting the interests, skills, and zeal of entrepreneurship to students who later go on to graduate from higher education institutions in Ghana and then start their own businesses. Thus, there is a burgeoning spirit of entrepreneurship among graduates that needs to continue in order to reduce the level graduate unemployment in Ghana.

Higher education institutions identified opportunities to exist in the area of business acceleration. Especially, those institutions that had incubation hubs realized that at the level of post incubation, most of the entrepreneurs were unable to scaleup and out. Hence, there is opportunity to provide support to accelerate start-ups; however, as alluded to earlier, the

availability of funding is hampering the realization of such an opportunity. One of the ways to address this is to establish a business village for students and incubatees, because the people are availing themselves to be trained to be empowered to realize their entrepreneurship potential.

It was established that public research organisations are a repository of research findings. Consequently, opportunities are immense for transforming research findings into products and services. This can be better harnessed through the development of agribusiness and support for start-up companies to develop products and services, or innovations based on research findings of public research organisations. A strategy is needed on ways to proceed in this regard.

Furthermore, for public research institutions, there are opportunities to access international funding to support their research and development activities. However, the downside of this is that the focus of such international funding agencies may not be the focus of Ghana's development priorities. One way to address this challenge would be the design of R&D programmes that are aligned to national development priorities and then on that basis, seek for international funding that fits into the national R&D programme.

A number of specific opportunities were identified for specific public research institutions. For example, there is opportunity at the Forestry Research Institute of Ghana of the Council for Scientific and Industrial Research (CSIR-FORIG) to improve bee hives for high productivity of honey. CSIR-FORIG has successfully commercialised its honey making technology and therefore the institute finds that there is opportunity to increase production in order to rake in more internally generated funds. At the Building and Roads Research Institute (CSIR-BRRI), it emerged that if there were enforcement of the policy to use 60% local materials in construction, patronage of their products (especially the pozzolana cement) would see greater patronage.

The incubation and innovation hubs identified a wide variety of opportunities, among them include:

- Clean transport (Solar vehicle)
- Zoning out part of Accra as spatial niche for innovators
- Business acceleration
- Promoting public understanding and support for incubation hub

- ICT training for SHS graduates
- Professional skills for employees
- Coding for children
- Specialised skills in trade areas
- Advocacy for incubation and innovation hubs
- Business to business (B2B) matching
- Funding of community innovation projects
- Funding SDG businesses
- IT development among women
- Establish business village for students
- Leveraging on Double Track System to design programmes for SHS graduates
- Software development training
- Building young talent locally to localised externally procured technology and services
- Access to internet services
- Engagement of rural areas in IT
- Developing the business aspect of tourism

4.4. Case Studies of Incubation and Innovation Hubs

Given the diversity among the incubation and innovation hubs, the ecosystem study and analysis did cases of different types of hubs on the basis of thematic areas of focus, source of funding, and geographical location. In the end, nine (3) organisations' cases have been chosen and presented in the following.

4.4.1. Educational Quality Work Improvement Programme (EQWIP) Hubs

EQWIP Hubs was chosen for the case study because of its uniqueness as a project as well as for being one of the hubs that could fund their start-ups to some extent. Also, its location in the northern part of Ghana ensures that there is spatial diversity in featuring of the case study stories.

Services

The services provided by the EQWIP Hubs borders on its mandate, and includes livelihood empowerment, entrepreneurship and employability, and mainstreaming gender and environmental sustainability in its operations. It is a project which commenced in 2015 but with actual implementation in 2016. The project is an initiative of Youth Challenge International and Canada Worldview through the funding support of Global Affairs of Canada.

The whole idea about the project is to equip the youth with the skills needed to bridge the gap between theory and practice.

Based on its mandate, the hub builds capacity in the area of entrepreneurship and business management using business model canvas as a tool in business development (the tool is used to develop business ideas into business plans). The hub recruits, provide training, funding support, mentoring and coaching which is free of charge unlike other hubs. The courses taught include innovation, key partnerships, business operations and finance, costing, management and revenue generation. The key words that guide the hub in the training are innovation and creativity. As a result of the concern for the environment, the hub also encourages green businesses for environmental sustainability.

The hub started in Accra, served for some time and then relocated to Kumasi and Tamale to continue operations. The branch in Kumasi is housed at the Kumasi Technical University (KTU), whilst that of Tamale is hosted in the Regional National Service Office. To ensure sustainability of the project, the hub is working in partnership with the Regional National Service Office and building their capacity to take over the implementation of the project even after the project has ended. Currently, the hub is transitioning to the National Service Office to take over the project as it ends.

Achievement

Some achievements chalked by the hub include the introduction of Girls-Only-Spaces and Child Care Services for incubatees who were mostly women. The child care service was introduced because most of the youth benefiting from the training programmes were mothers with children. As a result, an avenue has been created for the women to leave their children under child care at a child care centre, so they can attend the training programme. The Girls-Only-Spaces was introduced to also create a safe place for women to meet and share ideas. This is because, culturally women are shy to talk in the region, so a safe place will encourage the women to share ideas among themselves. The success of this model for training has enabled its adoption by the Department of Gender and Civil Society Organisation (CSOs) in the Northern Region.

Also, the hub provides ICT support for the youth to provide them with soft skills because a lot of the youth after school, could not operate a computer. The ICT training covers Microsoft Word, Excel and PowerPoint.

The achievement of the hub also rides on its ability to raise funds to train the youth free of charge. As a non-profit venture, there is no intension of making money or profit by charging fees because human capital gain and employment are the priorities of the project, unlike other hubs that charge some fees to generate some income for sustainability.
The hub has also been able to introduce Youth Community Mapping research undertaken by the youth leadership team to study how the unemployment situation could be supported through the project in the area.

Since the inception of the project in Tamale, the hub has trained over 600 youth and 45 of them supported with the Youth Innovation Fund. The Youth Innovation Fund is opened to all who have been trained to present their businesses and portray creativity and innovation. One has to apply and there is a selection committee from the ecosystem (expertise in youth livelihood and entrepreneurship who leverages on their resources to advance the course of the youth) who will review the applications for selection. The best is selected so they can benefit from the funding. After the selection, the start-ups are taken through 5 days of comprehensive accelerator workshop to equip them with the practical experience needed from the captains of industry in the Northern Region.

There are specific topics which are taught at the accelerator workshops including business planning, finance management, business operations among others which takes about 12 weeks to complete. After the accelerator workshop, an amount ranging from $500.00 to $2,000.00 is given to the start-ups depending on the business idea and which is paid in two tranches, first 75% and later 25%. So far, 75 of the businesses start-ups are running successfully.

The project also instituted 6 months sustainability service, where the start-ups are matched to mentors in similar industry to meet and discuss their businesses, provide support and guide them through the start-up phase. There is also a second part of the sustainability service which also involves coaching, where peer to peer mentorship is done between the Canadian Volunteers and their Ghanaian Start-ups. This is usually done every month by coaching the start-ups on their businesses, identifying challenges and finding solutions, among others. These

activities also involve field trips and regular visits to the start-ups. Throughout the period of the sustainability service, there is monthly workshop organized for start-ups where proposed topics are taught in line with the identified challenges in the coaching of the start-ups. These interventions are done to minimize the rate of failure of start-ups because research shows 9 out of 10 start-ups fail in businesses.

Challenges

The challenges of the hub include the lack of adequate funds to support the business start-ups. Some of the start-ups have good ideas that $2,000.00 may not be enough to push their business ideas through. The rationale behind the funding from the hub was to support start-ups that might need small money to start after the business pitching of the various start-ups, it is realized that the maximum amount of money offered ($2,000.00) by the project may not be enough to support them. As a result of this challenge, the hub met with the private sector such as the banks in Tamale to extend credit support to the start-ups which have shown positive response. However, the banks specified the need for start-ups to keep their records clean so as to use same as basis to access credit from them. Some hub network members with businesses in the metropolis have also shown interest to support some start-ups that have creative and innovative ideas.

As regards the market penetration, the challenge is that the hub cannot reach out and enrol all the youth who need our services. The hub usually gets over 100 subscriptions for enrolment but could only admit a maximum of 30 people per training workshop for entrepreneurship. This shows that we have more population to deal with and therefore the need to expand. The hub tries to reach out to those who were not enrolled and others through a module called tertiary trainings. This is usually a one-day training workshop to reach out to those who could not be admitted to also acquire some form of skills.

The hub stated that though infrastructure such as space is a challenge, per the dictates of the project, what is available could only be catered for by the project. There is no vehicle available and other logistics to effectively monitor start-ups and for outreach programmes. There is a need for adequate logistics to effectively carry out our mandate.

Sources of Funding

The funding support comes from the Global Affairs of Canada and funds are also raised by Canadians Volunteers to support the project with each raising $3,500 Canadian Dollars to qualify to participate on the project. The money raised is put in the Youth Innovation Fund for the start-ups.

Equipment and Machines

- Laptops
- Fast speed internet for research
- Standby generator to keep the hub running as a result of unreliable electricity supply
- Dispensers
- Other office equipment such as printers

Organizational Structure

The number of core staff is 3 who are paid salaries. There are 8 Canadian and 2 local volunteers who are given stipends in the discharge of their duties. Staff turnover is not really common with the hub. Out of the three-core staff, the hub coordinator holds master's degree in administration and the other 2 hold Degrees each in Integrated Development Studies. The 8 Canadian Volunteers have pursued degrees from bachelor's to masters, whilst the 2 local volunteers have HND and Diploma qualifications.

The organizational structure starts from the head in Canada who is the Project Director followed by the Ghana Country Manager, the hub coordinators, then the training coordinators and the volunteers.

Some Start-ups

The following 5 start-ups are supported by the hub:

- Saha collections- uses local fabrics to design clothing, sandals, bags
- Hami Comfort- uses waste products to produce eco-friendly pillows
- On-the-Dot Deliveries- uses courier-based services for local same day deliveries
- Zee Poultry Farm- producing poultry and distribution of processed poultry (dressed), supplying quality and organically sourced nutritious eggs.
- Unique Groundnut Production- producing quality hygienic, nutritious, affordable, well-defined and packed groundnut products.

Figure 7: Training, Recreational, and Working Spaces at EQWIP Hubs

Source: Fieldwork (2019

Saha Collection Start-up (Issah Yakubu Wushie, Contact: 0548184848)

Services

Saha collection started in 2018 and operates in the area of craft making where products such as bags, footwears, apparels and smocks are produced using local fabrics. The nature of the support received during incubation includes training on foundational business support, entrepreneurship development and financial support of ₵5,000.00 Cedis from the Youth Innovation Fund.

Achievement

Saha Collection producing and selling on retail basis but now produces in larger quantities for wholesale locally and for export to Togo and Cameroon. Currently, the business generates revenue from sales and ploughing back profits to grow.

Challenges

- The challenge with market penetration was that the acceptance of the products took some time for the public to embrace them. As a result, the market was poor at the beginning but now better than it used to be.
- Product delivery by transport is expensive, especially when transporting to Cameroon.
- Skills in the manufacture of my product are high in demand. Some of my employees usually come and learn and leave later to establish as competitors.
- With regards to infrastructure, the space used for manufacturing is small (15 by 10 feet structure). Renting a store ranges from ₵200 to ₵350 per month with advance payment of 2 years which makes it expensive. There a need for bigger space but cost of renting is high.

Equipment available

The equipment is mainly sewing machines but needs industrial sewing machines, filing machine and extension machine.

Organizational structure

The structure is flat with 6 staff and an estimated turnover of 1 staff per year. The educational qualification of 5 of the staff is SHS and 1 is an undergraduate student in school who comes to provides support especially on vacations.

Figure 8: Products of Start-Up Company Under EQWIP Hubs

Source: Saha Collections

4.4.2. University of Cape Coast Business Incubator (UCC-BI).

The UCC-BI was chosen to represent the group of hubs owned by higher education institutions. Also, its local in Central Region made sure that the western part of coastal Ghana was covered in the case studies

Services

The business incubator was established with funding from the School of Business in 2013 and provides support in the mixed area of ICT, Agribusiness and Fashion. They also carry out professional services and tuition including ICA, accounting and auditing. As an incubator, they support start-ups with mentoring, training, and provision of co-working space to help start-ups. UCC-BI does not provide funding. The incubator has 8 spaces available for start-ups which are provided for a maximum of 2 years after which they leave with the hope of establishing on their own. The number of staffs is 4 including other unspecified number of instructors from different departments of the various colleges of the university.

Achievements

The centre has incubated about 30 businesses and formed partnership with the Ministry for Business Development (MoBD) and National Entrepreneurial and Innovation Programme (NEIP) to train about 300 entrepreneurs. Some of the entrepreneurs are start-ups with already existing businesses. Biweekly, the centre meets the incubatees to train them. As a result of limited resources, the centre finds it difficult to follow up on all the trained entrepreneurs.

Challenges

This is a University with limited resources. After incubating the start-ups, it is difficult for them to go out and survive because of harsh conditions outside such as rental of space and payment of utilities and staff. However, on campus they pay only Eighty (80 Cedis) per month for everything including the space to work. In order for start-ups to survive out there, they will need funding, which is difficult to come by. The challenges include resource constraints to train and to monitor the performance of start-ups. Notwithstanding, the incubator has identified about seven (7) entrepreneurs who are surviving and performing well.

There is time limitation for training in terms of time for lecturers who are full time workers in other departments. The time allocation is limited to do all the things because we are not autonomous unlike others. The university system also has constraints because the business incubator is a unit within the Centre for Entrepreneurial and Small Enterprise Development (CESED) which is embedded in a larger university framework. The work is done within a hierarchy which limits to some extent what can be done. There are no human resources challenges because the incubator taps into all the expertise in the school of business and others within the university.

Funding to support incubatees directly is non-existent and the incubator cannot afford to support them. The incubator once had a challenge with one of our start-ups whose time was up to leave but he didn't because according to him, he had no financial resources and enough skills to be weaned off. The incubatees such as Tonem Hospital Software Platform and the Automated Dustbin Innovation have brilliant innovations, but funding is a challenge.

The incubator has limited space for incubatees because of the non-availability of funds to expand in order to enrol more incubatees. The centre has architectural design for a new Centre for Entrepreneurship and Small Enterprise Development (CESED) Complex which is ready but no funds available to build. The design has 20 office spaces for incubatees, conference

room, training room, meeting rooms and exhibition space for incubatees works. UCC-BI is looking for funding for the project. The centre has vast experience both in theory and practice, but the limitations are not helping to impart that knowledge.

With regards to equipment and machinery, the procurement processes go through time and delay in the procurement of equipment. There is a new rule which ensures that before procuring good and services, we should acquire 3 separate invoices from suppliers for selection before the issuance of cheque for procurement. This is unlike the other private companies that make direct purchase as and when needed. Some of the equipment such as computers and printers need replacement and some maintenance. UCC-BI contacted Ghana Investment Fund for Electronic Communication (GIFEC) which is under the Ministry of Communication, to support us with computers and we have been told to submit a proposal which is being prepared. GIFEC source funding to support with the provision of the ICT equipment and there is no payment for that service from the beneficiary institution.

Sources of funding

The source of funding is mainly internally generated fund. The centre has eight spaces for incubatees which each pay rent of Eighty Cedis (80 cedis) per month for all the facilities they use. NEIP also pays UCC-BI for training of entrepreneurs. The NEIP brings their rate per person in the training. UCC-BI also organizes training which generate income for the hub. The challenge is funding because there is no funding from the university, so we write proposals and do projects that will bring funds for our operations. For example, some work was done for Rainforest Alliance that brought in 35,000 Dollars. The centre also did some training for market women on records keeping because they still rely on *san danho* (putting marks on the wall) as a way of keeping records.

Market Penetration

Start-ups don't get enough market within Cape Coast. However, the centre is able to help them access market but not much. The greater market is outside Cape Coast and we wish we could help them with a marketing platform where they could market their produce such as Jumia. The centre advised the start-ups to use Jumia and even with that platform there is no drop off centre in Cape Coast but only parcel delivery. The products developed by the incubatees are both tangible and intangible products. The intangible mainly consists of IT software development products. The incubatees are helped to find a business niche and do target

marketing especially within the university because there is a lot of students doing entrepreneurship, which makes it easy market. The incubator usually experiments marketing the products with the students to help perfect the market outside.

Organizational structure

The centre has three units, namely, Entrepreneurship Education and Training (EET), Business Incubation (BI), and Research and Communication (RC). Each of the units has a coordinator. At the centre level, the hierarchy starts with the Director of the Centre of Entrepreneurship and Small Enterprises Development (CESED). This is followed by the Coordinators. The Coordinator for the Business Incubation is followed by the administrators and lastly the messenger. The incubatees are our main clients and are not part of the hierarchy.

Number of staff: four (4). However, there are other experts such as…. from different colleges within the university who help in the work of the business incubator.

Expertise and Background Training in the Business Incubator

Coordinator is a PhD Holder with expertise in business training, small business finance, business planning and proposal writing. The administrators are two (2). One has bachelor's degree of Commerce and the other is bachelor's in general administration. The Messenger holds a Middle School Leaving Certificate. Notwithstanding the expertise of the hub, the centre is under staffed and which could be attributed to the national ban on employment, which is affecting the hub. However, the hub has vibrant proactive expertise from different departments and the support of the university that help the work of the hub. Staff Turnover is Zero and there are however transfers within the university transfer system.

Equipment Available

1. Desktop computers in all cubicles
2. Photocopier
3. Projector
4. Cabinet and office desk in all cubicles
5. Furnished conference room

Start-ups supported

Some of the start-ups supported or currently being supported include the following:

1. Coastline Consultancy- left the hub in 2016
2. Tonem MultiTech- admitted in 2017 to date
3. Mothers Kitchen- started as a student in 2016 and has left
4. PITS (Premium information Technology Services)- left 2016
5. Inka Accessories- admitted in 2019

Interview with Inka Accessories- Irene Naa Korkor Armah

The services of this start-up include skills training in vocation, fashion, managerial, book keeping and entrepreneurship.

The nature of the support received from the UCC-BI is training with funding from Tony Elumelu Foundation (TEF) and partly self-financing. According to the incubatee, Tony Elumelu is the largest shareholder of UBA Bank and support entrepreneurs.

Achievement- Some students have taken the bead making as an alternative source of income.

2018-Received funding from TEF

2018-Trained tourist groups in bead making which was paid by each participant

-Trained final year undergraduate students in entrepreneurship and bead making

2019-Secured a space on campus to target students and providing training and mentoring sessions for students and business people.

4.4.3. Ho Node Innovation Hub

Services

The Ho Node was established in 2017 with the mission to inculcate the culture of innovation among the youth in the city. The hub wants the youth to think and see problems as opportunities that can be turned into solutions for development and not always complain about challenges. In order to achieve the culture of innovation, the hub trains by teaching digital skills such as design, artificial intelligence (AI), coding and other emerging technologies. The hub provides entrepreneurship support for people with business ideas and helps transform the ideas into products for the market. They also carry out research advocacy on science, technology, engineering and mathematics (STEM) at the secondary and primary schools to encourage and show the need to be interested in STEM programmes.

Achievement

The achievements of the hub include the shaping of the youth to develop the culture of innovation which led in the creation of innovation communities for like-minded people such as

- Community for software developers or those interested in technologies
- Community for women entrepreneurs to create a safe space for women to meet and deliberate on issues and help each other.
- Community for creativity such as tourism and graphic designing and
- General Community for entrepreneurs

All those in Photography, videography and graphic design are put in the community for creativity. Why is this an achievement? It is because other hubs conduct their training in a scattered manner, but our hub brings the various innovation communities together regularly to plan their own meeting schedules to help them innovate. The communities regularly have virtual meetings and also meet together physically to engage and encourage peer learning and sharing of ideas to foster innovation. This is also encouraging the innovation communities to grow.

The hub has also done a lot of digital skills training with much focus on women. This has enabled the training of women in coding and artificial intelligence, photography, mobile app, graphic design among others. In terms of numbers, the hub has trained close to 500 people in learning and use of digital skills.

The hub has further provided business support to entrepreneurs such as one-on-one support for entrepreneurs. The support include teaching them how to keep their books good in business management, financials, records keeping among others, which are facilitated by mentors. There is an on-going training for 20 people in artificial intelligence and creating start-ups for 4 people out of the 20. Usually, the 4 bright talents are selected out of the 20 based on their business pitching for further training. Those 16 talents who were not selected had the option for internship with our industrial partners in Ho. The partners are individual private businesses in the Ho Municipality. The hub is helping the 4 talents to develop their start-ups with the skills acquired. The competitive approach used in the selection of the start-ups is due to the limited space and resources to accommodate more start-ups.

The hub doesn't have the capacity to send the incubatees for internship in Accra and as a result we encourage localization of businesses to develop communities. Some of our partners in the municipality include:

- Ired GH — a software development company
- Bellarich — an auditing and accounting firm with some aspect of software development
- Geodex—into spatial recognition and predictive analysis using technology to understand and analyse weather pattern for farmers. It is more aligned to agriculture.

Challenges

In the area of human resources capacity, the hub is facing the challenge of attracting and keeping talents or expertise. This is because most people want to move to Accra (rural-urban migration) and as a result it will take a lot to attract high level skilled expertise from Accra. In order to overcome that, we need to provide something more competitive than other companies. For instance, some of the expertise sacrificed and left more lucrative jobs in Accra to come and work in the hub without good remuneration. To be able to attract expertise, there is the need for motivation in the face of competition and that is a big challenge. The challenge of expertise could be solved if the government develops a policy to support innovation hubs with at least one national service person to work with the hubs. As a private institution, if we request for national service persons, we have to do double payment, paying the service person and also the national service secretariat for the request.

The financial status of the hub is a challenge because it is a non-profit and also self-funded by the founders of the hub. The founding members invested in the business in terms of provision of infrastructure and logistics. The hub also depends on the traditional method of funding which is grants and project funding from donors. The idea behind the establishment of the hub is setting social impact as a priority and not revenue, notwithstanding the fact that the business must be sustainable. In order to remain sustainable, the hub has other business models that also generate some money.

The challenge with funding also comes from the fact that a lot of the youth can't afford the full cost of the training programmes, so ways have to be found for making the training free for them. For instance, in Accra, the minimum amount charged for Mobile App training is 1,000

Cedis per month. The hub decided to reduce the cost for the municipality and charged 200 Cedis per month for 6 weeks, but only few people registered. Clearly, the people could not afford even with the reduction of the cost of training. So, if the cost of training is absorbed and becomes free, somebody has to pay for it and that is the nature of the funding the hub provides. The hub firstly thinks about the impact, the change to the individual and to society.

The location of our hub also presents a challenge and disadvantageous in seeking grants. Some projects or grant designs already predetermines where the project should be located before it is granted, which are mainly in Accra, Kumasi, Takoradi and Tamale. This is creating some challenge for Ho and we even foresee the challenge before trying to access it.

The challenge of infrastructure is mainly on internet. The hub spends a lot of money on internet, but it is not stable and not fast enough. The hub does not have access to the fibre optic backbone of MTN and Vodafone because it is very expensive connecting it. Vodafone is especially not stable. Basically, the 4G level of the networks are low in Ho compared to Accra and other places. For a hub to be successful, the fundamental thing needed is internet. If the internet is good, you can attract people to the hub for learning and research. The hub also has co-working spaces but because of internet challenges, it is not attractive to people in the municipality. However, the concept of co-working space is very good for bigger cities such as Accra because of good internet Access.

In terms of Equipment and machinery, the hub lacks skilled laboratory such as a Maker Space which is very expensive to establish. The hub is therefore interested in building a Maker Space with 3D Cutting and 3D Printers, where people can prototype their works and design. The Maker Space is very important because the hub is a nexus of educational institutions such as the Ho Technical University, Ghana Technology University College (GTUC), University of Allied Health Sciences and the Training College. These institutions provide us with the talents needed for the hub to build and develop. A Makerspace is important to help students improve research and innovation. The educational institutions around the hub lack the Maker Space due to procurement issues and that is why the hub hopes to fill this gap. In other advanced areas, the hubs play the role of the high skilled labs for the academic institutions to prototype and improve on their research and innovations.

Sources of funding

The hub is a non-profit organisation and also funded by the founders of the hub. The founding members invested in the business in terms of provision of infrastructure and logistics. The hub also depends on the traditional method of funding which is grants and project funding from donors. The hub has other business models that also generate some money.

Organizational Structure

The hub has an organizational structure, but the principle is more of a flat and open system of organization. This is because there are no specific private offices for the various positions and each of the staff could play different roles in the delivery of our mandate. There is the chief executive (CEO) followed by the chief innovation officer (CIO) and the chief technical officer (CTO) at the same level. These are followed by Business Innovation Associates, Digital Skills Training Manager, In-house developers, Administration which include Programmes Manager and Communication, Interns, etc). For example, the programmes manager could play a different role based on the need. This happens because of the challenge of getting expertise and the cost involved. In summary, there is innovation department for business development and the technical department for the digital skill training, and administration which also handles financials and also interns. Some of the roles are given to consultants as and when we need them.

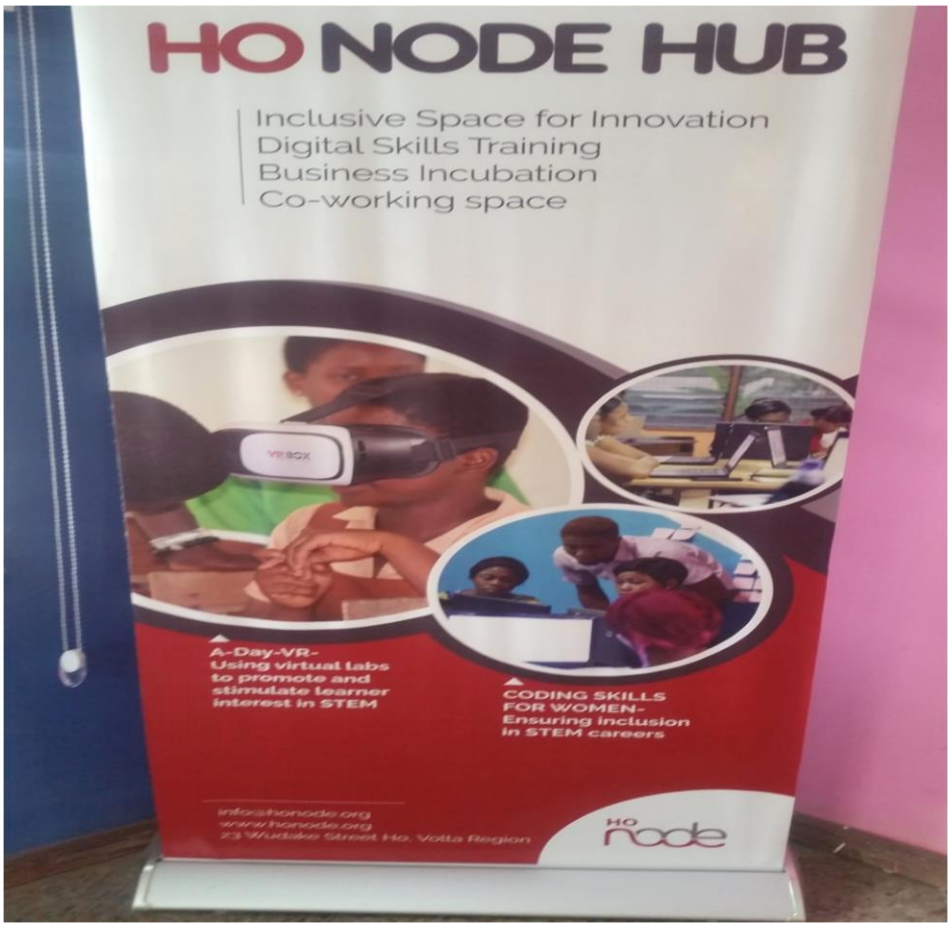
There are 4 full time staff and 5 consultants who work with us as and when we need them. The expertise of the hub includes:

- CEO-Electrical Engineering and Policy
- Programme Manager- Real Estate Management
- MBA Marketing and Digital Innovation
- Software Developer- Computer Engineering
- Accountant- who is a consultant and not on full time
- Interns
- National Service Person

Start-ups Supported

Usually, the hub selects the best talents which form our start-up base from the Festival of Hackathon Platform. This is a platform where talents gather with their ideas, build prototypes and pitch. The best talents are selected and supported to develop their pitches into products for commercialization. It is this platform which gave birth to start-ups such as the Town District.
The hub provides different level of support to the following start-ups based on their needs:

- Poll Deck- Customer experience Software Company which started in Feb 2019
- KD Photography- is into creating tourism experiences which started 2018
- Delom Fresh Farms- which is into agribusiness (innovative Fish Farm- one can personally select the fish in the water to be captured for instant fresh food preparation). Started 2016
- Town District- is into software development which started 2017
- Track U- use Artificial Intelligence to do CCTV Monitoring and Tracking. Started 2019.



KD Photography Start-up

The KD Photography is a media and videography company with area of operations including corporate headshot for organizations, videography for events, photography and digital marketing. The start-up begun in 2017 and was incubated at Ho Node. The nature of the support received during the incubation period include technical support in business incubation training, business proposal writing, due diligence training such as keeping books right so as to attract investment. The sources of funding for the incubation are self-funding and also financial support from the Ho Node hub. The source of funds for the start-up is mainly revenue generated from the business and ploughing back of profit. The business also obtains funds from referral of projects and outsourced contracts from other partners.

Achievement

The achievements of KD Photography include:

- Documented the December 31 events of the NDC Party in 2017
- Covered the Ghana Hub Network event in Accra in 2018
- The official media partner for the Turkish Embassy 96th Anniversary celebration in Accra in 2019. During this period the embassy carries out their corporate social responsibilities (CSR) activities in the country.

Challenges

- The market is saturated with a lot of competitors
- Equipment and machinery are expensive and there is the need to save and plough back profit in order to buy the expensive gadgets. Examples include Camera, lightening system, studio, backdrop, and drone among others.
- As regards infrastructure, there is limited space at the Ho Node. As a start-up, I pay for the space and there is the lack of financial resources to go and rent a bigger space for my operation. The internet is not stable but very important in sending most of our works to our clients.
- The challenge faced with human resource capacity is the need to upgrade skills with new technologies.

Organizational structure

The structure of the organization is mainly flat with 4 staff, comprising 2 employees and 2 partners who come onboard when there is a project. Staff turnover does not really occur. Our expertise includes Degrees in Economics, Political Science, Physics and HND Graphic Designing. The clients of the business are individuals and organizations

5.0. Summary and Recommendations

Women's participation at the top level of the innovation ecosystem is low; top level management of actors in the innovation ecosystem favour the participation of men. There are attempts to improve the participation of women in the innovation ecosystem through specific programmes and projects, while deliberate efforts have been made by specific actors to recruit female participants during training. For instance, Ghana Tech Lab advertised its strong encouragement of women to enrol during its recruitment of trainees for its artificial intelligence training programme. The Ministry of Communication, in recognising the gender gap in the innovation ecosystem, has launched a programme called Ms Geek. This programme is r to empower through a competition with the overall aim of empowering young women to enter the fields of Science, Technology, Engineering, and Mathematics (STEM). Furthermore, from the cases presented earlier in this report, Ho Node and EQWIP equally recognize the need to take steps to close the gender gap in the ecosystem. However, a coordinated programme or strategy at the national level is missing.

Despite the fact that National Gender Policy recognises that challenge of women's access to STEM not only "how to bridge the gap," but also "to include women's needs and strategic interests in the establishment of digital knowledge–based society." Thus, it is recommended that the various programmes being run by the ecosystem actors with the end goal of increasing women's participation in the ecosystem must be deliberately designed to include women's needs and strategic interests. To achieve this a gender strategy needs to be developed for the ecosystem taking into considerations provisions of various national policies on gender, STEM, and innovation.

It emerged from the study that there is a geographical concentration of the ecosystem actors in two regions in Ghana. Indeed, most of the innovation ecosystem actors are located in the major cities of Accra and Kumasi. Such a concentration is the result of deficiencies in national

development planning that have historical backgrounds, and which further serves to entrench regional inequalities in Ghana. Thus, any interventions to address the imbalance of the distribution also lies beyond the ecosystem. Nonetheless, it should be emphasised that deliberate strategies should be designed that targets the goal of spreading innovation ecosystem actors (especially incubation and innovation hubs) across the country.

Government organisations named as key actors of the ecosystem include National Entrepreneurship and Innovation Programme, Ministry of Business Development, Ministry of Trade and Industry, and Ministry of Environment Science Technology and Innovation. For the private sector, important organisations named include Ghana Tech Lab, MTN, Vodafone, Association of Ghana Industries, and Ghana Hubs Network. For the financial sector, the most important banks identified were Agricultural Development Bank (ADB), Stanbic Bank, Ecobank, Cal Bank, National Investment Bank (NIB), and Universal Merchant Bank (UMB). In addition, the study identified key development partners that are critical for the innovation ecosystem. Among these are GIZ Ghana, British Council Ghana, Delegation of German Industry and Commerce in Ghana (AHK Ghana), and the European Commission These organisations can be considered the core of organisations that can provide support for enhanced commercialisation of research and innovations in Ghana, particularly when it comes to developing start-ups and growing entrepreneurs. Therefore, the proper coordination of programmes, projects, and interventions among these organisations is crucial.

Furthermore, the top private sector actors in the ecosystem (as identified by this study) include the two biggest telecommunication companies in Ghana, Ghana Tech Lab, AGI, and Ghana Hubs Network. This suggests strong activity in the digital innovation space. Whiles it is recommended that support be provided to the innovation ecosystem in general, it is strongly recommended that the ecosystem be diversified through support for the commercialization of traditional R&D outputs that sitting on the shelves of the various research institutions and universities in Ghana. As alluded to earlier, in the attempts to improve on their commercialization activities, some of the research institutes and universities have began establishing incubation and innovation hubs to incubate entrepreneurs and to commercialize research findings. These efforts need to be encouraged and supported under a national framework or strategy. This framework should also be designed such that it will seek to address issues relating to all incubation and innovation hubs in the country.

It is important to underscore the fact that the financial sector is an important part of the innovation ecosystem with specific banks (ADB, Stanbic, Ecobank, Cal Bank, NIB, and UMB) having been named as key actors. Given that funding was identified as a major challenge of the ecosystem in general, having banks onboard means that the potential to obtain funding from the financial sector is huge. However, issues such as regular engagements between research organization and the banks have to be worked out to enable the sharing of ideas and information. In this light, research organisations have to adopt the appropriate means to communicate their research findings with bankable outputs and innovations for commercialisation to the banks. In so doing, the understanding with the banks for decision-making is enhanced and thus making it easier for the banks to know what is needed for the commercialisation of research and innovations.

The stakeholder mapping revealed that GIZ, British Council and European Commission are very important development partners acting in the innovation ecosystem. It is recommended that MESTI develop a strategic paper or roadmap on the basis of which to engage the development partners. This will ensure that activities in the innovation ecosystem are addressing national development priorities as determined by the nation.

A number of national policies exists that have provisions that support research and innovations, albeit mostly from within specific organisations. And, although most of these policies do not necessarily have provisions that facilitate commercialisation, there are possibilities for doing so. Yet these possibilities lie mainly within the ambit of the organisations using their discretion under their corporate social responsibility plans to make allocations to research organisations for the purposes of supporting research and innovation commercialisation. But this is inadequate. It is therefore recommended that a national strategy be drawn to cater for the commercialisation of research and innovations

The innovation ecosystem of Ghana has several areas of strengths, weaknesses, opportunities, and threats. Key areas of strengths identified include the abundance of human capital in terms of numbers and areas of expertise. In addition, there is the strength of abundance human capacity for research and development, albeit that is skewed towards the agricultural sector. Hence, it is recommended that the higher education institutions and research organisations be encouraged and supported to design and implement R&D programmes that target other sectors

of the national economy. Furthermore, these organisations should be encouraged to upgrade the skill sets of their human capital to enable them to be competitive in the global economy.

Incubation and innovation hubs in Ghana have a strong network that is very supportive of individual hubs so they in turn support the development of ideas and innovations for commercialisation. This is a strength of the innovation ecosystem. Moreover, incubation and innovation hubs have strength in start-up development. This mean that any efforts towards the commercialisation of research and innovation should make use of them. Hence, it is recommended that support for incubation and innovation hubs should be part of the strategy for research and innovation commercialisation in Ghana.

Among the weaknesses of the innovation ecosystem identified, two deserve the spotlight. First, the weak linkage between traditional research and development organisations and the private sector in Ghana requires conscious and innovative efforts to address. It is recommended that the research organisations adopt the hubs' approach to pursue commercialisation of their research and innovations. This is because the hubs have shown that they know how to interact with sectors of the economy, especially the private sector. Second, the issue of inadequate funding for research and innovation activities is affecting the activities of research organisations in respect of research and development. Hopefully, when the National Research Fund takes off, this should be a problem of the past; however, it is recommended that the Fund puts emphasis on research and innovations that show, of have potential for, strong research-private sector linkages, and which have aspects for commercialisation.

The Planting for Food and Jobs Programme is one major area that provides for immense opportunities to promote agribusiness—an opportunity in potential. Hence, opportunities exist for actors in the innovation ecosystem to support and grow agribusinesses in Ghana. Moreover, given the fact that the traditional research institutions and the universities are a repository of research outputs that can be commercialised, opportunities for growing companies and start-ups exist. Hence, it is recommended:

- A strategy be designed that would see the participation of already existing hubs with research organisations to develop start-ups based on the existing research and innovations outputs of the research organisations

- Provide adequate financial resources to such start-ups. After all, one of the weaknesses identified to be associated with innovation hubs is their inability to support start-ups grow beyond their establishment.

The major threat to the innovation ecosystem was inadequacy of funding. Funding for research and development is inadequate, same for developing and improving capacity of human capital, expanding infrastructure, and providing competitive remuneration to retain staff and experts. Thus, the recommendation is that the Ghana Innovation and Research Commercialisation Centre (GIRC-Centre) should be established with careful thought and clear plans to provide it with sustainable model of funding, which will in turn enable the Centre to support actors in the innovation ecosystem with timely and adequate funding.

6.0. References

Adner, R., & Kapoor, R. (2010). Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. *Strateg. Manag. J.*, *31*(3), 306–333.

Akon-yamga, G. (2018). *Oil in Ghana: A Curse or not? Examining Environmental Justice and the Social Process in Policymaking*. University of North Texas, Denton.

Bartels, F. L., Voss, H., Lederer, S., & Bachtro, C. (2012). Determinants of National Innovation Systems: *Innovation: Management, Policy & Practice*, *14*(1), 2–18.

Chesbrough, H. (2003). *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston, Massachusetts: Harvard Business School Press.

Edquist, C., & Johnson, B. (1997). Institutions and Organizations in Systems of Innovation. In *Systems of innovation, technologies, institutions and organizations*, (pp. 41–63). London: Pinter.

Gomes, L. A. de V., Facin, A. L. F., Salerno, M. S., & Ikenami, R. K. (2018). Unpacking the innovation ecosystem construct: Evolution, gaps and trends. *Technological Forecasting and Social Change*, *136*, 30–48. https://doi.org/10.1016/j.techfore.2016.11.009

Jackson, D. J. (2011). *What is innovation eco-system?* Washington, D.C.

Lee, Nam, Y., Lee, S., & Son, H. (2016). Determinants of ICT innovations: A cross-country empirical study. *Technological Forecasting and Social Change*, *110*, 71–77. https://doi.org/10.1016/j.techfore.2015.11.010

Lundvall, B.-Å. (Ed.). (2010). *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning*. London and New York: Anthem Press. https://doi.org/10.1057/9780230512603

OECD/Eurostat. (2018). *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation* (4th ed.). Paris and Luxembourg: OECD Publishing.

OECD. (1997). *National innovation systems*. Paris. https://doi.org/10.1504/IJEIM.2008.018615

Oh, D. S., Phillips, F., Park, S., & Lee, E. (2016). Innovation ecosystems: A critical examination. *Technovation*, *54*, 1–6. https://doi.org/10.1016/j.technovation.2016.02.004

Quaye, W., Akon-Yamga, G., Daniels, C., Ting, B., & Asante, A. (2019). *Transformation Innovation Learning History of Ghana's E-Waste Management System*. Brighton.

Rabelo, R. J., & Bernus, P. (2015). A holistic model of building innovation ecosystems. *IFAC-PapersOnLine*, *28*(3), 2250–2257. https://doi.org/10.1016/j.ifacol.2015.06.423

Republic of Ghana. University of Ghana Act, 2010 (ACT 806) (2010). Ghana. https://doi.org/10.1002/9780470423851.part2

Smorodinskaya, N., Russell, M., Katukov, D., & Still, K. (2017). Innovation Ecosystems vs. Innovation Systems in Terms of Collaboration and Co-creation of Value. In *Proceedings of the 50th Hawaii International Conference on System Sciences (2017)*. https://doi.org/10.24251/hicss.2017.636

Tidd, J., Bessant, J., & Pavitt, K. (2005). *Managing Innovation: Integrating Technological, Market andOrganizational Change*. *Credit Control in Boom and Recession* (3rd ed.). West Sussex: John Wiley & Sons, Ltd. https://doi.org/10.1057/9780230390249_12

UNIDO. (2012). *Evidence-Based Policy Making: The Ghana National System of Innovation – Measurement, Analysis and Policy*. Vienna.

Vrgovic, P., Vidicki, P., Glassman, B., & Walton, A. (2012). Open innovation for SMEs in developing countries - An intermediated communication network model for collaboration beyond obstacles. *Innovation: Management, Policy and Practice*, *14*(3), 290–302. https://doi.org/10.5172/impp.2012.14.3.290

Xu, G., Wu, Y., Minshall, T., & Zhou, Y. (2018). Exploring innovation ecosystems across science, technology, and business: A case of 3D printing in China. *Technological Forecasting and Social Change*, *136*(December 2015), 208–221. https://doi.org/10.1016/j.techfore.2017.06.030

Appendix 1: Terms of Reference

Description of the Approach and Methodology
STEPRI's methodology and approach to the **Study and Analysis of the Science, Technology and Innovation (STI) Ecosystem in Ghana** considers the Terms of Reference as advertised in the Proposal Selection number REP No: MESTI/REF/GIRC/2019 and are aimed at achieving the expected deliverables.

Approach and Methodology

In conducting the STI Ecosystem study, the following steps will be followed.

Mobilization

This is the study mobilization stage and focuses on study preparation, study activities scheduling and study management. The following activities will be undertaken during this stage:

- When notified of the award of the contract, we will hold an introductory meeting with the MESTI team during which we will clarify and confirm the terms of the engagement. We will also use this meeting to explain our approach and resources/facilities required to effectively execute the project and discuss other administrative procedures to ensure an effective project execution
- Comments expressed on the TOR would also be discussed to achieve common perspectives on the issues raised.
- A Study Steering Committees will be formed and headed by the Chief Director of MESTI to oversee the implementation of the study.

Key Tasks

- Hold introductory meeting;
- Confirm terms of engagement and methodology;
- Review project objectives if need be;
- Finalize contract;
- Prepare Inception Report.

Methodology

The table below gives a snapshot of the methodology per specific task for the Study and Analysis of the Science, Technology and Innovation (STI) Ecosystem in Ghana.

Specific Task	Methodology
1. Conduct a survey to identify all existing research and innovation actors	1a. Conduct a Desk top search of all existing research and innovation actors -Academia/universities -Research Institutes -Private Sector -NGOs

	-Consultants -Media -Policy Makers (MESTI, MOTI, MOE, MOF) 1b. Obtain the list of all existing STI actors from credible sources including MESTI, NCTE, AGI, GIPC and GSS among others 1c Develop checklist for data collection and interviews for STI Profiling indicating the following: -Ownership -Location -Areas of Innovation -Mandate/functions and missions -Organisational model and Existing capacity -Target Markets
2. Conduct a STI Stakeholder mapping	Map the identified STI actors in specific task 1 above highlighting the following: -areas of focus and strengths -Functions (policy, regulations, R&D Market/Demand -Financing options Use network analysis to show the linkages, level of influence and interests in commercialising R&D products and processes. This will also involve the role of Infrastructural Support providers, Innovation and Business Development Support Services incl. ICT and Transport, Financial Services Providers, donors, IPR support providers among others.
3. Conduct a SWOT analysis	3a.The checklist in 1 above will include the following specifics on the identified STI actors including innovation hubs: -Strengths -Weakness -Opportunities -Threats 3b. Analyse data collected on SWOT in 3a to identify STI actors' current needs and future priorities. The data collection instruments will include these as well. 3c SWOT will be done per STI category ie. Academia/Research, Private, NGOs, Policy makers
4. In-depth Interviews/Case Studies	4a. Select actors including innovation hubs for case studies by the various categories of Academia/universities, Research Institutes, Private Sector, NGOs, Consultants and Media 4b.Develop a checklist for in-depth interviews on successes, gaps and challenges facing commercialisation of research efforts in Ghana
5. Detailing Recommendations	From the analysis and outcomes on SWOT in 3a and in-depth case studies recommendations will be made for improving on: - Governance and institutional framework of STI ecosystem in Ghana

	- Mandate and functions of key STI actors and missing actors

Sampling Frame and Sampling Technique for Case Studies

The sampling frame will include all Public and Private Tertiary Educational Institutions (Universities and Polytechnics), all public research institutions and other organisations (NGOs) Private Non-Profit Enterprises) engaged in STI activities. After compilation of all existing STI actors a purposive sampling will be done to select the case studies. The selection will be informed by the level of involvement in R&D commercialization process in Ghana.

Deliverables

- Survey Report
- SWOT Analysis and Needs Assessment of Innovation Hubs in Ghana
- Recommendations on Scope and Support Services of the GIRC-Center

There will be inception report on how the assignment will be conducted and coordinated, followed by the progress and, draft and final reports.

Appendix 2: List of Principal Actors in Ghana's Science Technology and Innovation Ecosystem

No.	**Innovation and Research Category**
1.	Accra Technical University
2.	All Nations University
3.	Ashesi University College
4.	Bolgatanga Polytechnic
5.	Cape Coast Technical University
6.	Catholic University
7.	Central University
8.	Cocoa Research Institute of Ghana
9.	Council for Scientific and Industrial Research
10.	Ghana Atomic Energy Commission
11.	Ghana Health Services, Research and Development Division
12.	Ghana Institute of Management and Public Administration
13.	Ghana Technology University College
14.	Ho Technical University
15.	Kaaf University
16.	Koforidua Technical University
17.	Kumasi Technical University
18.	Kwame Nkrumah University of Science and Technology
19.	Methodist University College
20.	Noguchi Memorial Institute for Medical Research
21.	Presbyterian University College
22.	Radford University College
23.	Regent University College of Science and Technology
24.	Regional Maritime University
25.	Sunyani Technical University
26.	Takoradi Technical University
27.	Tamale Technical University
28.	University College of Agriculture and Environment
29.	University for Development Studies
30.	University of Cape Coast
31.	University of Education
32.	University of Energy and Natural Resources

33.	University of Ghana, Legon
34.	University of Health and Allied Sciences
35.	University of Mines and Technology
36.	University of Professional Studies
37.	Valley View University
38.	Wa Polytechnic
39.	Wisconsin International University College, Ghana
40.	Zenith University College
41.	Accra Digital Centre
42.	Africa Entrepreneurs Hub
43.	African Agribusiness Incubation Network
44.	Ashesi D-Lab & Design Thinking Ghana Lab
45.	British Council Skills Hub
46.	Centre for Social Innovation
47.	Devless
48.	Enablis Ghana
49.	Ghana Centre for Entrepreneurship, Employment, and Innovation (GCEEI)
50.	Ghana Multimedia Incubator Centre (GMIC)
51.	Ghana STEM Network
52.	Grassroot Hub
53.	HapaSpace
54.	Hatchery
55.	Ho Node
56.	I.Code
57.	Impact Hub Accra
58.	InnoHub
59.	Ispace Foundation
60.	KK Hub
61.	Kumasi Business Incubator (KNUST)
62.	Kumasi Hive
63.	MEST Ghana
64.	Mobile Web Ghana
65.	Nana Fosu Nyante – Kofi Annan ICT Centre
66.	New Media Hub
67.	PEN Hub
68.	Reach for Change Ghana

69.	Servled Ghana
70.	Social Enterprise Ghana
71.	Stanford SEED
72.	Suame Magazine Industry and Development Organization (SMIDO)
73.	Tanoe Hub
74.	Tentmaker
75.	Workshed Africa
76.	YALI Regional Leadership Centre
No.	**Policymaking Category**
77.	Committee on Communications
78.	Committee on Defence and Interior
79.	Committee on Education
80.	Committee on Employment, Social Welfare & SOEs
81.	Committee on Environment, Science and Technology
82.	Committee on Food, Agriculture and Cocoa Affairs
83.	Committee on Gender and Children's Affairs
84.	Committee on Health
85.	Committee on Information
86.	Committee on Lands and Forestry
87.	Committee on Local Government & Rural Development
88.	Committee on Mines and Energy
89.	Committee on Roads and Transport
90.	Ministry of Communication
91.	Ministry of Education
92.	Ministry of Employment and Social Welfare
93.	Ministry of Energy
94.	Ministry of Environment, Science and Technology
95.	Ministry of Finance
96.	Ministry of Food and Agriculture
97.	Ministry of Foreign Affairs and Regional Integration
98.	Ministry of Information
99.	Ministry of Interior
100.	Ministry of Lands and Natural Resources
101.	Ministry of Local Government and Rural Development
102.	Ministry of Roads and Highways

103.	Ministry of Trade and Industry
104.	Ministry of Transportation
105.	Ministry of Water Resources, Works and Housing
106.	Ministry of Youth and Sports
No.	**Commercial Category**
107.	Access Bank (Ghana) Plc
108.	Agricultural Development Bank Limited
109.	Association of Ghana Industries (AGI)
110.	Association of Ghana Industry
111.	Bank of Africa Ghana Limited
112.	Bank of Beirut (Representative Office)
113.	Barclays Bank of Ghana Limited
114.	CAL Bank Limited
115.	Citibank N.A. Ghana Rep. Office
116.	Consolidated Bank Ghana Limited
117.	Ecobank Ghana Limited
118.	Exim Bank of Korea (Representative Office)
119.	Export Development and Investment Fund (EDIF)
120.	FBN Bank (Ghana) Limited
121.	Fidelity Bank Limited
122.	First Atlantic Bank Limited
123.	First National Bank (Ghana) Limited
124.	Forest Services Division
125.	Forestry Commission
126.	GCB Bank Limited
127.	Ghana Angel Investor Network (GAIN)
128.	Ghana Chamber of Commerce
129.	Ghana Chamber of Commerce
130.	Ghana Export Promotion Authority
131.	Ghana Free Zones Board
132.	Ghana Highway Authority
133.	Ghana International Bank plc
134.	Ghana Investment Promotion Centre
135.	Ghana National Petroleum Corporation
136.	Ghana Oil Company Ltd

137.	Ghana Stock Exchange
138.	GHL Bank Limited
139.	Guaranty Trust Bank (Ghana) Limited
140.	Lands Commission
141.	Minerals Commission
142.	National Board for Small Scale Industries
143.	National Development Planning Commission
144.	National Entrepreneurship and Innovation Plan (NEIP)
145.	National Investment Bank Limited
146.	National Petroleum Authority
147.	Petroleum Commission
148.	Private Enterprise Federation (PEF)
149.	Private Enterprise Foundation
150.	Prudential Bank Limited
151.	Republic Bank (Ghana) Limited
152.	Société General (Ghana) Limited
153.	Stanbic Bank Ghana Limited
154.	Standard Chartered Bank (Ghana) Limited
155.	Tema Oil Refinery
156.	Timber Industry Development Department
157.	United Bank for Africa (Ghana) Limited
158.	Universal Merchant Bank Limited
159.	Venture Capital Trust Fund (VCTF)
160.	Volta River Authority
161.	Wildlife Division
162.	Zenith Bank (Ghana) Limited

Appendix 3: Profile of Organisations (Actors in the STI Ecosystem)

Organisation	Website	Main Functions	Three Main Focus /Activity Areas			Main Role in STI
Incubation and Innovation Hubs						
Agribusiness Innovation Hub (iHub)	www.savanet-gh.org	Promote innovation and technology transfer for agribusiness development; bridging the gap for access and adoption of modern technology in agriculture for agribusiness development	Crop production	Non-traditional agribusiness development	Agribusiness development and services	Incubation and Innovation
Centre for Social Innovations	www.csighana.org	Support for social and educational innovation, and community innovation and entrepreneurship	Educational innovation	Community entrepreneurship	Research and development	Incubation and Innovation
Dansyn Ghana Limited	www.dansynghana.com	To provide professional services to organizations, individuals and groups through training and skills development, capacity building, mentoring, coaching, and other growth support initiatives	Business incubation	Business acceleration	Training and consultancy	Incubation and Innovation
Enablis Entrepreneurial Network Ghana	www.ghana.enablis.org	Identify budding entrepreneurs and empower them to succeed	International Mentorship Programme	Access to finance through either direct funding or through loan guarantee programme	Business plan competition	SMEs Development
Eqwip Hubs	www.eqwiphubs.org	Provision of innovation spaces that transform the youth through market-driven work skills and entrepreneurship incubators	Livelihood empowerment	Entrepreneurship development and employability	none	Incubation and Innovation
Grassroots Hub	www.grassrootshubgh.net	Educate, innovate, and incubate eco-preneurship and SDG innovations	Impact investment	SDG Business	Networking and market access	Incubation and Innovation

Organisation	Website	Main Functions	Three Main Focus /Activity Areas			Main Role in STI
Hapaspace	www.hapaspace.com	Supports start-ups to move from just idea to full fledge business, provide co-working space, event space and	Start-up support	Space-Event co-working and training	Training (entrepreneurship)	Incubation and Innovation
Ho Node	honode.org	Empowering young people with digital skills and innovation culture to build successful start-ups, create sustainable jobs and prepare for future jobs	Digital skills training	Spaces for innovation	Advocacy for STEAM (Science, Technology, Engineering, Arts and Maths), and Entrepreneurship support	Incubation and Innovation
Hopin Academy	www.hopinacademy.org	Providing training in ICT, communication, and marketing for professionals and entrepreneurs	Agriprepreneurs	Entrepreneurship incubation	Parba in techpreneurship	Incubation and Innovation
i.Code	www.icodegh.com	Provide training in entrepreneurship and technology	Start-up training and incubation	IT training and mentorship	Community support through networking and capacity building	Incubation and Innovation
Impact Hub	www.accra.impacthub.net	Support early-stage innovator-ideas to market	Creating dynamic workspaces and co-living (real estate cluster)	Infrastructure for high speed consistent internet (infrastructure support)	Hyper-accelerator and curated programmes	Incubation and Innovation
iSpace	www.ispacegh.com	To provide training, mentorship, access to funding and entrepreneurship	Training programmes, coding, business development and workshops	Exchange programmes for mentoring	Access to investment networks	Incubation and Innovation
Kosmos Innovation Centre	kosmosinnovationcenter.com	Working with entrepreneurs into incubation and SMEs, growing start-ups and accelerating SMEs	Agri-tech challenge	Incubation programme	Boasting programme	Incubation and Innovation
Kumasi Hive	www.kumasihive.com	Support local innovation technology development, incubation, business development, co-working space and business capacity building	IT development	Entrepreneurial innovation support	Incubation and business support	Incubation and Innovation
MEST (Melwater School of Entrepreneurship and Technology)	www.meltwater.org	entrepreneurial training program, seed fund and incubator for Africa's next leading software entrepreneurs	Training Program	Incubator & Seed Fund	African Tech Community	Incubation and Innovation

Organisation	Website	Main Functions	Three Main Focus /Activity Areas			Main Role in STI
No Business as Usual (NBU)	www.nbuhub.com	Provide training in entrepreneurship and employable skills targeting 500 youth within the Asokre Mampong Municipality	Youth Entrepreneurship and Employability Programme (YEEP)	Promoting learning, inspiration, idea exchange, networking, and mentoring	Capacity enhancement of Asokore Mampong Municipal Assembly	Incubation and Innovation
Sun City Hub	www.suncityhubgh.com	Train entrepreneurs, incubate, business plan development, and empower women through capacity building	Incubation for Start-ups	Training entrepreneurs	Agribusiness	Incubation and Innovation
Tentmaker Ghana	https://www.tentmakergh.com	Innovation hub that provides business Incubation, co-working space and support services to entrepreneurs and/or start-ups for sustainability and scale.	Business incubation	Co-working space	Business acceleration	Incubation and Innovation
Workshed Africa Ltd.	www.ourworkshed.com www.workshedafrica.com	To help businesses attain success faster	Space (work) services	Consulting	Event organisation	Co-working Space
Yison Technology Hub	www.yisontechhub.com	Empower youth in the area of innovation activity and technology	Digital training	Business incubation and Co-working Space	Software/Apps development	Incubation and Innovation
Higher Education Institutions and Public Research Organisations						
Business Innovations and Incubation Centre, UDS	none	Contribute to the growth of SME sub-sector in Ghana by offering solutions	Incubation	Acceleration	none	Incubation and Innovation
Centre for Plant Medicine Research	www.cpmr.org.gh	Research into plant medicine for promotion, encouragement, extension, transfer and application of scientific research knowledge and development in field of plant medicine	Safety and efficacy analysis of medicinal plants	Bioassay-guided isolation of active constituents	Transforming research findings into products	Research and Development

Organisation	Website	Main Functions	Three Main Focus /Activity Areas			Main Role in STI
Centre for Entrepreneurship and Innovation Development (KTU)	https:\\ceid.ktu.edu.gh/contact-us	Help students acquire entrepreneurial skills so as to establish their own business	Entrepreneurial development	Training in trades (e.g. fashion, ICT, beads, detergents, etc.)	none	Incubation and Innovation
Centre for Business Development, KNUST	ki-hub.com	Industrial and academic relation office to promote spin-off from departmental levels	Building industrial and academia database	Training departments to improve products for market	Coaching, mentorship and incubation from idea to market	Incubation and Innovation
CSIR-BRRI	www.brri.org	Undertake research into all aspects of building and road design and construction, to develop construction materials from local sources to reduce construction costs and make housing affordable	R&D programmes in the building sector	R&D in the road sector	Commercialisation of research and development outputs	Research and Development
CSIR-CRI	www.cropsresearch.org	Undertake research to generate technologies in food crops (cereals, legumes/seeds, roots/tubers) horticultural crops, and industrial crops	Plant breeding	Agronomy	Biotechnology	Research and Development
CSIR-FORIG	www.csir-forig.org	Undertake forest, forest products and related research, disseminate, and commercialise research outputs and services	Biodiversity conservation and ecosystem services/climate change	Wood industry and utilization	Forest policy, governance, and livelihoods	Research and Development
CSIR-Head Office	www.csir.org	Pursue implementation of government policies on scientific research and development	Technology development	Policy advise to government in areas of research and development	Technology transfer	Research and Development
CSIR-SRI	none	Undertake research to generate technologies, commercialise these technologies and build capacity in sustainable management of Ghana's soil resources	Develop knowledge for management of Ghana's soil resources	Create environment for capacity development, engender multidisciplinary research, and attract funding	Commercialisation activities	Research and Development
GIMPA	www.gimpa.edu.gh	To provide higher and tertiary education, consultancy, and research and education	Business studies (education)	Public service and governance (leadership)	Law education	Teaching and Learning

Organisation	Website	Main Functions	Three Main Focus /Activity Areas			Main Role in STI
Ho Technical University	www.htu.edu.gh	Train students, conduct practical or applied research	Teaching	Research, innovation, industry engagement	Community service/engagement	Incubation and Innovation
Sunyani Technical University	www.stu.edu.gh	Teaching (Provide higher education in engineering science and technology-based disciplines, technical and vocational education and training, applied arts and related disciplines)	Teaching	Research	Extension	Incubation and Innovation
UCC BI (University of Cape Coast Business Incubator)	www.cesed.ucc.edu.gh	Produce leaders in entrepreneurship and small enterprise development in Ghana and beyond	Development of business start-ups (incubation)	Training, Mentoring, and provision of space	Professional services of ICA tuition, preparation of accounts and auditing	Incubation and Innovation
University of Professional Studies (UPSA)	www.udsa.edu.gh	Teaching and research	Teaching	Research	Extension services	Incubation and Innovation
Policymaking Category						
Ministry of Aviation	http://moa.gov.gh	Formulate aviation policies for the development of the aviation industry	Promote innovation, research, and development as well as information management	Develop human resource capacity and new technologies for the sector	Ensure sector performance management, monitoring, and evaluation	Policymaking
Ministry of Employment and Labour Relations	www.melr.gov.gh	Lead policy adviser to government on employment and labour related issues	Provision of employable skills through TVET	Ensure workplace safety and health	Collection of labour market information	Policymaking
Ministry of Energy	www.energymin.gov.gh	Formulation and implementation of energy policy, monitoring and evaluation of activities in the energy sector	Renewable energy	Petroleum	Power	Policymaking
Ministry of Food and Agriculture	www.mofa.gov.gh	Formulate policy relating to agriculture and backstopping in the decentralised department and monitoring and evaluation	Application of STI in agricultural development--inputs, seeds, fertilizers	Extension service delivery using mass media	Improving productivity using improved inputs, seeds, fertilizer, etc.	Policymaking

Organisation	Website	Main Functions	Three Main Focus /Activity Areas			Main Role in STI
Ministry of Health	www.moh.gov.gh	Formulate policies and regulatory frameworks to guide health service delivery in Ghana, Mobilize and allocate resources for health service development, and Train, deploy, and retain health professionals	Training of health professionals	Deployment of drones in supply chain management	Medical records management	Policymaking
Ministry of Information	http://moi.gov.gh	To disseminate government information	Development of platforms for information	Disseminating information, e.g., town hall meetings	National policy summits and other government communications	Policymaking
Ministry of Local Government and Rural Development	www.mlgrd.gov.gh	Ensure good governance of MMDAs through the formulation of policies on decentralisation and rural and urban development	Implementation of government policies on decentralisation	Monitoring and evaluation of implemented programmes	Reforming local government for mobilizing and harnessing local resources for development	Policymaking
Ministry of Roads and Highways	www.mrh.gov.gh	Formulate policies, coordinate sector performance, monitor and evaluate road infrastructure development and maintenance, and road maintenance financing	Development and maintenance of road infrastructure	Improving road safety and environment	Financing of road maintenance	Policymaking
Ministry of the Interior	www.mint.gov.gh	Ensure internal security, maintain law and order in the country	Digitisation of records of the ministry and agencies	Crime detection	Electronic migration	Policymaking and facilitating linkages
Ministry of Trade and Industry	www.moti.gov.gh	Lead policy advisor to government on trade, industry and private sector development	Development of industrial policy	One district one factory	Development of SMEs	Policymaking
Ministry of Works and Housing	www.mwh.gov.gh	Formulate housing and works policies, sustainably manage development of infrastructure, improve access to safe, secure and decent accommodation	Increase resilience of coastal settlements and infrastructure	Increase access to adequate, safe, secure and affordable shelter	Enhance capacity to mitigate and reduce natural disasters, risk and vulnerability	Policymaking
Ministry of Youth and Sports	www.moys.gov.gh	Promote youth and sports development	Research the development and implementation of the youth and sports sector	Use of social media to propagate policies and programmes	none	Policymaking and facilitating linkages

Organisation	Website	Main Functions	Three Main Focus /Activity Areas			Main Role in STI
Ministry of Finance	www.mofep.gov.gh	Formulating and implementing sound fiscal and financial policies of government, and managing the economy	Mobilising and allocating financial resources	Report to Parliament on financial performance	none	Policymaking and facilitating linkages
Commercial Category (Financial Institutions)						
Agricultural Development Bank	www.agricbank.com	Provide banking and financial services	Improve upon internal processes to enhance efficiency	Innovative products and services to meet customer needs	Using technology as an enabler in banking	Funding
Barclays Bank Ghana	https://www.gh.barclaysafrica.com/personal/	Financial intermediation				Funding and Incubating ideas for innovation
Ecobank	www.ecobank.com	Financial intermediation, economic development of Ghana, and value creation for shareholders	Process automation	Payment systems improvements	Financial inclusion	Uptake of output
First Atlantic Bank	www.firstatlanticbank.com.gh	Financial service/Commercial bank	Core banking services	Process/system automation	Products innovation (digitisation)	Funding
GCB Bank Limited	www.gcbbank.com.gh	Making banking services available to all	none	none	none	Funding and facilitating linkages
Ghana International Bank Plc.	ghanabank.co.uk	Providing correspondent banking services to financial institutions as well as financing solutions to selected corporate financial institutions and individuals. Ghana office is only a representative off	Tapping into emerging technologies for financial sector (e.g., intra bank)	Enhancing productivity of financial institutions	none	Funding
National Investment Bank	www.nib-ghana.com	Financial services	Technology in industrialization	none	none	Funding and uptake of output
Stanbic Bank Ghana Limited	www.stanbicbank.com.gh	Drive growth in Africa by offering superior financial products using our insights and experience	Digital transformation	Business incubator	Annual Hackathon (Hacklab)	Uptake of output

Organisation	Website	Main Functions	Three Main Focus /Activity Areas			Main Role in STI
		to unlock opportunities and mitigate risk for our broad range of clients				
United Bank for Africa Ghana Limited	www.ubaghana.com	Commercial Bank	Customer engagement	Transaction processing	none	Uptake of output
Zenith Bank Ghana Ltd.	www.zenithbank.com.gh	Banking	Use of technological systems to deliver banking services	Research on customer needs to develop innovative products for customers	Partner with organisations in the STI space to render banking services	Funding and facilitating linkages
Commercial Category (Public Agencies and Corporations)						
Forestry Commission	www.fcghana.org	Regulate the utilisation of timber resources; manages the nation's forest resources and protected areas; assist the private sector and other bodies with the implementation of forest and wildlife policies	Log tracing system using bar codes	E-resources	MRV activities	Regulatory
Forestry Commission (Forest Services Division)	www.fcghana.org	Protection, development, and management of Ghana's forest resources	Plantation development	New technologies for harvesting of trees	Enrichment planting	none
Ghana Export Promotion Authority	www.gepaghana.org	Develop and promote exports	Develop export markets	Provide trade information	Facilitate product development and supply base expansion	Facilitating linkages
Ghana Investment Promotion Centre	www.gipc.gov.gh	Promote investment in and outside of Ghana (ACT 865) 2013	Investment promotion	Registration of all foreign companies in Ghana	Business advisory	Uptake of output
Goil Company Limited	www.goil.com.gh	Market quality petroleum and other energy products and services	Develop point of sale technology to facilitate sale of products at the stations	none	none	Policymaking
National Board for Small Scale Industry	www.nbssi.gov.gh	To play a leading role in the promotion and development of MSMEs in Ghana (ACT 434)	Promotion and implementation of productivity improvement tools like Kaizer	Introduction of new techniques/technologies through technical training	Promoting the adoption of standards and research from institutions	Uptake of output

Organisation	Website	Main Functions	Three Main Focus /Activity Areas			Main Role in STI
National Development Planning Commission	www.ndpc.gov.gh	To advice the President of Ghana and Parliament on development planning, policy, and strategy	Formulation of national development policy that incorporates STI	Ensuring that MMDAs and MDAs prepare plans to implement national development policy in relation STI	Monitoring and evaluation of STI implementation in national development policy, MMDAs and MDAs plans	Uptake of output
National Entrepreneurship and Innovation Programme	www.neip.gov.gh	Create entrepreneurship	Youth industrialisation and innovation project	Presidential Business Support (Funding)	Greenhouse (ICT-based) for agriculture	Policymaking
National Petroleum Authority	www.npa.org.gh	Regulate, oversee, and monitor activities in the petroleum downstream industry	Licensing all petroleum service providers in downstream	Monitoring and inspection of all petroleum downstream infrastructure	Pricing of petroleum, planning of petroleum products supply	Facilitating linkages
Private Enterprise Foundation	www.pef.org.gh	Advocacy on behalf of companies and train members to improve technical and management skills	Engaging government at various levels for advocacy purposes	Engaging regional and international organizations for advocacy purposes	Training of Ghanaian businesses	Incubating ideas for innovation
Tema Oil Refiner	www.torghana.com	Refining crude oil for Ghana and exports	Refining crude oil into petroleum products	Pipeline transmission services	Laboratory services of petroleum products, and manpower training (engineers for MODEC)	Policymaking
Venture Capital Trust Fund	www.venturecapitalghana.com.gh	To provide long-term financing to SMEs through venture capital financing companies, and to develop the venture capital industry	Funding SMEs	Educate private sector to understand role of venture capital operations	Capacity building programmes for venture capital private equity	Uptake of output
Wildlife Division of Forestry Commission	none	Manages Ghana's protected areas, regulates the utilisation of wildlife resources, promotes public awareness, and support for wildlife conservation	Biological research	Protected areas management	Ecotourism	Regulatory

Appendix 4: List of Favourable Conditions

Conditions created by policy

1. Government policy on 1D1F
2. Legislation and existence of legal framework
3. Policy direction of creating jobs for the youth
4. Policy goal to achieve reduction in deforestation
5. Health policy mandates MoH to carry out R&D
6. Health Safety and Security Policy
7. Local Content policy

Existence of market opportunities

1. Increase demand for exportable goods--Expanding market size
2. Low productivity of agricultural sector
3. There is tremendous need for capital among SMEs
4. Demand for import substitution
5. Risky nature of agriculture and the need for insurance
6. Access to markets and investors
7. Uncompetitive nature of agricultural produce at the international market
8. Quest to meet world standards
9. Needs revealed by needs assessment carried out

Available support structures to start/incubate entrepreneurship

1. Incubating ideas at the SB Incubator and related activities-hackathons, etc
2. Proliferation of ICT
3. Relatively stronger economy in the sub-region
4. Digital transformation programme driving need to consume digitized services
5. Fintech
6. Relatively better infrastructure and labour force in the sub-region
7. Artificial intelligence
8. Better ranking on the competitiveness level with respect to ease of doing business, among others, and access to Ghana from international travels
9. Linkage with Industry Association

Others

1. Presence in 175 districts across Ghana
2. Organisation's own mission--use of technology to drive service
3. A proactive strategy department of organisation
4. Competencies and experience of staff
5. Linkage with industry partner abroad
6. Need for foreign exchange
7. Political will
8. Relevance of research relative to bank's strategy
9. There is financial capacity to support commercialisation
10. Accurate data for prompt decision-making
11. Awareness among MSMEs about NBSSI
12. Bank's allocation of budgetary funds for R&D
13. Competitive advantage, and commercial and social impact
14. Digitisation is a strong pillar of bank's medium to long-term strategy

Appendix 5: Responses for SWOT Analysis: Research Category of Innovation System

Strengths: What is your organisation best in?

Higher education and research	Public research and development	Public-private-partnership arrangement	Technology transfer	Incubation and Innovation Hub	Co-working space	Private Research and Development	Project with National Service Secretariat
Engineering training and expertise	Agricultural technologies and innovation	Capacity building	Technology and innovation transfer in agriculture	Community support	Competencies in helping businesses run sustainably	Market resources	Capacity building
Availability of specialists	Capacities in plant breeding	Livelihood empowerment	Human capital (university-wide)	Human resources	Office space	Capacity building (total talent development)	Livelihood empowerment
Extensive variety of human resources	Developing soil fertility management technologies		Technology Development	Start-up development	Quality service at lower costs		
Human capital (university-wide)	Efficient and skilled staff		Provision of agribusiness services	Availability of specialists			
Leadership and governance training	Products for commercialisation (prekese syrup, solar drying, and cassava flour)		Location and hence reliance on students	Personal (individual) development			
Professional education	Research			Diverse team			
Research	Capacities in agronomy			Entrepreneurship training			

Higher education and research	Public research and development	Public-private-partnership arrangement	Technology transfer	Incubation and Innovation Hub	Co-working space	Private Research and Development	Project with National Service Secretariat
Technology Development	Industrial research and development			Digital skills training			
Extensive variety of human resources	Product development			Financial Management			
Business education	Reclaiming degraded land			Training and capacity in entrepreneurship			
Location and hence reliance on students	Repository of information on sources of materials for production			Good at developing ideas to prototype			
Management motivation				community innovation			
ICT				Business training and technology			
Office space				Fundraising			
Teaching professional courses				Technology and entrepreneurship development			

Higher education and research	Public research and development	Public-private-partnership arrangement	Technology transfer	Incubation and Innovation Hub	Co-working space	Private Research and Development	Project with National Service Secretariat
Training, Coaching and Mentorship				Internal and external community is greatest strength- the connections made in these communities			
Management motivation				Co-working space			
				Incubation			
				Infrastructure			
				Product and services			
				Funding			
				Advocacy for STEAM			
				Customer service (customer delivery)			
				community entrepreneurship			
				Co-working space			
				Innovations at local Sectors			

Weaknesses: What/where could your organisation improve?

Higher education and research	Public research and development	Incubation and Innovation Hub	Public-private-partnership arrangement	Technology transfer	Co-working space	Private Research and Development	Project with National Service Secretariat
Capacity of teaching staff	Crop yield	Ability to fund companies	Start-up capital	Improving capacity of human capital	Obtain sustainable funding to complement services to start-ups	Partnerships that add more value	Start-up capital
Equipment	Funding	Data analysis		Bridging the gap in reaching the beneficiaries	Competencies in project management	Communicate success stories to reach more people	
Improving capacity of human capital	Inadequate working capital	Physical resources		Improving infrastructure and equipment			
Makerspace	Low visibility	Capacity and facilities for IT					
Research	Research capacity	Capacity of teaching staff					
Research funding	Research funding	Bridging the gap in reaching the beneficiaries					
Stronger linkages to the private sector	Low visibility	Improve income generation activities					
Adequate and skilled staffing	Absence of mechanised production system	Substantial funding					
Funding	Low rate of research commercialisation	Communication with start-ups					
Improving infrastructure and equipment	Attract and retain young scientists	Poor internet connectivity affecting functioning of co-working space					

Higher education and research	Public research and development	Incubation and Innovation Hub	Public-private-partnership arrangement	Technology transfer	Co-working space	Private Research and Development	Project with National Service Secretariat
Sources of funding for start-ups	Production capacity	Skilled labour to deliver programmes					
Technology transfer	Solid resources conservation	Research commercialisation					
Absence of mechanised production system	Attract and retain young scientists	Communication					
Technology transfer	Funding	Tailoring support for start-ups					
Stronger linkages to the private sector	Low rate of research commercialisation	Fund mobilisation					
	Stronger ties with Ghana's private sector	Alumi engagement to bring all on board					
		Research capacity					
		Ability to fund companies					
		Physical resources					
		Data analysis					
		Capacity building					
		Number of employees					
		Supporting growth of companies past early stage					

Higher education and research	Public research and development	Incubation and Innovation Hub	Public-private-partnership arrangement	Technology transfer	Co-working space	Private Research and Development	Project with National Service Secretariat
		Sources of funding for start-ups					
		Attracting and training more women and persons with disabilities					
		Competent human resource capacity					
		interactions with local assembly					
		Research Skills					
		Improve infrastructure					
		Adequate and skilled staffing					
		Supporting growth of companies past early stage					
		Providing access to opportunities in the community					
		Space capacity					
		Logistics organisation					

Opportunities: Is there a need no organisation is addressing that you could?

Higher education and research	Public research and development	Incubation and Innovation Hub	Public-private-partnership arrangement	Technology transfer	Co-working space	Private Research and Development	Project with National Service Secretariat
Agribusiness development	Accessing global climate change fund (of South Korea)	Clean transport (Solar vehicle)	Youth internship placements	Transferring modern agricultural technologies to the uneducated farmer	Growing need for co-working space	Full cycle development	Youth internship placements
Brand name	Improved bee hive for high productivity of honey	Zone out part of Accra as spatial niche for innovators	Formation of environmental clubs	People are ready to be trained		Mentorship programme to support entrepreneurs in the ecosystem	Formation of environmental clubs
Business acceleration	Transforming research findings into products and services	Business acceleration		Bridging gap between modern technology access and adoption			
People are ready to be trained	Enforcement of 60% use of local materials in construction policy	Public understanding and support for incubation hubs		Burgeoning entrepreneurial spirit			
Promoting entrepreneurship among higher educational institutions	Production of button mushroom	ICT training for SHS graduates					
Transferring modern agricultural Technologies to the uneducated farmer	SDF/COTVET facilities for training expertise	Professional skills for employees					

Higher education and research	Public research and development	Incubation and Innovation Hub	Public-private-partnership arrangement	Technology transfer	Co-working space	Private Research and Development	Project with National Service Secretariat
Agribusiness development	Formation of entrepreneurship hubs	Coding for children					
Assisting in the setup of business development to support start-ups		Specialised skills in trade areas					
Burgeoning entrepreneurial spirit		Advocacy					
Establish business village for students		B2B matching					
Regular programmes for students		Funding of community innovation projects					
Mitigating the emission of CH4 (methane gas) from nomadic cattle		Funding SDG businesses					
		IT development among women					
		Establish business village for students					
		Leveraging on Double Track System to design programmes for SHS graduates					

Higher education and research	Public research and development	Incubation and Innovation Hub	Public-private-partnership arrangement	Technology transfer	Co-working space	Private Research and Development	Project with National Service Secretariat
		Software development training					
		Building young talent locally to localised externally procured technology and services					
		Access to internet services					

Threats: What obstacle does your organisation face?

Higher education and research	Public research and development	Public-private-partnership arrangement	Technology transfer	Incubation and Innovation Hub	Co-working space	Private Research and Development	Project with National Service Secretariat
Funding	Inadequate funding	Inadequate funding	Funding	Attracting capital	Power/electricity		Inadequate funding
Inadequate equipment	Inadequate funding for research and development activities	Inadequate skilled personnel	Inadequate agricultural stations	Fundraising	Space		Inadequate skilled personnel
Inadequate funding	Inadequate numbers of research and technical staff due to government		Inadequate infrastructure	Space	Almost absence of investment community		

Higher education and research	Public research and development	Public-private-partnership arrangement	Technology transfer	Incubation and Innovation Hub	Co-working space	Private Research and Development	Project with National Service Secretariat
	restrictions on recruitment						
Need for equipment	No national policy on soil			Linking start-ups to funds and partners			
Visibility	Poor funding			Funding			
Bureaucratic processes of administration	Unsustainable use of medicinal plants			Competition			
Funding	Visibility			Sustainability after end of project			
Funding for start-up acceleration and operations	Foreign investors with high capacity equipment for production			Internet connectivity			
Inadequate government support	High staff attrition			Need for equipment			
Inadequate infrastructure	No funding for research			Upscaling of the hubs without regulation			
Inadequate laboratories and workshops	Inadequate agricultural stations			Inadequate exposure to meetings(?)			
Limited infrastructure	Lack of enforcement of government policies			Visibility			

Higher education and research	Public research and development	Public-private-partnership arrangement	Technology transfer	Incubation and Innovation Hub	Co-working space	Private Research and Development	Project with National Service Secretariat
Inadequate laboratories and workshops	Non-enforcement of laws			Team capacity			
Weak collaborations with industry				Finding highly skilled local talent			
Inadequate funding				Physical resources			
Need for equipment				Bureaucratic processes of administration			
Upscaling of the hubs without regulation				Funding for start-up acceleration and operations			
Limited infrastructure				Absence of policy/regulation of the sector			
				Access to funds for training			
				Qualified staff			
				Absence of soft loans			
				Inadequate space			
				Perception of local business			
				Space capacity			

Higher education and research	Public research and development	Public-private-partnership arrangement	Technology transfer	Incubation and Innovation Hub	Co-working space	Private Research and Development	Project with National Service Secretariat
				Bureaucracies in dealing with third parties			