Report on

Baseline study and paradigm assessment for the development of Research Innovation Socialisation, Communication, Advocacy and Marketing

Presented to Heritors Labs

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Executive summary

Scientists in African institutions of higher learning, including Universities and research centres, spend many hours carrying out innovative research, sometimes in poorly resourced labs and field circumstances. The results of such innovative research tend to have the potential to solve many societal problems if they were known to uptakers with the capacity to commercialise innovations that have commercial potential. However, beyond getting published in academic journals targeting other academics, the general society, including industry leaders, does not benefit from such research and innovation.

This report is the result of "a baseline study and paradigm assessment on Research and Innovation Socialisation, Communication, Advocacy and Marketing (RISCAM) in Ghana," commissioned by Horitors Labs Limited. It is a first step to developing a blueprint that would stipulate strategies, initiatives, infrastructure and capacity-building recommendations to address the gaps discovered towards enhancing research and innovation (R&I) uptake and commercialisation, where possible. The specific objective was to assess capacity, infrastructural and structural factors that negatively affect the opportunity to promote research and innovation toward uptake and commercialisation.

To this end, the present study sought to: (a) understand the current infrastructure of R&I socialisation, communication, advocacy and mainstreaming; (b) explore the current state of connections between academia and industry as regards research and innovation advocacy, commercialization, mainstreaming; (c) understand the foundations of RISCAM gaps among researchers and innovators in Ghana; (d) ascertain R&I communication and advocacy assets in Ghana. Data were collected through a survey, Key informant interviews, content analysis and a desk research.

The study revealed that research outcomes and the innovations therein are limited in their reach to industry audiences, being hampered by individual, institutional and industry level factors. At the individual level, a preoccupation with scholarly publications for purposes of promotion as well as resource and skills gaps de-emphasise the attention that should go to research uptake and impact efforts including communication, advocacy and marketing. In addition, institutional resource constraints, bureaucratic IP processes and promotion systems that privilege scholarly publications over impact serve to derail the outreach that should facilitate research uptake and commercialisation. Limited industry markets, interest and funding readiness; distrust in authenticity of home-bred knowledge and a short term minded industry posture compound the problem.

Thus, there is little deliberate effort to promote R&I to industry audiences. While researchers and innovators are aware of the need to promote their R&I and know about different options for doing so, their actual actions on this are generally low. At the institutional level, R&I communication, advocacy and marketing efforts are, somewhat, better enabled by the existence, in some cases, of communication officers, institutional or project websites as well as various stakeholder engagement fora.

As regards R&I communication, advocacy and marketing assets in the country, the study found that four main types exist in an ecosystem that equally emphasises information dissemination and engagements. Publications such as journals, newsletters and policy briefs as well as websites and social media pages are used to push information about R&I. These serve informational and awareness creation purposes rather than engendering active engagement. However, a substantial part of the journals in particular target scholarly audiences and remain inaccessible to industry audiences.

Beyond this, the study notes that real engagement and collaborative opportunities lie in the many stakeholder fora, workshops and meetings that bring industry and academia together. However, these tend to be episodic rather than in any sustained manner as will be the case of say associations or databases that bring the two sides together. The closest to this are maker spaces/innovation hubs. These tend to target young innovators and give them space to create, rather than targeting commercialisation, necessarily. In addition, the study discovered that very little exists by way of deliberate, sustained effort to use the media to build visibility for R&I and to increase uptake. Based on these and other findings, a number of recommendations have been proposed.

Introduction

Africa's Agenda 2063, formulated by the African Union (AU), articulates seven aspirations as evidencing *The Africa We Want*. These are:

1. A prosperous Africa based on inclusive growth and sustainable development
2. An integrated continent, politically united and based on the ideals of Pan-Africanism and the vision of Africa's Renaissance
3. An Africa of good governance, democracy, respect for human rights, justice and the rule of law
4. A peaceful and secure Africa
5. An Africa with a strong cultural identity, common heritage, shared values and ethics
6. An Africa, whose development is people-driven, relying on the potential of African people, especially its women and youth, and caring for children
7. Africa as a strong, united, resilient and influential global player and partner

The second, sixth and seventh of these aspirations underscore the need for well-curated, context-led knowledge as the empirics that guide development. To realise *The Africa We Want,* development efforts must not only draw on the realities of Africa's people but also on its rich human resource, and their capacity and potential to position the continent as a global leader. This places Africa's scientists and researchers and the knowledge and innovations they produce at the very centre of efforts towards achieving *The Africa We Want*. The AU recognises this critical role of home-bred science and innovation and has instituted the Day of the African Renaissance, celebrated on June 30th across the continent annually. By this, the AU seeks to revitalise and draw attention to African science while encouraging scientists and researchers to join forces with governments, civil society and industry to solve the continent's developmental challenges.

Yet, a common theme in discussions about the impact of scholarship in Africa is the need to bring research findings closer to the doorstep of industry (Mihyo, 2013). Such discussions often cite a gap between industry and scholars which ensures that scientific research and innovations (R&I) often only translate into journal publications that

industry players do not have access to nor understand. Accordingly, knowledge about R&I within academic circles have, to a large extent, remained the preserve of the 'ivory towers' in which they are produced. The consequence is that opportunities in extracting value from such research innovations remain unexplored as are their benefits to societies.

Attempts have been made to address this gap between industry and academia including a recent trend towards setting up technology transfer centres in academic institutions. Their purpose is to link research to industry, and promote research and innovation uptake in industry. However, their effectiveness is hampered by the fact that industry executives sometimes consider innovations as potentially disruptive to their routines and business performance. This, coupled with the fact that some 90 percent of new products fail, means that business executives are quite reluctant to collaborate with academics to develop and commercialise innovations.

The foregoing indicates a weak state of affairs in encouraging academics and industry to team up. Thus, additional effort is required to give life to the aspirations of AU and the quest by researchers and research institutions to realise the full impact of their scientific endeavours. This report explores considerations that should guide such effort.

Objectives

The object of this research was to explore and assess the factors including capacity, infrastructural, environmental and structural, that negatively affect the opportunity for promoting research and innovation towards industry uptake and commercialisation. The findings presented below were guided by a quest to:

- understand the current infrastructure of R&I (R&I) socialisation, communication, advocacy and mainstreaming
- explore the current state of connections between academia and industry as regards research and innovation advocacy, commercialization, mainstreaming
- understand the foundations of RISCAM gaps among researchers and innovators in Ghana
- ascertain R&I communication and advocacy assets in Ghana

Methodology

The study relied on four data sources to gather evidence from which to address the objectives guiding the inquiry. This ensured that a comprehensive view of the issues under exploration was attainable. Below, the design for each mode of evidence is explained.

Survey

A survey of academics across public universities in Ghana enabled the assembly of responses regarding their research communication practices. The focus on public universities was informed partly by ease of access to databases of academics there and their generally stronger emphasis on R&I. A convenient sample of responses was assembled by sharing a link to a virtual survey through the faculty databases of four public universities - University of Ghana (UG), University of Development Studies (UDS), University of Cape Coast (UCC) and Kwame Nkrumah University of Science and Technology (KNUST). Two hundred and twenty four responses were completed within three days of survey launch and form the basis of the analysis presented here. The survey explored respondents' demographics, research areas, innovation counts, R&I communication practices and the considerations that guide them in this.

Key informant interviews

Interviews enabled a more in-depth exploration of the structural and environmental factors impinging on RISCAM in the country. They also enabled some insights into the nature of the linkages between academics and industry as well as the gaps therein. We conducted key informant interviews with different stakeholders including researchers and innovators, industry players, technology transfer and intellectual property officials as well as **research communication officials** in academic and research institutions.

The interviews explored, among other things, the current state of R&I communication infrastructure, research dissemination practices, gaps in R&I communication, obstacles in promoting uptake of innovation and scientific research findings, and audiences to which researchers and innovators target their knowledge sharing activities. Interviewees were assigned codes as follows:

Interviewee profile	Code assigned
*P*rofessor of cell and molecular biology	*Interviewee 1*
CEO of biotechnology firm	*Interviewee 2*
Professor of biomedical engineering	*Interviewee 3*
Officer in the University of Ghana's Technology Transfer and Intellectual Property office	*Interviewee 4*
Lecturer in electrical engineering	*Interviewee 5*
Industrial chemist and chemical engineering researcher	*Interviewee 6*
Lecturer in electrical and electronics engineering	*Interviewee 7*
Communication and public engagement officer	*Interviewee 8*

Content analysis

A content analysis was conducted to assemble evidence on RISCAM assets in the country and their potential for promoting R&I with a view to increase uptake and commercialisation. The websites of thirteen (13) key research institutes and centres were purposively selected for review, guided by their fundamental focus on applied science. Table 1 presents the names of the selected research centres and their affiliated institutions of higher learning, as well as their regional location.

Table 1: Research Institutes/Centres studied

No.	Research Institution	Affiliated Institution	Region
1	Africa Centre of Excellence in Coastal Resilience (ACECoR)	UCC	Central
2	Biotechnology and Nuclear Agriculture Research Institute (BNARI)	UG/GAEC	Greater Accra
3	Centre for Climate Change and Sustainability Studies	UG	Greater Accra
4	Institute for Environment and Sanitation Studies	UG	Greater Accra

5	Institute for Scientific and Technological Information (STI) of the Council for Scientific and Industrial Research (CSIR)	CSIR	Greater Accra
6	Institute of Applied Science and Technology	UG	Greater Accra
7	Kazuhiko Takeuchi Centre for Sustainability and Resilience (KTCSR)	UDS	Northern
8	Kumasi Centre for Collaborative Research	KNUST	Ashanti
9	Noguchi Medical Research Institute	UG	Greater Accra
10	West Africa Centre for Crop Improvement	UG	Greater Accra
11	West African Centre for Cell Biology of Infectious Pathogens	UG	Greater Accra
12	West African Centre for Water, Irrigation and Sustainable Agriculture	UDS	Northern
13	West-African Centre for Sustainable Rural Transformation Development	SDD-UBIDS	Upper West

The websites were coded for:

- Information on strategic partnership with policy actors and industry players
- Inclusivity of key policy actors and industry players in leadership
- Availability of dedicated pages/portals for knowledge sharing
- Membership of online communities for knowledge sharing
- Information on research uptake events or activities
- Evidence of information on new publications or innovation eg: technical/policy briefs, articles, policy papers
- Availability of (research) communications or information Office and or staff

Besides the websites, and where applicable, social media (Twitter, Facebook, and YouTube) handles of the sampled organisations were also examined for evidence of

- information on research dissemination events or activities
- membership of online communities for knowledge sharing
- information on new publications or innovations
- technical/policy briefs, articles, policy papers
- For this we looked back at the last five years.

Desk research

Using the Google search engine, a key word search was also conducted to gather information about RISCAM assets both online and offline. In addition, the institutions included in the content analysis were used as keywords to search specifically for news articles on two online news aggregation platforms, the Ghana News Agency and Ghanaweb. The purpose was to identify and document evidence of dissemination activities or engagements among research institutions and industry actors. The desk research also enabled access to knowledge about RISCAM assets in grey media.

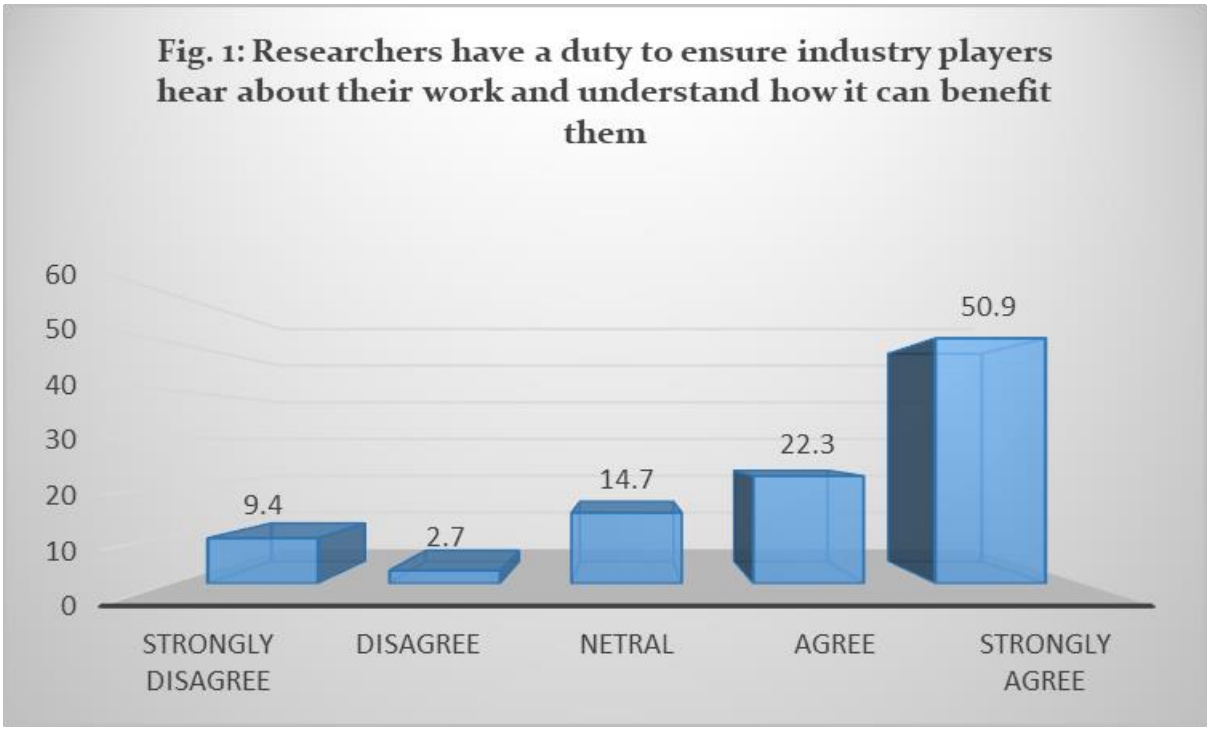
Findings

Infrastructure/Affordances for RISCAM

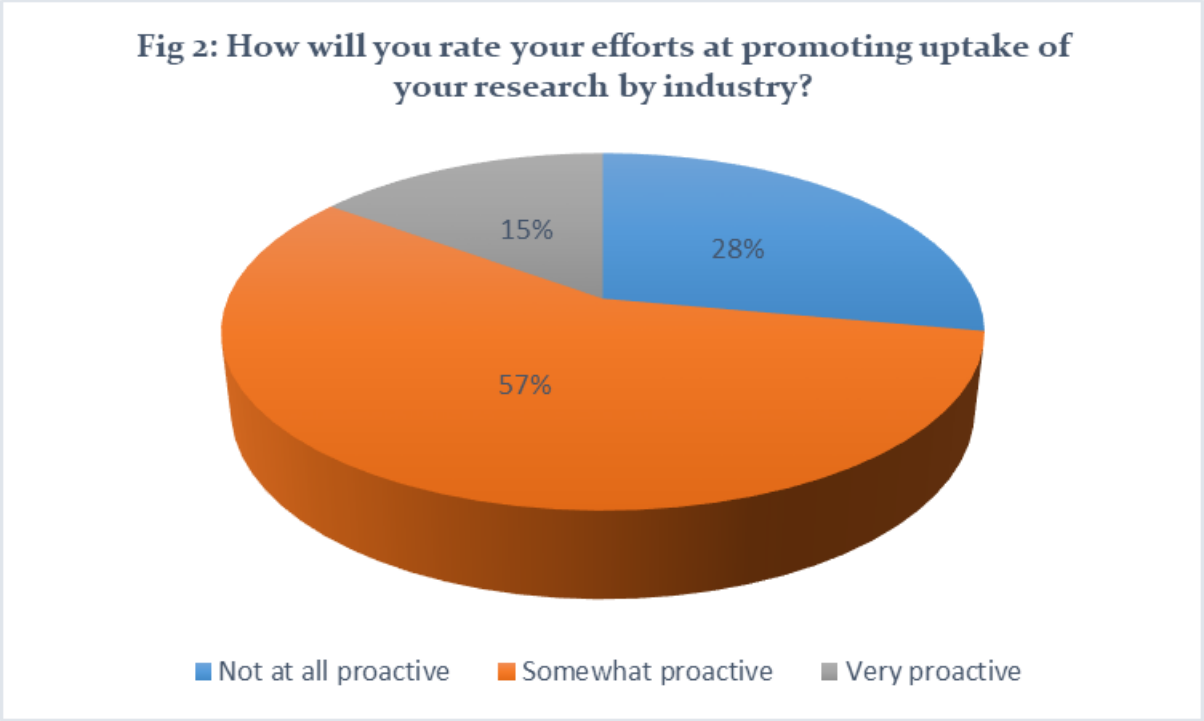
This section presents findings relative to what pertains now as regards the infrastructure for RISCAM in the country. It explores affordances that should facilitate RISCAM. In particular, it explores the posture, readiness and actions taken by researchers and institutions towards communicating and advocating for the uptake and commercialisation of their innovations. The posture of individual researchers and institutions about RISCAM is critical to effectuating it. Equally important is the practices towards communicating R&I to the attention of industry audiences. The study explored questions relating to how important researchers and scientists consider it to be to communicate and promote R&I to the attention of industry audiences. It also explored their motivations for embarking on RISCAM efforts as well as the specific actions deployed. This provides a useful baseline to guide efforts at correcting the fault lines in RISCAM in Ghana.

Posture and readiness

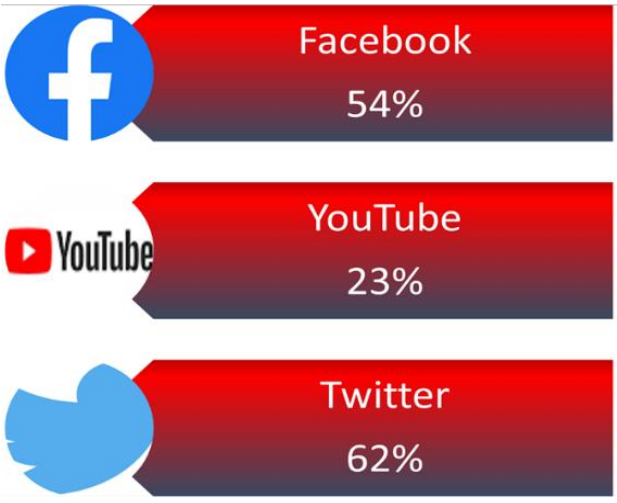
Generally, posturing towards RISCAM is quite positive among individual researchers. Two out of every three respondents agreed with the proposition that researchers have a duty to actively promote their work to the attention of industry audiences (Fig. 1). This means that the ground is quite fertile for efforts that enable researchers to begin to promote their work.



In spite of this, it appears that individual scientists and researchers have a rather laid-back posture when it comes to activating this posturing and communicating and promoting their R&I. As figure 2 shows, only 14 percent of the 224 respondents consider themselves to proactively promote their research and innovations to the attention of industry. This means only one out of every seven respondents. The remainder admit to only being 'somewhat proactive' (majority: 57%) or 'not at all proactive' (nearly 30%) in communicating, and advocating for industry uptake of their R&I.



At the institutional level, a slightly better picture emerges in which more effort appears to be invested in communicating with industry players. Five of the 13 sampled institutions (i.e. nearly 40%) have dedicated officers in charge of research communication whose work is "... to bridge the gap between the scientific world and the social world" by making "research output or results meaningful to society, making them beneficial to society" (Interviewee 8: Communication and public engagement officer).



Ownership of Social Media handle

The interviewee sums up the work of the communication officer as:

> *Our interest is to know what each research group or each lab is working on and what are the very interesting outcomes they have produced. Just about a week or two ago, the molecular biology lab had developed a database for detecting Buruli ulcer. And we got that published on our website as well as the University website.We want people to know that we are beginning to find local solutions to our own problems. And we also want to move away from the past where very*

> *brilliant research works have been done, good results have emerged and then we shelve them. So that is how come the communication and public engagement unit is so at the centre. And the donor partners feel happy when they see the impact of what their money has produced* (Interviewee 8: Communication and public engagement officer).

In addition, each of the institutions has a dedicated website by which they share research results and innovations to the attention of industry. Information shared on these websites and social media pages are mainly about events such as dissemination workshops and seminars, advertisement of calls for proposal applications, notices of vacancies and recruitment opportunities, achievements and project documentaries. They tend to lack details on the practical applications of research findings and innovations that could excite industry interest towards commercialisation.

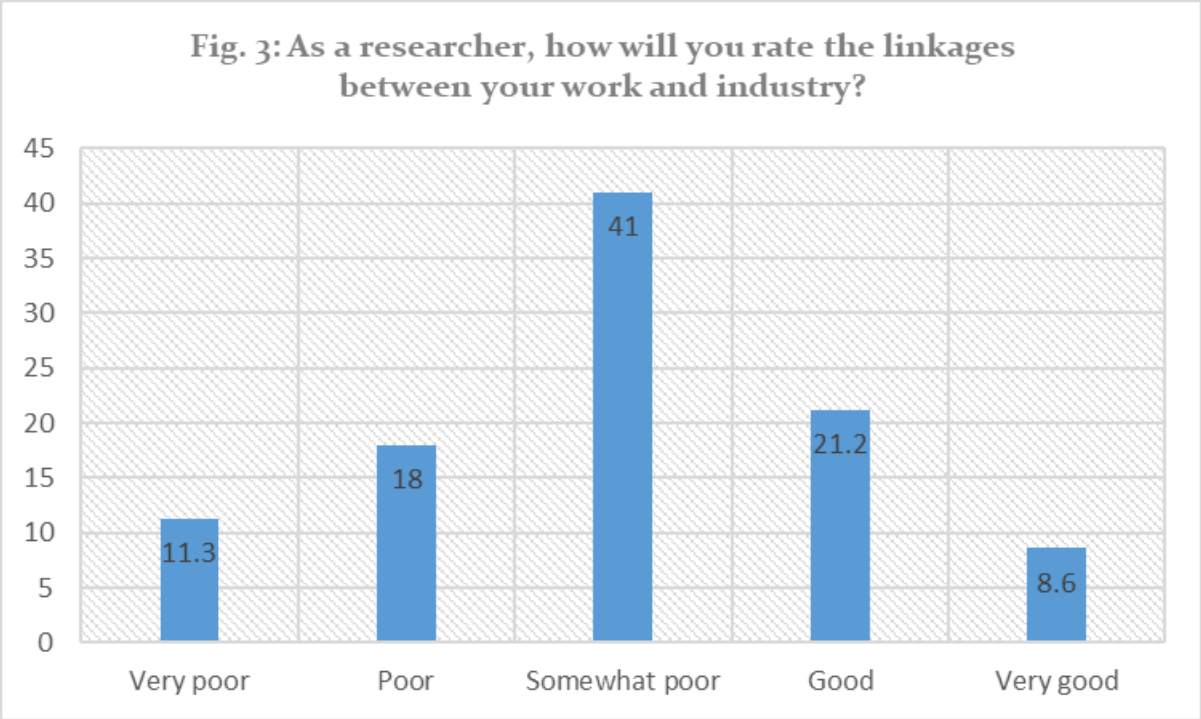


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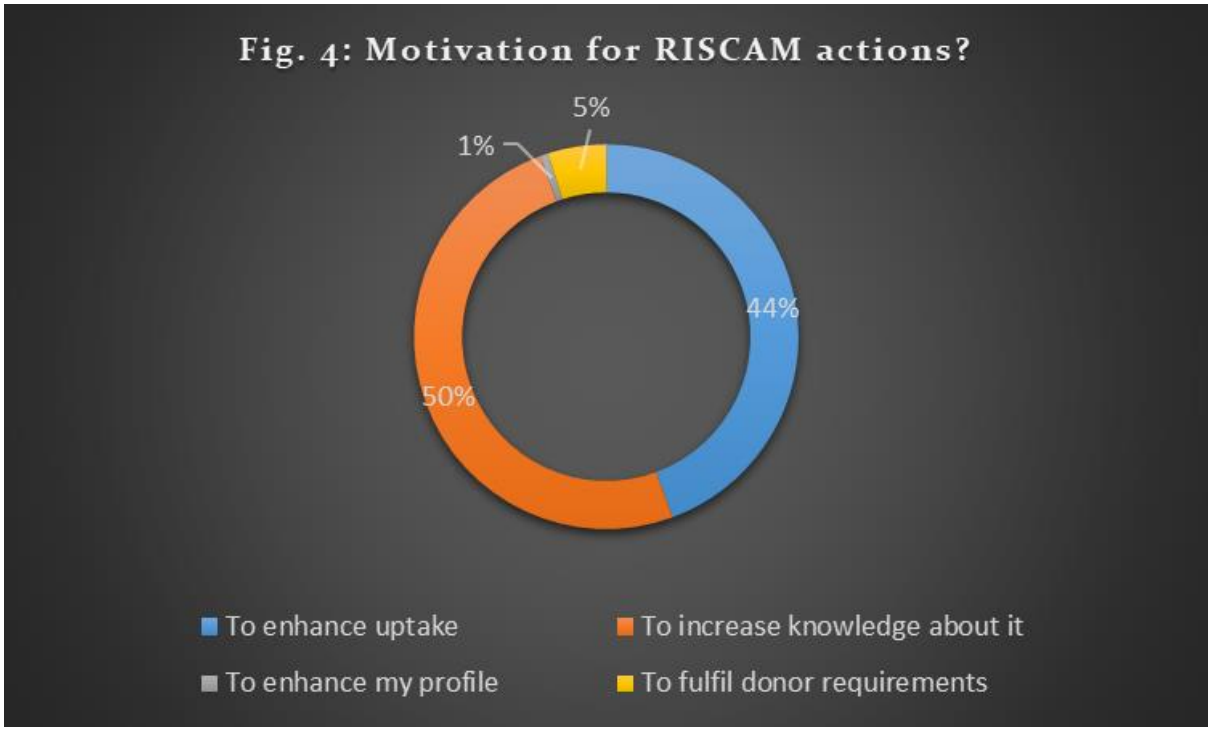
Secondly, as is typical of most websites, in spite of their interactive affordances, they tend to merely disseminate information rather than engender engagements around them. The websites, generally, do not include chat elements to encourage conversations with industry players.

Researcher-engineered RISCAM actions

The study also explored the actions taken by researchers and scientists towards promoting their work to the attention of industry with a view to increase uptake (including commercialisation). Findings also show that the majority of individual scientists and researchers (70%) generally rate the level of contact between their work and industry to be weak (Fig. 3).

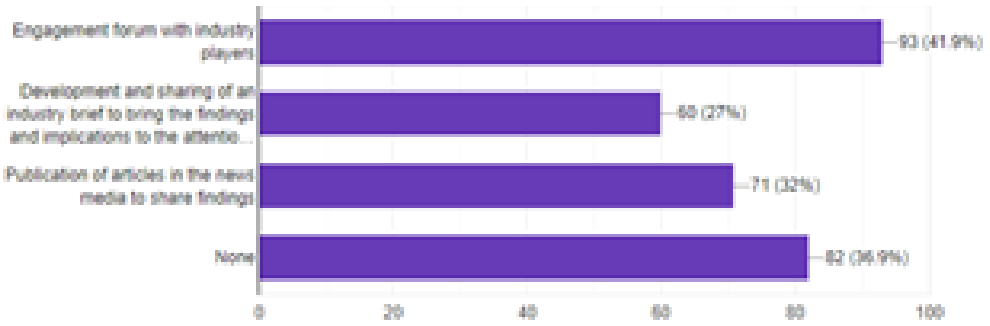


Interestingly, however, where they take action to promote their R&I to industry audiences, the motivation tends to have a more informational rather than action-oriented purpose. As the chart below (Fig. 4) shows, the biggest reason for such contact with industry is to ensure awareness among industry stakeholders. This is a slightly stronger motivation than that for enhancing research uptake. In other words, there is more of a drive to disseminate R&I than there is to work towards uptake and commercialisation. Besides these, some RISCAM efforts are driven by quests towards improving the scholar's standing, and fulfilling funding obligations.



Three primary RISCAM action prompts were presented to respondents to indicate which they have ever used. These are industry stakeholder engagement forums, development and sharing of industry briefs and publication of articles in the news media. Generally, use of these RISCAM tools was found to be quite low. Not even one of the three had ever been used by up to half of the respondents. Specifically, only a third of the respondents (32%) indicated ever having published a knowledge sharing article about their research in the mass media. Even less (27%) indicated ever having used an industry brief to share their research findings and implications with industry audiences. The most commonly used format is industry engagement forums. Even for this, less than half of the respondents (42%) indicated having ever used them (Fig. 5).

Fig. 5: Which of the following have you done?



It is important to note that beyond these the breadth of RISCAM action options in the respondents' knowledge is expansive. Fig. 6 presents a word cloud of responses to an open ended question as to the best way to promote one's research and innovation to industry audiences. Not surprisingly, engagement-based activities rank quite high.

Fig. 6: Word cloud of RISCAM tools deemed effective by respondents



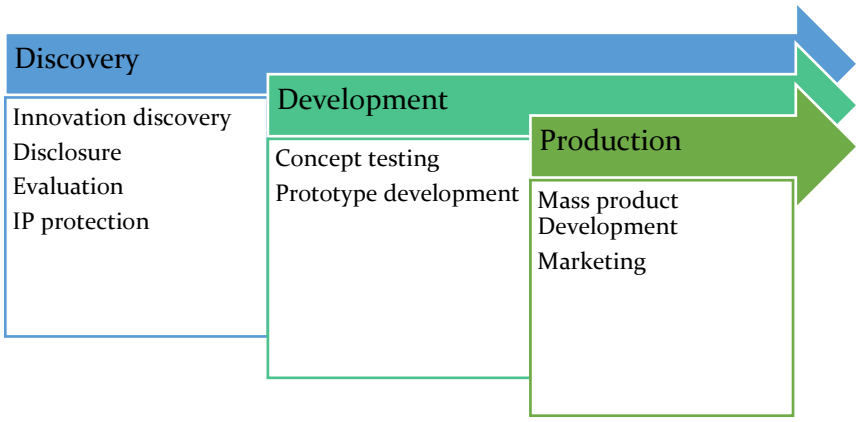
At the institutional level too, there is evidence of efforts towards engaging industry, albeit to a low extent. Some 38 percent of the sampled institutions have evidence of partnership with industry. Indeed, in the case of Institute of Applied Science and Technology (IAST), its Management Committee membership, as listed on its website includes key industry players such as the Chief Executive Officer of the Private

Enterprise Foundation (PEF), the Ghana Chamber of Telecommunications and a representative from the Association of Ghana Industries.

Academia-industry linkages for R&I commercialization

Globally, two main pathways serve as the foundation of innovations that eventually hit markets as products. In the first instance, business organisations set up internal Research and development (R&D) units, the focus of which revolves around uncovering innovative ideas and solutions that can be commercialised. In the second, innovations and other solutions are the products of research in academic institutions and research centres. While the former has commercialization as its default end-point, in the latter the case is different. Academic institutions have a core responsibility of knowledge production and training. Innovations emerging from this knowledge production quest can well only result in journal publications without much interest in turning them into actual usable products. Increasingly, however, there is a drive towards moving such innovations for adoption in industry, leading several universities to set up technology transfer and intellectual property offices. The journey from innovation to commercialization is comprised of three primary stages- discovery, development and production as depicted below (Fig. 7) [see a more complex model here[1]].

Fig. 7: A model of the innovation-to-commercialisation process



Scientists and researchers discover innovations and inventions which set into motion several activities towards proving concept and intellectual property protection. The next two stages are best realised where there is opportunity for industry uptake. The first of

[1]https://www.ug.edu.gh/ttips/sites/tdtc/files/Technology%20Commercialisation%20Process%20V3_%2010.%202019.pdf

these, development stage, involves industry investments to develop and test marketable versions of the innovation while the latter involves making the new product commercially available to the market.

The study found that in Ghana this model, for the most part, remains only ideal. The innovation-to-commercialisation process in Ghana is actually, often, one that terminates at the first stage. As one interviewee, a professor of cell and molecular biology, recounts about the many discoveries he and his colleagues and research students have made,

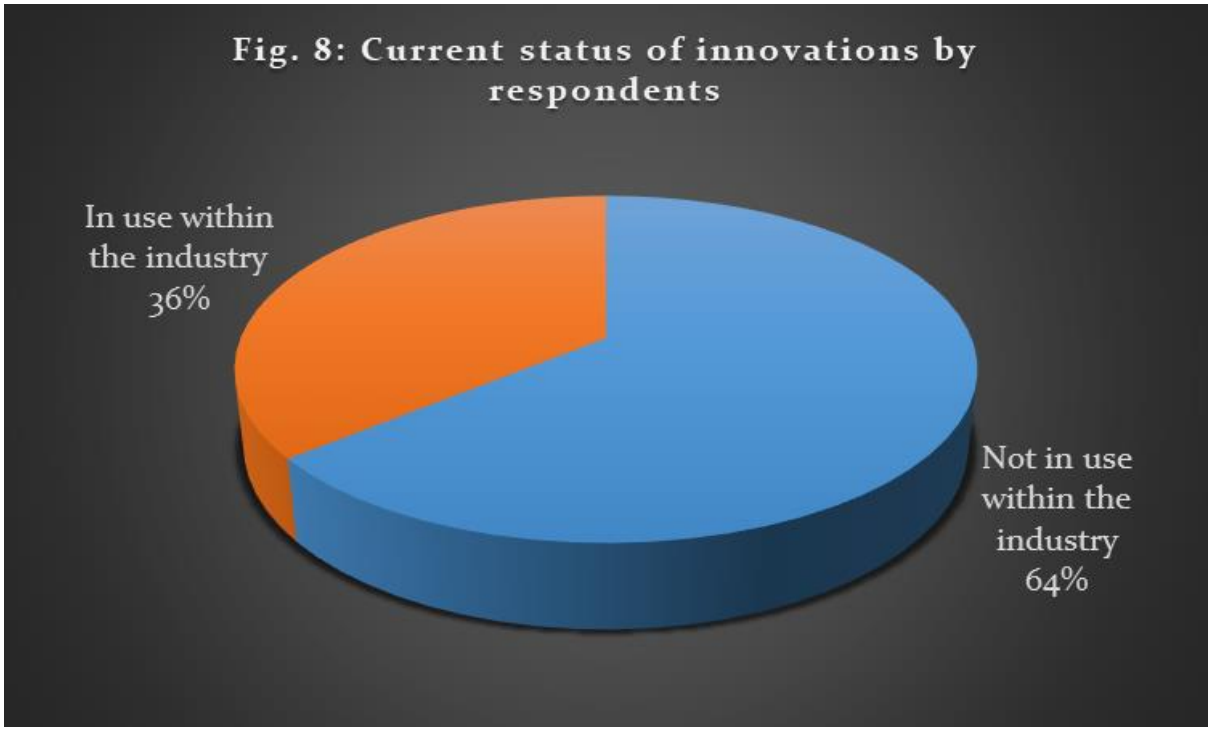
> *What we haven't had is an industry taking them and working with them further and I think it's one of the challenges on the continent as a whole. We don't have a biotech industry. So, in the developed world you'll have a biotech company which will take the information we've generated and develop them further into possible products but we don't have that here. So, that gap is there and so, we generate a lot of potential commercializable information but it doesn't go any further because we don't have the local industry to take it up and we don't want to go and give our ideas to companies that are outside Ghana (Interviewee 1: Professor of cell and molecular biology)*

The point is corroborated by another interviewee who has transitioned from academia to industry and now runs a biotech company in Ghana because he was frustrated that R&I in universities mostly only ended as journal articles rather than real-life solutions to problems. As he explained,

> *…we do these things, we publish papers, we train students but then what happens? The students leave Ghana because they can't find any jobs to do and our discoveries end up getting people promotions at the universities but they don't necessarily result in tangible outputs. So, yes, scientists are left with "okay, where do we go?" and because we don't have the industries there's nowhere to go and to be honest … (Interviewee 2: CEO of biotechnology firm).*

Similar evidence was shared by a third interviewee, a professor of biomedical engineering who also finds it "very frustrating" that the research she does with her students "normally result in proof of consent and that is usually where it ends".

Given these assertions about the limited opportunity for R&I to complete the innovation-to-commercialization course, it is not surprising, therefore, that the survey shows only about a third of the respondents whose work has ever resulted in an innovation have seen industry uptake.



The study finds that a number of individual, institutional and structural level factors account for this situation.



Individual level challenges

At the individual level, a major hindrance to promoting research to industry audiences is a general lack of drive to do anything beyond engaging the scholarly community.

> *Okay, communication about findings is mostly in publications, that is what we do... publications and sometimes conferences. That's where we get the chance of communicating our findings. Through publication, through journals and also conference proceedings (Interviewee 5: Lecturer in electrical engineering).*

> *Okay our institution here, the only opportunity we have is the conferences we have here. I think next year we are going to hold one of the conferences here and the organising committee has called for abstracts to be sent. So once an abstract is sent and it is accepted, researchers are asked to come and present… And there is this kind of journal publications and sometimes, they advertise or they publish your papers on their website for people who visit their website to see the work you are doing (Interviewee 6: Industrial chemist and chemical engineering researcher).*

As demonstrated by Interviewee 5, and quotations from Interviewees 1 and 3, academic institutions privilege scholarly conversations. Publications in scholarly outlets bring tangible benefits for academics whereas contacts with industry do not, necessarily. Researchers in these institutions are, therefore, not socialised to actively promote their research and innovations to the attention of industry. On the contrary, at the point of entry into academic careers, there is a lot of emphasis for them to publish (in scholarly journals). This being the case, individual researchers develop orientations towards prioritising only conversations with the scholarly community through journal publications etc.

Secondly, there appears to be capacity issues that stand in the way of researchers' outreach to industry to boost R&I uptake and commercialisation. Given the focus on scholarly publications, researchers and scientists have and take up opportunities to build their competencies in presenting conference papers, writing journal articles etc. for instance the Pan African Doctoral Academy runs short courses, every year on academic writing and presentation skills. Basic skills for research communication and promotion are harder to come by. In addition, they may be deemed the preserve of other professionals for which reason one may not feel inclined to build their capacity for it.

> *Currently, we don't have much experience but as I'm saying, I am part of the team that is organising the next next conference year so with that experience I'm sure going forward, I should be able to organise some of these workshops or something like that to help us communicate some of our findings to industry players (Interviewee 6: Industrial chemist and chemical engineering researcher).*
>
> *If lecturers or researchers are able to create their own website and they can advertise whatever they are bringing out, I think that one too… and I think there are a whole lot of things that we can do using the internet… Yeah, you see, when it comes to those areas, I think it's some area specialisation for some people. So, if maybe here, at least we have an ICT department so if the ICT department can take up these things it doesn't necessarily mean the researcher will do all these things. We can have dedicated people for this social media thing so when you're done you*

can just submit whatever you have to them and they'll just upload it into the system for you (Interviewee 5: Lecturer in electrical engineering).

After all at academics, we are very interesting. Personally, I'm not a business person, I can't imagine myself sitting down with one project for a lifetime, writing business plans and raising funds. I can't do that, the excitement for me is identifying a new problem so that I can put it out. So, it's not up to me or I don't feel like my talents will be best served by dwelling on one project all the way to the commercialization. I need help to transition from that proof of concept to the commercial product. We need people from all around and we need to make our processes easier for them to be able to engage with us and work with us (Interviewee 3: Professor of biomedical engineering).

Institutional level factors

Beyond the individual factors are the meso level factors operating at the institutional level. While there is a growing awareness of the benefits of innovation commercialization, and consequently, increasing actions towards this, institutions are hampered by their resource constraints. Moving innovations to the markets is resource-intensive, requiring funds for intellectual property (IP) protection at the very least, and for product testing, development and production. Typically, industry will be expected to partner institutions in the latter three stages. However, the costs of securing IP protection (time, effort and funds) can be daunting as explained by Interviewee 4.

… the process is a bit more robust, it's when you have an invention, the patents, because it's expensive, it costs a lot of money to protect and also it costs a lot of money to move it from the research stage to the market. Again, with that one, it'll go to the IP committee (Interviewee 4: officer in the University of Ghana's Technology Transfer and Intellectual Property office).

While costs vary depending on the type of protection sought (copyright, trademark, patent), they can be exacerbated by the number of territories one must secure protection in.

Normally, you would have to file for protection, there are a number of routes. You can do in your country, you can do a regional or you can try also international application but that is all dependent on the nature of the technology and also… where the potential market is for that technology. IP protection in Ghana is cheap but it's not cheap in countries like the US. Intellectual property rights are territorial, so if you file for protection in Ghana and you're granted in Ghana, it's

> *only in Ghana that you have the right to commercially exploit your invention, all other countries in the world can commercially exploit your invention and it's fine. So, if you don't want people to do it then you need to go and file it in those other countries (Interviewee 4: officer in the University of Ghana's Technology Transfer and Intellectual Property office).*

Unfortunately, most research institutions and researchers lack adequate funding to enable them to easily cover the costs for securing IP protection for innovations. Besides the monetary challenges, there is also the time and human resource demands to contend with which, in most cases, is a luxury institutions cannot afford.

The second meso level constraint has to do with the funding structure that underpins most of the research that yield the innovations. In the absence of any meaningful state nor local philanthropic support for funding R&I, institutions and their researchers have resorted to external donor funding. Often these come with conditions for making access to any resulting new knowledge or innovation public.

That being the case, any opportunities for protecting the IP of resulting innovations and commercialising them may be limited.

> *Within the academic sector currently in Ghana and parts of Africa, there's a lack of resource. So, funding is very hard to come by and all the funding we receive is from oversees grants. Now, this means that scientists are not actually free to chase ideas that they're interested in, they have to chase what they think is fundable but secondly, funded projects typically come with certain conditions usually around the push to publish, make all discoveries completely open and publicly accessible. That limits your ability to necessarily register your IP. So, it's great for the global knowledge community but it doesn't necessarily allow scientists to generate or extract commercial value of their work. If you are unable to extract commercial value from your work, you're unable to develop it. You are unable to take it further in the pathway of development because you need resources (Interviewee 2: CEO of biotechnology firm).*

The third factor identified is the current promotions systems within academic institutions. Knowledge production and training being at the core of their mandate, current promotion criteria privilege scholarly publications, as exemplifiers of knowledge creation. Academics in such institutions must publish defined numbers of scholarly materials (journal articles, book chapters, books, monographs etc.) to become eligible for promotion. Moving innovations beyond the discovery stage is not a requirement. And yet it can serve as impediment to progression as information about innovations must remain unveiled until the completion of IP protection processes. This

being the case, academics seeking IP protection for their inventions must delay their publications which actually lead to promotions.

> *So let me tell you, when you appear before these IP committees, of course at the start of the process they'll tell you not to publish… you don't want to give out the information otherwise it's no longer possible to protect the idea. So, in the meantime, my promotion is dependent on publications and this is the type of research I do, while I'm waiting around. What happens to me? And the longer I wait the less relevant it becomes and so, later on I cannot publish anyway. Do you see where the challenges are? So, it's easier for me to give the idea away, publish it and then move on (Interviewee 3: Professor of biomedical engineering*).

Closely related to this is the challenge presented by the dual factors of administrative bureaucracy and low levels of understanding of the innovation-to-commercialisation continuum. IP processes securing innovations for value extraction are quite bureaucratic with layered steps:

> *So, we have disclosure forms that they have to fill. Depending on what you have done [designs, inventions, logos etc.], you have to fill one of those forms and then provide the necessary supporting documents… we'll screen it at our office. Once we have everything then we would assign your unique identification number… For example, … when you have an invention, … it'll go to the IP committee… So, we have a guideline that we share with the inventor to help them prepare a brief presentation… the committee members will ask questions, clarifications and all that then each member would complete an assessment form… So, let's kindly assume that the committee has recommended that the IP should be protected… we now have to engage the services of the patent attorney… We have to draft the specifications for the patent. So, we have to go through procurement and then get the services of the patent attorneys draft… Once we have the attorney, he will work closely with our office and the inventor to draft the specifications … Normally, you would have to file for protection, there are a number of routes, you can do in your country, you can do a regional or you can try also international application but that is all dependent on the nature of the technology and also, we have to do a market research to inform where the potential market is for that technology (Interviewee 4: officer in the University of Ghana's Technology Transfer and Intellectual Property office).*

For researchers, who already have their plates full with teaching and other responsibilities, this can be a disincentive.

> *I have been to the IP committee of the University[name] three times with three different projects. They look at the projects that I have with my students, they seem to be interested, they tell us they'll help us to get intellectual property rights. Years later, nothing and I'm frustrated… I actually went to Citi, I had an interview with Citi TV, Citi FM and people started coming forward that they want to help. The first group to come is a Ghanaian, he had a partner who is also a Ghanaian but works as someone who raises funds for these kinds of projects in Africa. They wanted to know how they could help. Again, doing the right thing, I introduced*

them to our technology transfer office… The processes alone… First, to come up with an NDA [non-disclosure agreement], to come up with an MOU [memorandum of understanding], months. In the end they told me they're [the technology transfer office] not serious (Interviewee 3: Professor of biomedical engineering)

National/industry level challenges

Finally, at the national/industry structural level, four primary factors are identified that mitigate the opportunity to move innovations beyond the discovery stage. These are low industry interest, low trust between industry and academia, absence of or poorly structured industrial markets, absence of patient capital/investment and facilitatory support systems.

The study finds that there is, generally, very little interest coming from industry to prompt researcher proactiveness towards pursuing R&I communication and uptake.

I have not seen that big of an interest in that but anyway hopefully things will change. Also, another thing maybe because we don't have a history of doing this. And so, if an industry is coming to engage with you, do you have anything to show that you are capable of doing it? We haven't gotten to that stage yet (Interviewee 3: Professor of biomedical engineering).

The people out there, sometimes, they don't even appreciate the relevance of your research, what you are trying to communicate, how relevant it is to them, because most of them may not even understand the language you are speaking. Even if you talk about industry, how many of the industry drivers, the people who are experts in those areas, how many understand the details of what you are communicating. And even sometimes, I think they don't even know where to access that information (Interviewee 6: Industrial chemist and chemical engineering researcher).

… the industries also have to come in because as we sit here, if we don't go to the industries for us to know what problems they are having it'll be difficult for us to know what is going on there. So, even though we sometimes go in there because we take our students there to go and do attachments and the rest, and they come and defend whatever they see at [in] the industry. Sometimes we pick some of the issues there, then we give it to them as their project work. Then we take it and see how best we can solve the problem. So, if the industries can also come to us and tell us that 'this is the challenge that we are facing and we need you to research into it' then I think we can take it up (Interviewee 5: Lecturer in electrical engineering).

> *The industry drivers, sometimes, they are not ready to collaborate. So there is no collaboration between the researchers and industry, by way of let's say coming over... 'okay this is a particular finding. okay we have already gotten the details so going forward what do we do? okay we are going to put you guys on projects. in the next five years there is going to be an MOU, your masters students or your senior researchers could work on this project. So that together in the next five years we can see how best your input can bring a kind of progress or development as far as our products here are concerned (Interviewee 6: Industrial chemist and chemical engineering researcher).*

The study also found that part of the challenge is limited understanding among industry people of the meaning and implications of research findings.

> *Finally, the lack of awareness. Some industry players are unaware of the findings and the research output by the researchers. Some are aware but do not understand how these outputs can translate into profitability and there are also inadequate platforms or database systems that provide industries with the avenue to peruse these findings and make sense out of them for themselves (Interviewee 7: Lecturer in electrical and electronics engineering).*

Without such interest coming out of industry, researchers and scientists have settled into the status quo where the logical conclusion of their R&I products is scholarly publications rather than real impact through industry uptake and commercialisation, where applicable. As Interviewee 1 argues,

> *the students we've had, they're very highly motivated and passionate about what they do and they're very determined to make a difference. But that enthusiasm is dampened by the fact that they realise that they'll get to a stage where there's not much more they can do without the support that we need in terms of having the industry taking up the ideas (Interviewee 1: Professor of cell and molecular biology).*

Underlying the low interest from industry, is what appears to be some simmering distrust between industry and academia.

> *Apart from the fact that some of them don't appreciate the relevance of the research, some of them they don't even trust you being an African, a colleague Ghanaian, you have come up with something. some of the comments they they make, they kind of don't have any trust in the work you are doing ... There are certain times, you may have to rely on some other institutions to get your data. For example you want to run some analysis and you don't have the facilities in your lab. You either go to GSA or probably you are going to any of these institutions where they have the facilities. You run, you get the results. Sometimes, you interact with them 'how were these results attained?'. 'Okay I didn't have this, I have to come to this particular institution for this kind of analysis. okay so what do you*

> *think?'. 'Can you be so much sure of the results?'. And because you tell them that you didn't do this aspect yourself, because of lack of facility over that particular area, they begin to doubt the authenticity of your findings. That's why I see sometimes, trust becomes a challenge (Interviewee 6: Industrial chemist and chemical engineering researcher).*

> *Also, another thing maybe because we don't have a history of doing this. And so, if an industry is coming to engage with you, do you have anything to show that you are capable of doing it? We haven't gotten to that stage yet. So, we need a little bit of understanding, that we have to develop this capacity to do this. So, a bit of patience will be required and usually the business people are looking for their profit right away. They are not willing to work with you to develop a capacity. So, that's another thing that we need. Opportunities to develop capacities, and this is where some places I have heard, there'll be a national challenge. For example, the government will throw a challenge, we want to solve this particular problem, bring your ideas, we will support you. It may not be the best solution at first but they will support and then people eventually build the capacity for people to attend to some of these things.*

Given that Ghana is an import market, attention to manufacturing which is a key catalyst for moving innovations beyond discovery has lagged. This means that even if researchers and innovators were inclined to pursue commercialisation, little opportunity actually exists to realise this. This is due to the priorities of industry which seem to be attracted to quick returns rather than the long-term orientation that the innovation-to-commercialisation process requires.

> *Oh, I think there's a disconnect in our visions and goals. The industry in Ghana is set up to make immediate money which is that, they just want to make things and sell, they don't want to develop things that they own intellectual property, that's not their focus. So, if you look at the pharmaceutical industries for example, none of them have tried to develop their own drug. What they do is, they take the formula and they just make some locally and sell. So, they're making paracetamol from a formula, they're making a cough syrup from a formula. They're not sitting down and trying to say, 'we want to make our own cough mixture that can compete with the one that is made from any of the international companies'. So, their focus is completely different, they're more interested in just producing and selling rather than developing (Interviewee 1: Professor of cell and molecular biology).*

There is no interest in investing in R&I as companies tend to "*just buy the compounds, they just produce tablets and syrups. They don't do R&D"* as explained by Interviewee 2.

Accordingly, there is little drive from industry to encourage researchers and institutions to pursue commercialisation agendas.

Closely related to this is the absence of 'patient capital' to invest in the rather risky and, sometimes long phase of product testing and development. As explained in the preceding section, local manufacturing firms tend to prefer the shorter route of buying and producing validated formulae. This means they are unwilling to invest money in product development, the eventual success and returns for which cannot be assured.

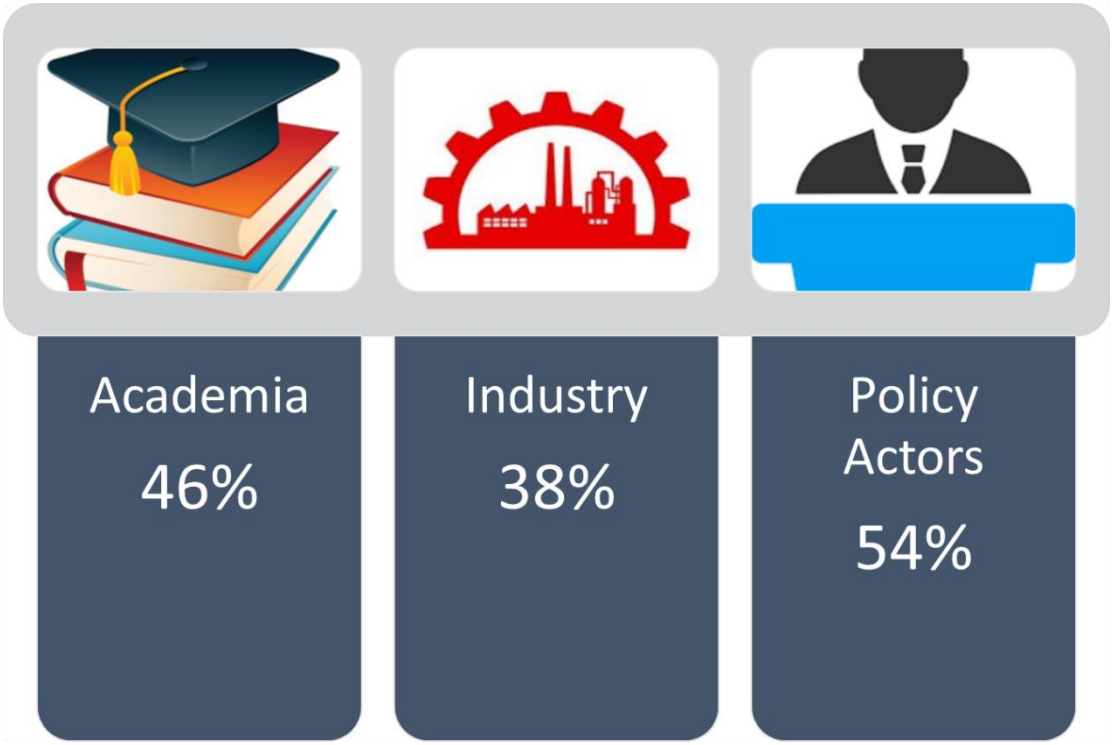
> *…the African Union in 2007 made a declaration asking for African governments to commit at least one percent of GDP to R&D. We are now in 2022 and I think only one country out of the 54 has succeeded and the challenge we have is actually that 1% is impossible for governments to achieve if business is not playing a role… If you look at these countries, America, Japan, Turkey, North Korea, all of these countries that spend more than 1% of their GDP on research, majority of that money actually doesn't come from their government, that money is coming from businesses because business is the only one capable of extracting the value from research (Interviewee 2: CEO of biotechnology firm).*

> *So, developing a product is where you spend a lot of money, there's a lot of investment there and there's also a lot of risks to be honest because many products get developed and they don't succeed. So, it's those that succeed that they use to recover. So, if you see one drug, hey would've tried maybe nine others that didn't work. So, it's very cost-intensive and it's risky and Ghanaian businesses are not wired that way. They don't do that at all. So, in fact, they're supposed to all have RND units but they don't (Interviewee 1: Professor of cell and molecular biology).*

The challenge posed by the resource gap is exacerbated by the absence of the necessary facilitating conditions. While the private sector holds the key to the finance challenge, the state must provide the right atmosphere that encourages investor interest and assures support. Unfortunately, industry stakeholders indicate that the picture is far from ideal.

> *right now we don't receive much support from the government, I mean, I didn't expect it at this stage. I believe that our government needs to learn and they learn by observing. So, a few of us are going to have to go the hard road, achieve some level of success and then put pressure… one thing we are doing is engaging in the GIPC (Ghana Investment Promotion Centre), how they can provide certain incentives for business including tax incentives, import duty exemptions, so, we are engaging with them to try to help facilitate some of the work we do because obviously if we do well it's a promotion for Ghana. So, there is that but besides that, there really are very few avenues for support. I mean, there are areas that*

government need to spend money so, providing incubators, providing seed funding, those are things that other country governments do to try to spur, to provide a little bit of a kick start to businesses. Those are all things that governments could do or our government could do to make it easier for companies like us to start but currently there's very little of that support (Interviewee 2: CEO of biotechnology firm).



❖ *Figure 5: Information on strategic partners*

RISCAM assets in Ghana

The study attempted a stock taking of various assets available for bringing R&I to the attention of and for uptake in industry. A desk review using the Google search engine enabled a profiling of categories of available assets in the country into four groups. These are publications, websites & social media pages, maker spaces/innovation hubs and forums.

Publications

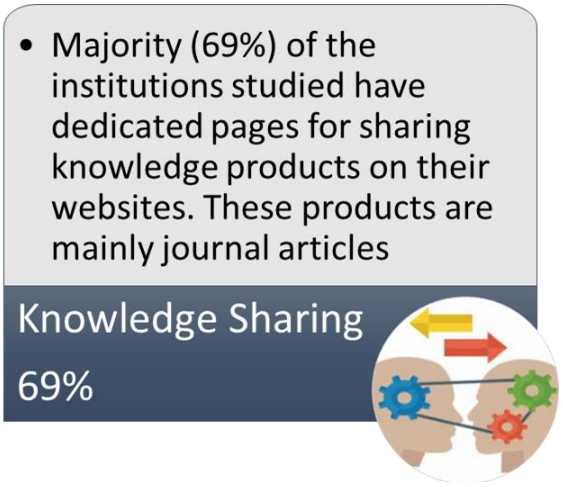
Several different types of publications exist in the country that are either designed to, or have the potential to enable partnerships between academia and industry through knowledge sharing. The first set of publications are journals which, at best, will have

industry players as secondary targets. These are scholarly journals published mostly by academic/research institutions and scholar associations. They are used to share information on the design and outcomes of scholarly research and tend to be written in a language not particularly suited to lay audiences. However, industry executives could learn a lot about new innovations that have implications for their specific industries from such publications. Examples of such journals include:

- Ghana Science Journal by CSIR
- Journal of the Ghana Science Association
- Journal of Science and Technology by the KNUST
- Journal of Fisheries and Coastal Management by UCC
- Science and Development Journal by UG
- The Ghana Medical Journal by UG
- Ghana Journal of Science, Technology and Development by UDS

Besides these are also newsletters published by academic institutions in which research summaries are provided. Examples include UG's Research Magazine and the Research Report of KNUST which shares, in simple language, reports of R&I.

A few publications were found to directly target industry audiences in which researchers and scientists could take advantage to connect their work with industry people. These tend to be published by industry and trade associations and provide platforms for enabling industry people to access research information. For instance, there is the Journal of the Ghana Institution of Engineering. Its audience includes engineering practitioners, scientists, researchers, academics and industrialists and aims to "provide a standard, highly visible, international platform for publishing engineering and related scientific research projecting excellence in engineering practice and technological advancement".



*igure SEQ Figure * ARABIC 6: Dedicated pages for knowledge sharing*

A sub-strand of publications targeting industry stakeholders are policy briefs, often posted on the websites of research/academic institutions.

Publications in the media are quite sparse and do not appear to be the result of any conscious effort to offer platforms that bring industry and academia together. Our analysis did not unveil any dedicated platforms in the media that puts researchers and industry players in the same conversation on a consistent basis. The solo example of a programme of this nature was Research Agenda by Radio Univers which has temporarily stopped airing. What seems to be in common practice are occasional appearances by researchers to explain aspects of their work. This also takes the form of occasional features in the media by researchers. Several examples of this can be accessed, for instance, from the Conversation platform.

Websites/social media

This is, perhaps, the most common form of R&I asset for sharing information about innovations with industry audiences. Most institutions either have websites or dedicated pages on their websites as well as social media accounts for sharing their research and innovations. Details about the use of these in communicating research findings and innovations have been shared under the section headed '*Affordances for R&I communication and advocacy in Ghana'.* In the case of portals, an example is the University of Ghana's Online Technologies Portal lodged within the University's website. It presents brief profiles on technologies developed by UG scientists including the names of developers, status of innovation (i.e. pre commercial or in commercial use etc), features, benefits and target markets. Particularly for technologies indicated as 'pre-commercial stage', the page presents cues that could invoke potential investor interest. Again, the study shows that the majority (62%) of the 13 institutions have at least one official social media handle that is linked to their respective institutional websites. These include, in order of popularity: Twitter (62%), Facebook (54%), and YouTube (23%). A content analysis of the social media post from January 2017 to date shows that these social media handles are mainly used for sharing news; events such as workshops and seminars; advertisement of calls for proposal applications; notice of

admission openings and vacancies; celebration of staff/faculty achievements; and project documentaries

Maker spaces and innovation hubs

Another form of RISCAM assets recorded by this study is Maker spaces and innovation hubs. Maker spaces provide a platform for academics, students, communities and industries to curate solutions to challenges in communities and industries, including those that promise commercial value. They also serve as incubation hubs for business concepts developed. Several of these exist in the country and are hosted in both research/academic institutions and private, often, not-for-profit entities. Research/academic institution-based Maker spaces include the UG Maker space, the KNUST Innovation Centre Maker space, Ashesi University's AT Maker space and the CSIR's INSTI Maker space. Academic City University is also, reportedly, in the process of starting its own maker space.

But, perhaps, the more common ones are those outside of academic and research institutions for which we found several including:

- Ghana Tech Lab Maker space (https://www.ghanatechlab.com/)
- Kumasi Hive (https://kumasihive.com/)
- Daani Maker space (https://daanigh.com/)
- The Creativity Group (http://ww.creativitygroup.org/)
- Noni Hub (https://nonihub.org/#)
- Hive Bio Lab (https://kumasihive.com/hive-biolab/)
- Accra Impact Hub (https://accra.impacthub.net/)
- Heritors Labs (https://heritorslabs.com/home)
- Agbogbloshie Makerspace Platform

(https://www.designforthecommongood.net/dcg-exhibition/curated-works/agbogbloshie-makerspace-platform/)

Forums

A scan of the ecosystem for sharing knowledge between academic and industry towards research uptake and commercialisation also reveals meetings as a common platform. Owing partly to demands of donors as means to enhance knowledge and uptake of research, it is common practice for stakeholder (including industry) engagements to be organised as part of projects. These come under different rubrics, including research workshop, research dissemination forum, stakeholder forum, industry-academia forum and conference etc. Generally, they can be grouped into two broad categories - one off, and institutionalised forums.

Most tend to be on-off contact points between academia and industry, coming as part of specific projects. For example, the Africa Centre of Excellence in Coastal Resilience (ACECoR) in November 2022, together with the National Development Planning Commission organised a 3-day workshop in Keta to facilitate mainstreaming of findings of a biodiversity study within the Keta Lagoon Complex Ramsar Site (KLCRS) into the District Medium Term Development Plan 2022-2025.

The more impactful assets of this nature are institutionalised forums for sharing research. A number of these exist and are championed by both academic and non-academic institutions. The Institute of Applied Science and Technology' periodic industry-academia interactions and exhibitions and the quarterly industry-academia symposium organised by the Institute of ICT professional Ghana are examples of the two. Besides this institutionalised platform, some academic institutions periodically hold inaugural lectures for academics who attain full professorship to share their research and also direct industry and policy on issues related to their scholarship. However, the majority of such institutionalised knowledge sharing forums tend not to directly target industry audiences, being conferences primarily for scholarly discourses.

Finally, it is worth noting as a potential asset, the many industry associations/institutions that offer platforms for sharing knowledge and innovations. Organisations such as the Association of Ghana Industries, Ghana Electrical Contractors Association (GECA) offer such opportunities.

Beyond these, however, we did not find any evidence of online communities comprising academic and industry players and organised around science and innovations knowledge sharing.

Conclusions

The present study has revealed that research outcomes and the innovations therein do not go beyond their instrumental function of enabling the researcher to access career progression opportunities including promotion. There is no deliberate effort to promote results of R&I with the view to bringing them to the attention of uptakers in industry. Individual scientists and researchers understand the need to communicate their R&I beyond scholarly audiences. In particular, they are conscious of the need to promote their work to the attention of industry players with a view to enhancing its impact. However, the opportunity to realise the benefits inherent is hampered by a rather laid-back posture when it comes to actually taking steps to engage industry on their research, capacity limitations, resource challenges as well as systemic disregard for such effort. This is despite the time and effort required and the institutional benefits.

A major reason why scientists do not pursue commercialisation of their innovations is the delay this introduces to their career progression. Once they file for IP protection, they are precluded from sharing their research findings even by way of journal publications. Unfortunately, the process is long and laden with bureaucracy. During this period the knowledge may become "obsolete" and not fit for publication. The researcher may not be able to benefit from their work for the purpose of upward mobility in their academic careers. A potential solution to this would be for the institutions to consider IP filing for the purpose of promotion, given that the institution stands to gain from the granting of the IP.

Besides this, the study also found that the impetus that should come from industry to drive RISCAM actions by researchers and innovators is weak, at best. Industry markets are small or non-existent and hardly reach out to academia for collaborations. Importantly, capital in the Ghanaian industry sector is geared towards quick returns making it impatient for the risky and time-consuming R&D processes that R&I commercialisation requires.

The study also found that four main types of RISCAM assets exist that facilitate contact between academia and industry. These are publications, forums, innovation hubs and websites/social media. The assets tend towards owned or researcher/institution-initated platforms. Assets in media designed to bridge industry-academia gaps are totally missing. Given the technical nature of scientific language, it will be important to train industry people to understand the language of scholarly publications. It would be even better if channels could be provided for the result of R&I to be presented in formats and language that can be easily understood by industry. To this end, we recommend a

publication (it may be called "pop-Science Quarterly") which will be dedicated to presenting R&I in a language that is easy to understand. For this to be successful, there will be the need to train specialists in R&I communication to discuss and present R&I in language that would be accessible to potential uptakers in industry.

The study revealed quite a positive posturing towards RISCAM among individual researchers, where they agreed with the proposition that researchers have a duty to actively promote their work to the attention of industry audiences (Fig. 1). We recommend that this positive posturing be leveraged to offer training that builds the capacity of researchers to communicate and promote their R&I.

Recommendations

Based on our findings, the following necessary steps/actions are recommended

- The creation of a research development fund to support research promotion and commercialisation efforts without unduly burdening academic institutions. This could be drawn on a competitive basis depending on how well scientists and innovators are able to demonstrate proof of concept and the market prospects of their innovations.
- Setting up parallel publication outlets that enable communication of R&I emanating from academic and research institutions to lay audiences, particularly in industry.
- A related point to the above is for academic and research institutions to give consideration to IP registrations in the promotional process. This will incentivise researchers to work towards uptake.
- The introduction of industry-academia conferences to serve as analogous platforms for communication of scholarly knowledge outside of primary scholarly circles.
- Partnership with media organisations, including campus media, to mount specific programmes and publications in the media to explain and promote R&I in a language that is accessible to industry.
- Training for media personnel in science reporting to engineer interest, coverage and emergence of more media-based platforms for promoting R&I.
- Advocacy to academic and research institutions to prioritise and incentivise research uptake by including it in promotion requirements.
- Training workshops targeting scientists, researchers and innovations to conscientise and capacitate them to use different tools and channels to promote their research and engage industry audiences

Appendices

Appendix 1: Survey questionnaire

Dear respondent,

Thank you for taking your time to participate in this quick survey that seeks to assess your communication activities around your scientific research and innovations. We will be exploring issues concerning whether and how you attempt to bring your research to the attention of industry in hopes of enhancing uptake.

The study targets researchers and scientists in academic and research institutions and forms part of efforts by a local innovation hub to implement interventions that facilitate research and innovation uptake in industry.

Completing the survey should take no more than ten minutes.

Thank you.

Sincerely,

Abena A. Yeboah-Banin

1. Which institution type do you work in

   - ❖ University
   - ❖ Research centre
   - ❖ Other

2. Which is your area of work

   - ❖ Natural science
   - ❖ Social science/humanities
   - ❖ Applied science

3. Please indicate your sex Male Female

4. Typically, do you consider your research to be of the type that can lead to an innovation?

   - ❖ Yes No

5. Has your research ever led to an innovation that can be taken up and commercialized by industry?

   - ❖ Yes No

6. If you answered 'yes' to Q5, what is the current status of the innovation?

   - ■ In use within industry

- Not in use within industry

7. How will you rate your efforts at promoting uptake of your research by industry?

- Very proactive
- Somewhat proactive
- Not at all proactive

8. Please rate the extent of your agreement with the statements below:

Researchers have a duty to ensure industry players hear about their work and understand how it can benefit them

- Strongly agree Agree Neither agree nor disagree
- Disagree Strongly disagree

Industry people must show interest in research findings by reaching out to researchers

- Strongly agree Agree Neither agree nor disagree
- Disagree Strongly disagree

9. Beyond publishing your research findings and innovations in a journal, which of the following have you done before? (Select as many as apply)

- Engagement forum with industry players
- Development and sharing of an industry brief to bring the findings and implications to the attention of industry
- Publication of articles in the news media to share findings
- None

10. If you chose 1, 2 or 3 for Q9, what was your main motivation? (select all that apply)

- To enhance the chances of industry uptake
- To ensure relevant stakeholders know about and understand the study
- To enhance my profile within industry circles
- Fulfilling requirements of the project grant

11. As a researcher, how will you rate the linkages between your work and industry?

Very poor Poor Neither good nor poor Good Very good

12. What do you consider to be the best way to promote your research and innovations to industry?.....

Appendix 2: Content coding

Appendix 3: Interview transcripts

Interview 1:

INTERVIEWER: If you'll just take a moment to introduce yourself just for the purpose of our profiling, the kind of work you do.

Interviewee: Okay, my name is Gordon Awandare director of WACCBIP. We do research into the molecular and cellular aspects of diseases both infectious and non-commutable diseases. So, we look at different approaches, one is to understand pathogen biology with the aim of identifying targets for diagnosis for drug development or vaccine development. And for non-commutable diseases we look at understanding genetic factors that may predispose people to non-commutable diseases.

Interviewer: So, I take it then and correct me if I'm wrong that the first part of your work will ever so often possibly lead to some innovation?

Interviewee: Yes

Interviewer: And has that occurred during the term of your career, whether for you directly or a student you're supervising or a colleague you're working with, is it something you've come up with?

Interviewee: Well, as you know, the work we do is basic science so we generate the target and like you said, we then need industries to take it from there. So, we've generated several of this type of potential vaccine candidates for example. What we haven't had is an industry taking them and working with them further and I think it's one of the challenges on the continent as a whole. We don't have a biotech industry. So, in the developed world you'll have a biotech company which will take the information we've generated and develop them further into possible products but we don't have that here. So, that gap is there and so, we generate a lot of potential commercialise information but it doesn't go any further because we don't have the local industry to take it up and we don't want to go and give our ideas to companies that are outside Ghana so, we don't have control over that. So, what we've been trying to do is to encourage some of our faculty and students to start small companies to build it. So, one of our faculty actually started a biotech company called Yemaachi

Interviewer: I think I've heard about it before, it was on radio during the covid

Interviewee: Yeah, so, he's the first to go ahead to do that but there are others too who are also looking to do that. The other thing is that we develop diagnostic methods or tests and currently we have a few for malaria and covid but now we need to take them to the field and test them. So, that's something we're looking to do next, these are things that are within our capacity to do so we'll do. we'll take them as far as we can but the industry part is what's missing.

Interviewer: If the industry existed and were vibrant, what would the journey be from your lab to the thing becoming something on offer that when I need it, I can buy?

Interviewee: Well, so, what would've happened is that the next phase would've been for the industry to come and work with us to refine what we've done and try to make it in commercial quantities and test it out and try it and see whether it works. That would be the next stage. And then if it works, you'll have the FDA coming in to validate that it works before you can go to commercials. So, those would be the steps. What is missing is the development stage, which is … you need a lot of money and that is the part that is missing.

Interviewer: Yemaachi which you mentioned, is that to your knowledge the only biotech company or there may be others that they're so small it's insignificant, in Ghana?

Interviewee: Well, that's the one that I know that is directly relevant to what we do. there maybe a few others but like you said, they're probably too small and insignificant to make a difference because for a difference to be made they have to have a lot of capital because this… to make a drug, you spend millions and millions of dollars or even for some cases up to billions of dollars before you get to the point where you can sell it as a product and that is when you start making your money back. But you need an initial investment to do the development and that's not available.

Interviewer: So, let's talk about the one that is within your control then. You said there were some innovations that you're going to take as far as you can to promote, what does that mean? What does that entail?

Interviewee: Those are like methods that we have developed. So, those ones, we can test them. For example, for diagnosing malaria, we can test that and compare it to existing methods. On a small scale, we can do those types of things. We do it on a small scale and see whether it works well in a clinic for example. So, we've been doing it in the lab and it works well, now we have to try it on actual samples in clinics and see if it works well and then, that will be as far as we can go because for there you need to make that into a product on a commercial scale, you need to have a facility that can make large quantities of those medicines and package them nicely for people to be able to buy and that is very capital intensive.

Interviewer: we heard during covid that there's been a setup of a west African vaccine… I've forgotten the name, they were going to be producing vaccines not only for covid but for all sorts of things.

Interviewee: Yes, vaccine manufacturing yeah.

Interviewer: Any news on that?

Interviewee: Oh, well, I think they're still trying but it's lost some steam because covid has receded but it's still ongoing, every now and then we hear something about it going forward but you can see that it has lost a lot of the momentum. But, it's still something that is still alive. So, they're still developing but I think Senegal have positioned themselves very well, Senegal and Rwanda, they have taken the lead and positioned themselves well and they are likely to be the host for those efforts because their government has embraced it and committed resources to position their country well to be a host. In Ghana, we're not doing that, we're not spending any money, we're just talking so, not much is happening.

Interviewer: Don't talk so much, noise is not good.

Interviewee: They say money doesn't make noise so…

Interviewer: What is the general inclination towards pushing so that their innovations, their research findings eventually become available to solve problems for the general populace? Individually, how driving are the scientists who you've come in contact with to do something extra if it means so, to ensure that their innovations don't remain innovations within university circles and journals but will eventually see the light of day? In spite of the challenges, you've spoken about the industry gap.

Interviewee: For me, the students we've had, they're very highly motivated and passionate about what they do and they're very determined to make a difference. But that enthusiasm is dampened by the fact that they realise that they'll get to a stage where there's not much more they can do without the support that we need in terms of having the industry taking up the ideas.

Interviewer: How about institutionally, so, ORID has a unit that is meant to be helping with commercialising intellectual property.

Interviewee: Yeah, technology transfer…

Interviewer: Yes, even that doesn't help?

Interviewee: Oh, I mean, they don't have any money. So, those that they can help mostly are innovations that come from the humanities and social sciences, those ones you don't need a lot of money. Maybe you've designed a teaching method, for those ones you don't need money, you need computers and things but you don't need but you don't need the kind of money for bioscience so, it's completely different.

Interviewer: So, if I ask you then to do a subjective assessment of the relationship between the scientist and industry, what would you say?

Interviewee: you mean in Ghana?

Interviewer: yes, in Ghana.

Interviewee: oh, I think there's a disconnect in our visions and goals. The industry in Ghana is set up to make immediate money which is that, they just want to make things and sell, they don't want to develop things that they own intellectual property, that's not their focus. So, if you look at the pharmaceutical industries for example, none of them have tried to develop their own drug. What they do is, they take the formula and they just make some locally and sell. So, they're making paracetamol from a formula, they're making a cough syrup from a formula. They're not sitting down and trying to say, "we want to make our own cough mixture that can compete with the one that is made from any of the international companies". So, their focus is completely different, they're more interested in just producing and selling rather than developing. So, developing a product is where you spend a lot of money, there's a lot of investment there and there's also a lot of risks to be honest because many products get developed and they don't succeed. So, it's those that succeed that they use to recover. So, if you see one drug, hey would've tried maybe 9 others that didn't work. So, it's very cost intensive and it's risky and Ghanaian businesses are not wired that way. They don't do that at all. So, in fact, they're supposed to all have R&D units but they don't.

Interviewer: they don't at all?

Interviewee: oh, no, they don't. some of them, even if they do, it's just a name on their paper that they have R&D.

Interviewer: but the people are not doing no research nor development.

Interviewee: exactly, all they do is quality control, the product is in let's check to see if it meets the requirements, that's what they do. There are not sitting there and developing new products. So, that's the disconnect. So, scientists are generating ideas that need to be developed, industry just wants to make stuff to sell. So, we're sort of on different pages. We're not aligned.

Interviewer: so, this disconnect, are you aware of any attempt to build bridges?

Interviewee: talking, talking in the meetings, that's what we do. Occasionally there'll be a meeting, industry, academia partnership, we'll go and have a meeting and talk but nothing will change unless companies spring up that are willing to take the risk and invest in some of the ideas that are coming out because you have to look at the idea and say "oh, this one has the highest probability of success so we need to gamble and put some money on it" nobody is willing to do that so basically it's talk and talk and talk, nothing is happening.

Interviewer: part of my interest is, and in fact that's why I asked the question that you said you didn't quite understand, let me pull it back, I wanted to see whether as part of some effort I was hoping to bridge the industry and scientist gap, there is any for instance presently some grouping, some association, some database in which scientists who's work tend to lead to innovations are congregated and if we are even lucky there are some industry members also on there, is there any such thing in the country?

Interviewee: no, I'm not aware of any such thing.

Interviewer: But are there associations for the scientists alone, exclusively?

Interviewee: oh, we have Ghana Scientists Association, we have Ghana Biomedical Association, we have Ghana Biochemical Association, we have a number of associations, scientists' associations. But there's nothing going on, it's just talking and expressing our frustrations about what could be. To be honest with you, I haven't seen anything that is a serious effort to make a difference in terms of transforming anything into products. There's nothing, it's not a serious effort.

Interviewer: is it a totally hopeless venture then, for scientists like you who are busy producing these things?

Interviewee: in terms of product development yes, it's hopeless unless we do our own. That's why I was saying that, we are encouraging our people to do their own in their own way. So, that's why Yemaachi has started and so, since they started, I think they've raised about 5 million dollars or something like that from investors. So, basically, they go round looking for people to invest. So, they invest in the company so they co-own the company. So, that's what he has been doing, mobilising resources to do that and he's raised some money but not nearly enough yet to do anything significant.

Interviewer: thank you very much. I'm very grateful.

Interview 2

Interviewee: my name is Dr. Yaw Bediako, I am immunologist by training, I am a co-founder and CEO of Yemaachi biotech which is a young biotech starter here in Accra and adjunct research fellow at WACCBIP at the university of Ghana.
Interviewer: when you say Yemaachi, I know you focus on cancer, am I wrong?
Interviewee: no, you are right.
Interviewer: does your work involve innovations? Does it lead to scientific innovations that will be taken up by industry?
Interviewee: yes, actually Yemaachi represents biotech, we are a biotech company so we can be considered to be an industry. So, I started off working fulltime at WACCBIP. I was a fulltime fellow at WACCBIP and then I started my company and transitioned out.

So, I flicked from being full time at WACCBIP to be part time at WACCBIP but I do Yemaachi fulltime. Call us an early-stage life science discovery company. We are focused on trying to understand cancer among African people. With the view towards developing new ways to diagnose and treat cancer so yes, we are very transnational and the goal of the work we do is to lead directly into the development of new diagnostics and new treatments. We are an industry, we're not a pharmaceutical company, they will de clients of ours. So, we will develop intellectual property that we will ultimately license to pharmaceutical companies but my dream for Yemaachi is in time, as we build more capacity to do more and more of that clinical development ourselves, but at this stage, we're sort of at the early discovery part of life science research which we then translate with the view towards translating that into products.

Interviewer: so you're telling me Yemaachi is still at the first part of the broad picture?

Interviewee: yes, you can think of it as discovery, development and production. Yemaachi is currently focused primarily on discovery although we are also involved in a few projects that we could consider development where we're looking to take existing technology but then optimize it for use here. Also, in time, as our discoveries yields fruit we want to take some into development. So, Yemaachi is primarily interested in the first 2 things, whereas pharmaceutical industry will then be interested in the production phase. But of course large pharmaceutical industries do all 3 stages. They tend to have the muscles and the resources to really take things into production. So, you can think of for instance, covid vaccines, the Pfizer vaccine for instance, BioNTech develops it but then Pfizer produces it. So, Pfizer provided the muscles to take it all the way to mass production for distribution. So, Yemaachi is involved in the first 2 stages which are all innovations, I mean, innovations appear across the spectrum but academic institutions like UG are only interested in the discovery. So, universities focus entirely… in fact they do mostly training. So, you could add another section that is called training. So, training that involves discovery but discovery in a context of a biotech company like Yemaachi is focused on registering of IP, whereas discovery in academic institutions is focused on publications. So, you can do discovery for the sake of a paper and you can do discovery for the sake of developing IP and to develop IP, you need to push your discovery further than you would if you're just focused on publication. So, even within discovery there's industry based discovery and there's academic based discovery and obviously at Yemaachi we are among the industry side.

Interviewer: you having exposure to the industry and the academics, when you come up with a discovery, what are your next steps to try and get industries aware and take on these innovations?

Interviewee: well, the reason I started Yemaachi is because Ghana and much of Africa really doesn't have biomedical industries. We don't really have pharmaceutical industries; I mean, we have companies that manufacture drugs but they just buy the compounds, they just produce tablets and syrups. They don't do R&D to develop, there's not much novel pharmaceutical industries in Ghana. When it comes to biotechnology,

we don't have any at all. So, as a scientist, I was frustrated that yeah we do these things, we publish papers, we train students but then what happens? The students leave Ghana because they can't find any jobs to do and our discoveries end up getting people promotions at the universities but they don't necessarily result in tangible outputs. So, yes, scientists are left with "okay, where do we go?" and because we don't have the industries there's nowhere to go and to be honest, foreign oversees big pharma industries doesn't really look to Africa for discoveries. They all see Africa as a very... I mean, it's not entirely a fair assumption they make but currently we are not really on their radar. So, I thought that the solution was we needed home grown, local industry to begin to take on this challenge. But, we have to start from the generation of the ideas because to be frank there's not enough IP, there's not enough discovery happening in the universities because the discovery is meant to be published. It's not discovery for the sake of innovation, it's discovery for the sake of publications. So yes, Yemaachi is my attempt to try to bridge both of those by doing both myself but the challenge or reason I do almost all my research at Yemaachi is because working in an academic system provides certain limitations that often stifle innovations and stifle your ability to be competitive. In my opinion and happy to be challenged about this, I think that currently it's very difficult to innovate competitively within the academic sector.

Interviewer: can you unpack for me?

Interviewee: within the academic sector currently in Ghana and part of Africa, there's a lack of resource. So, funding is very hard to come by and all the funding we receive is from oversees grants. Now, this means that scientists are not actually free to chase ideas that they're interested in, they have to chase what they think is fundable but secondly, funded projects typically come with certain conditions usually around the push to publish, make all discoveries completely open and publicly accessible. That limits your ability to necessarily register your IP. So, it's great for the global knowledge community but it doesn't necessarily allow scientists to generate or extract commercial value of their work. If you are unable to extract commercial value from your work, you're unable to develop it. You are unable to take it further in the pathway of development because you need resources. Investors are not going to invest in the university lab because the university lab doesn't own anything. So, how will an investor get the returns on investment? So, the only source of funding for university labs is either the government which as we know in Ghana provides nothing or oversees grants. As I said, oversees grants, either it's public money from other countries like NIH grants and they will require you to make everything public or it's foundations and philanthropists who themselves also will push you to say "once we've funded you, you should make your findings available to everybody to drag back the course of research" so, you'll find yourself in a very tough situation. To be honest, academia is geered towards training, academia does research but the primary role of the university is to train, to share, to train up a new generation of capacity. So, if your focus is translation, you need to find new ways of doing research and I think biotech provides one such example where you're

able to hopefully attract investment which allows you to retain ownership of your work. Allowing you to generate intellectual property that has value that you can leverage to now continue to attract the resources you require to push your innovation towards ultimately being taken up by pharma for production.

Interviewer: is there a readiness towards this? Do you have funding without these conditions that tie you down, does it exist and is it available?

Interviewee: it exists; it just doesn't exist easily in Africa. Biotech is a seven hundred-million-dollar industry in the United States, globally majority of it is in Western Europe and the United States. There are thousands of biotech companies that operate the way Yemaachi wants to operate and primarily they raise money from venture capital and private equity. So, they raise money like a business trade before you find an investor and say I'll sell you 10% of my business in exchange for this amount of money and when my business grows your money will grow. It's a very simple calculation. So, it's how all these apartments are being built in Accra. It's investors investing because in that case they know they'll get the return when you finish building the apartment and you sell them. With biotech, it's a much longer path way, 8 to 10 years, the risk is higher. So, African investors are not very interested in investing. So, even though the module is very well established oversees, it's not very well established in Africa. Which means that companies here have a harder time raising money. But in my opinion, because our government doesn't support research it's the only way you can go. Because how can you provide assurance to investors that you present a good value? So, it's possible, we are making some strives but I'll say that it's much more difficult to be a biotech company operating in African than to be a biotech company operating in California.

Interviewer: are there others like yourself? Are there others like Yemaachi in Ghana?

Interviewee: No, as far as I know, we're the only truly biotech company of its kind right now. There are a few companies working in certain areas of life science, there's Incas Diagnosis that is trying to build locally manufactured diagnosis. They're based in Kumasi. So they're doing some good stuff, I wouldn't call them a biotech because they're a diagnosis maker, so, to some extent there's some element of biotech but mind you, traditional biotech involves a large amount of research. So, research that looks a lot like what you see in the universities is what's being done in our company whereas Incas is primarily a diagnosis manufacturer. So, that is the only one I know in Ghana. Nigeria has a company called 54Gene that is a genomics company. It's probably the closest on the continent to anything like Yemaachi. A couple of years older than us although lately they've had a few financial issues, their CEO has resigned, I mean if you just google 54Gene, you'll see a lot about them. They've raised quite a bit of money in the last couple of years but then over the last few weeks have had quite significant problems. But no, this module is not very common, if you look at the US though, there're a lot and lot of companies in that module. So, I started Yemaachi because I felt that the time has come for our science to mature to that level. That we have to think beyond simply, academic research. We have to begin to think of how we can build commercially viable research.

And the more I've done it, the more I've researched it, the more convinced I am because the African Union in 2007 made a declaration asking for African governments to commit at least one percent of GDP to R&D. We're now in 2022 and I think only one country out of the 54 have succeeded and the challenge we have is actually, that 1% is impossible for governments to achieve if business is not playing a role. So, all the countries around the world, the US for instance put around 3% GDP in research, it's actually not government money, 75% of that investment is actually from private businesses. So, it's a bit misleading when you say government should commit. Lastly, the countries that have succeeded to have in total gross domestic expenditure on research over 1% of GDP, majority of that actually come from private businesses. So, it's not so much that government has to have find 1% of GDP to put into research which is how it has been positioned in Africa. It's actually that government has to create conditions that support businesses to begin to do research such that the local investment in research surpasses 1% of GDP but majority of that money actually doesn't come from government coffers. So I think that is the mistake we made in Africa. As usual, post-colonial, we think the government has to do everything but if you look at these countries, America, Japan, Turkey, North Korea, all of these countries that spend more than 1% of their GDP on research, majority of that money actually doesn't come from their government, that money is coming from businesses because business is the only one capable of extracting the value from research that is required to generate the revenues required to drive that level of investment. So, we need biotech in Africa if we're going to see greater investments locally in research.

Interviewer: you mentioned earlier that the help that's supposed to come from government is more of a facilitative help, does it exist in Ghana?

Interviewee: no.

Interviewer: since you've been doing Yemaachi, what is the architecture of help by way of facilitation for your work?

Interviewee: right now we don't receive much support from the government, I mean, I didn't expect it at this stage. I believe that our government needs to learn and they learn by observing. So, a few of us are going to have to go the hard road, achieve some level of success and then put pressure… one thing we are doing is engaging in the GIPC (Ghana Investment Promotion Centre), now they can provide certain incentives for business including task incentives, import duty exemptions, so, we are engaging with them to try to help facilitate some of the work we do because obviously if we do well it's a promotion for Ghana. So, there is that but besides that, there really are very few avenues for support. I mean, there are areas that government need to spend money so, providing incubators, providing seat funding's, those are things that other country governments do to try to spur, to provide a little bit of a kick start to businesses. Those are all things that government could do or our government could do to make it easier for companies like us to start but currently there's very little of that support. It's not just a Ghana problem, to be honest most African countries do not really provide much

support for businesses. I am of the opinion that if we wait for government we will never do anything. So, we have to manage the absence of government support while still advocating that the government needs to find ways to facilitate. Obviously finding ways to provide task exemptions and import duty exemptions is probably maybe the first place to start. As well as, with Africa free trade maybe movement of goods and services across Africa may also begin to improve. But right now, to be honest, it's extremely difficult, you're working on your own but the quicker you accept you're on your own then the quicker you can achieve progress.

Interviewer: my last question to you is to find out whether there's any congregation point, some platform, meeting, etc. that researchers who have the kind of mindset you have are sharing experiences, learnings, even if it's only to encourage and push each other, are there any such conversations or platforms?

Interviewee: not too many, I mean, the start off scene in Africa's renaissance, I think we're beginning to see a swing, I am beginning to get invited to… you know, Africa Union is organizing a number of workshops focused primarily on scientific innovations. I mean, you yourself reaching out to me is a sign, people are beginning to ask, how do we promote more innovations. So, I believe that it's beginning to happen, that they are trying to create avenues where people can come together and discuss what measures are required to promote developments of this in Africa. So, I think we are at the beginning of a new age. How long it'll take us to see tangible results, I don't know but at least, for instance, I've been invited to Nairobi to speak in a workshop, once a few of us have heard then you get invited to come and talk and it's nice because typically the discussion for the last 5 years have involved bureaucrats and government officials who to be honest don't understand the first thing about innovation. And when they talk about science, they bring in the academics, they bring in the old professors who also know nothing about innovation. So, there need to be a movement where young people who are beginning to try to do things are listened to. I hope that that begins to happen more and more but there's hope, we're seeing a few things start and we just hope that by God's grace we'll…

Interview 3

Interviewer: can I start by asking you to introduce yourself, what you do in the university just for the purpose of context?

Interviewee: alright, my name is Elsie Kaufman, I'm an associate professor of biomedical engineering and also the dean of the school of Engineering sciences at the University of Ghana.

Interviewer: so, I take it that the kind of research you do must certainly result in some kind of innovation?

Interviewee: absolutely.

Interviewer: have there been any innovations?
Interviewee: yes, certainly, but you know what we do at the university is, we look at the proof of concept. So, we are normally looking at proof of concept and so our students are not required to commercialise their products before graduating. So, the research I do with my students normally result in proof of concept and that is usually where it ends. Very frustrating.
Interviewer: what you're saying is, after bringing an idea on board, making the research and having solutions to some of the problems, that is where your job ends?
Interviewee: that's what has been happening. Yes.
Interviewer: what should be happening?
Interviewee: the ideal is, by the way we don't need to reinvent the wheel, the ideal is, we have seen modules from other universities elsewhere, there's support. So, there should be some kind of support that will help link those of us coming up with the ideas and proofs of concepts with those who are able to scale and go all the way to commercialization. As we speak now, I don't think we have structures in place to do that at the university of Ghana.
Interviewer: what form would this support have taking for instance if you don't mind?
Interviewee: okay, let me share somethings I have been doing over the years. Since about 2010, I have been working with colleagues at University of Michigan, what was happening was, you know global help? They were bringing their students to Ghana. They come and identify problems and then they go for their capstone, for engineering we normally have a capstone project which is the final year project for the graduate students where they have to solve some problems and provide a proof of concept. So, they were bringing their students to Ghana, they were identifying problems here and going off to the US and developing all kinds of solutions. So, when I met my colleague Kathleen Sienko, I decided to work with her. After all, I had her contact in Ghana but I didn't see why I should just use my networks to help University of Michigan students. So, I decided to add my students on to it. So, we developed a very innovative idea, at the time it was very innovative. We even published this model, a program where students come from the University of Michigan, they join with our students from the University of Ghana, they go off to the hospitals, that's how they identify the problems. They identify many problems and they go back at the end of the period to work on their capstones. They pick a problem that they've identified and they'll work on it for their final year capstone projects. Through these programs, I have seen University of Michigan students from the original program, the old program that they were coming to Ghana. I don't know if you know about this company, it's called Sisu Global health. It's one of the student groups from university of Michigan, came to Ghana, identified a problem and now they have a product. The product is called the Hemafuse, it's a medical device for collecting blood during surgery and then using it for re-transfusion. So, it looks like a huge syringe, they've gone through the process, what happened? The same students, undergraduate students, right. So, what happened? They come from an

environment where it's possible to do these things and so it's not unusual for them to, after their undergraduate capstone project, set up companies, startups, they get support from the University of Michigan in the fund raising efforts, you know the nurturing… and now they have a product. By the way that product is licensed for use in Ghana now, unfortunately Ghana's processes is a little bit bureaucratic so they've started deploying it in Kanya, East Africa that's where they've started deploying this solution to a problem they identified right here in Ghana. So, what's the difference? I have been to the IP committee of the University of Ghana 3 times with 3 different projects, they look at the projects that I have with my students, they seem to be interested, they tell us they'll help us to get intellectual property rights, years later nothing and I'm frustrated, this is my own university, I should be speaking positively but this has been the real experience. I don't think we are ready yet. I actually went to CITI, I had an interview with CITI TV, CITI FM and people started coming forward that they want to help. Again, the first group to come is a Ghanaian, he had a partner who is also a Ghanaian but works as someone who raises funds for these kinds of projects in Africa. They wanted to know how they could help, again, doing the right thing, I introduced them to our office here, technology transfer office here at the university of Ghana. The processes alone, at the time it seemed as if they were not ready or prepared. First, to come up with an NDA, to come up with an MOU, months, in the end they told me they're not serious. So, these are some of my frustrations. I know you haven't asked yet but I've told you all my things.

Interviewer: I know and it's amazing how you're replicating things that other interviews have given me. So, beyond what even at the micro level. The kind of support scientists should be getting within their own institutions there are frustrations that means that when you finish your research the best bet is publish it and move on.

Interviewee: exactly, so let me tell you, when you appear before this IP committees, of course the start of the process they'll tell you not to publish because you don't want to give out the information otherwise it's no longer possible to protect the idea. So, in the meantime, my promotion is dependent on publications and this is the type of research I do, while I'm waiting around what happens to me? And the longer I wait the less relevant it becomes and so, later on I cannot publish anyway. Do you see where the challenges are. So, it's easier for me to give the idea away, publish it and then move on after all at academics, we are very interesting. I personally, I'm not a business person, I can't imagine myself sitting down with one project for a lifetime, writing business plans and raising funds. I can't do that, the excitement for me is identifying a new problem so that I can put it out. So, it's not up to me or I don't feel like my talents will be best served by dwelling on one project all the way to the commercialization. I need help to transition from that proof of concept to the commercial product. We need people from all around and we need to make our processes easier for them to be able to engage with us and work with us.

Interviewer: how about the national level? Is there any support at all you're familiar with?

Interviewee: again, after my interview with CITI, GNPC came forward, so I think there're programs nationally, I know some of my students sometimes go off and do this … I know some of them are private activities and some maybe national, I'm not sure. But I don't personally know of any formal way of getting support nationally for these ideas. I have not seen any calls to solve specific problems which happen in other countries by the way.

Interviewer: how about industries actively reaching out to scientists?

Interviewee: recently, I represented the provost of the college of basic and applied sciences to visit Reroy Cables, that was a welcome thing because Reroy is a cable company, they are situated in Tema and they are producing cables but they want to include a research component to their research and they want to find out how they can work with them in these projects. So, yes, something like that has started happening and I was very happy to be involved in this visit with Reroy. We're now working on MOU, hopefully something will come out of it. Usually, what companies have done, it hasn't been that much of a push for developing commercial products but it's more about internships for our students. So, they're willing to take on students for internships but you know, because many of them don't have research departments.

Interviewer: so, I've heard and I've also heard that they are not very keen to invest the money. The part of the work that is risky and heavy on money, they don't want, they just want to take formula and produce things.

Interviewee: exactly, so, they're looking for engineers to help them to produce not to come up with new products or new innovations. I have not seen that big of an interest in that but anyway hopefully things will change. Also, another thing maybe because we don't have a history of doing this. And so, if an industry is coming to engage with you, do you have anything to show that you are capable of doing it? We haven't gotten to that stage yet. So, we need a little bit of understanding, that we have to develop this capacity to do this. So, a bit of patience will be required and usually the business people are looking for their profit right away. They are not willing to work with you to develop a capacity. So, that's another thing that we need. Opportunities to develop capacities, and this is where some places I have heard, there'll be a national challenge. For example, government will throw a challenge, we want to solve this particular problem, bring your ideas, we will support you. It may not be the best solution at first but they will support and then people eventually build the capacity for people to attend to some of these things.

Interviewer: what else do you do, if any, to promote your research to the attention of industry?

Interviewee: okay, first of all, let me alert you that the university professor first and foremost, science and maths quiz is my extension activity please take note of that, I'm an academic in my own right, I'm a university professor, that did not come from doing science and maths quiz. So please let me alert you to that. The science and maths quiz gives me an opportunity to be visible but I was doing all sort of things even before the

science and maths quiz. My responsibility is to promote my discipline, it's one of the things that we're told when we're given appointment to work as a university academic. We have to promote our discipline and I do that very well. I am a founding head of the department of the Biomedical Engineering at the University of Ghana and a founding head of the department of Orthotics and Prosthetics at the University of Health and Allied Sciences. So, what do I do? I do go around, on my own, nobody pays me to do these things, it's something I believe in, I go to schools, I talk about biomedical engineering, I talk about publications of biomedical engineering and how we might be able to harness the science that we are learning to be able to be useful and productive. So, I do this on my own, I start from basic school and go all the way to senior high schools and all of that. If you will notice, if you come to our school of engineering sciences for example, we have two flagship programs, computer engineering and biomedical engineering, although biomedical engineering was very new to Ghana, in fact it was the first program in the country and most of Africa. Same with my department of Orthotics and Prosthetics, there's no other such program, a degree granting program in Ghana or even most of Africa. So yes, this is how I promote these things, I encourage students to join, they come, some of them come and specifically work with me on this engineering activities, I teach engineering design, I supervise students in the engineering design and that is how the ideas come about. So, I'm at every opportunity making sure that we use our knowledge of science and maths to do this, what the national maths and science quiz does and please go and do your research and find out the objectives, it's basically to put signs that will make science appealing and reachable. That is exactly what the program does. As a quiz program, the innovations and the things they're talking about do not happen there, next is to identify the talent, the program that they're very well in. it brings interest in science, it is when they move on, they come to me in the engineering school that we start developing these products.

Interviewer: prof, by way of assert, for instance platforms for sharing knowledge between academia and industry, are there any? Say, is there a journal for instance that speaks to your specific, an industry basing journal that is not our usual academic journal but are there things like that that you're familiar with that people in industry could be reading to get familiar with innovations by yourself and other people like you?

Interviewee: not that I'm aware of at the moment but there is for example, on the council of the Ghana Institute of Engineering, and at the Ghana Institute of Engineering you know we have members who are engineers in industries and we also have the academic members. There's a journal there that has recently been relaunched and there's a lot of advertisement for people to put papers in there. That is some of the ways in which the Ghana Institute of Engineering is trying to bring academia and industry together. So, that is one of the ways that I'm aware of. Another thing is, individuals doing different things, I don't know if you are aware of this but July, end of July I launched my own NGO. My foundation is supposed to do some of these activities as well because one of the things we are really interested in is to make sure that we product the students that

are able to think critically and able to use the science and maths that we're teaching them and the engineering we're teaching them to make an impact in the industries but we need to bring the people together and so it's one of the things that I'm very passionate about and we'll be seeing more of that. The foundation is still young now, I'm still on my first project.
Interviewer: prof, I'm done with my questions, is there anything you'll like to add?
Interviewee: yes, we need more people to identify some of these challenges we are facing. We need maybe some policy direction on how we may proceed to make useful contributions. We're doing well in terms of the teaching and learning of the basic sciences, maybe the engineering sciences but not the engineering itself or the application of the science to actually come out with products and there's a lot that you can do to change that story. So, that is why I want to find out what your findings are for this interview and see what we can do about it.
Interviewer: thank you very much prof.

Interview 4

Interviewer: Can you introduce yourself? Who you are and what you do at the ORID or IP office?

Interviewee: Okay, my name is Diana Owusu Antwi, I'm a research development officer, a member of the Intellectual Property and Technology Transfer Services team. The name has been changed to Technology Transfer and Intellectual Property Services (TTIPS). Generally, what the team does is, we lead and manage university industry partnerships, intellectual property and technology transfer for the university.

Interviewer: what does university industry partnership mean?

Interviewee: so, we normally want to engage with industries to find out the challenges that they are having that are making it difficult for them to become competitive on the market. And normally, these challenges will relate to the absence of innovations or the non-introduction of innovations and technology to improve upon their work. So please, there are other reasons but for us, our purpose and reason for engaging has to do with research, innovation and development. Because some of the challenges they face include access to credit and all that, that is not part of our interests. So, we normally would engage them, sometimes they come with us with their problems and then based on the needs or the challenges they have identified, we try to find a faculty within the university who has expertise in that field so that the faculty can work with the industry partner. The idea is that the industry would fund research that solves their problem that is being faced. And that research, once it's done, we transfer it to that industry for their use. So, some of them are tailor made for particular business but others are just generic

that anybody at all can use. So, sometimes, in trying to foster these collaborations, they may be asking for student internships and all that. Usually when it happens like that we reach out to the department. For example, if they want internships with students with business related backgrounds, we'll reach out to the business school for that but for some of these internship things too we kind of push them to IAST or the Careers and Placement Center so that we can focus on the research things.

Interviewer: with the picture you've painted, how frequently for instance are you getting attention from industry players? Or how frequently are you also reaching out to industries to try and build connections?

Interviewee: well, I'll say if I can rank it, I'll give it a 6 out of 10. Because sometimes not all the engagements end up in something. So, we try to distinguish between engagement and partnerships or collaborations. So, we came up with our own definition but it was informed by what was meant by engagement and what is meant by collaboration. So, we normally identify the collaborations as the first thing that we take to reach or talk to a company. So, to engage them to find out if they have any challenges, where, how we can help. So, if we can move this forward to let's say, we're able to sign an MOU or have an agreement or do some research for them, then we in turn call that a collaboration. So, we have facilitated a number of them, we did one for MTN, with that one, it works closely with Business cool because they needed to do something related to HR. the people they work with, it's an HR related thing so they work largely with Computer Science and University of Ghana Business School. There was one that supported a faculty at the school of engineering, he had developed a smokeless cook stove and Solidaridad was the industry partner. So, they supported him to build three of the cook stoves like a demonstration so that they could test to see if it was really working. The number of them, I don't readily recall. My other colleague does industry partnerships, I just support that but normally the partnerships relate to things of this nature. So, sometimes they also come to us, they don't usually come to us like TTIPS but they journey with us, engage a faculty or a department and the department will reach to us. But for the industry, the businesses that we have worked with before, those who know of us, if they have any, they will approach us but those who don't know us they normally would speak to faculty and then the faculty, some of them come to us, some of them don't come to us.

Interviewer: so, are you aware of any of these collaborations that have actually resulted in a product on the shelves?

Interviewee: not really but let me explain it and maybe you can kindly draw your own inference. So, for example FanMilk, they approach someone at the department of Nutrition and Food Science and say for research and product development. So, through that, I think some of the things that they did led to the production of the new flavours

of FanYogo, FanMilk Products that you see on the market. I think previously it used to be chocolate, strawberry and vanilla. But now they have some other flavours. So, the department provided R&D support and then they also did sensory evaluation. So, it was one of the things that led to that. I think that FanMilk probably had conceived of the idea and they would have been able to do it with their parent company in France but they wanted to work with a local research institution so they approached us. So, this is our dear own product that they extended the product line to include other flavours. The University of Ghana Yoghurt, with that one, the university was already doing it but we supported a faculty, also from the same Department of Nutrition and Food Science, they applied for a grant through the field development fund and the idea was to introduce new flavours. They actually did it, it was sold at the Night Market for some time but I don't know what happened, now you don't find it there again. So, they were selling some that was made from I think fresh milk and I think it didn't even have sugar in it at all. So, it came in a container like. It was called Boyo. So that was also… that one, it was largely like a university thing but the funding was provided by the Skills Development Fund on behalf of the government of Ghana

Interviewer: how about the IP side of your work?

Interviewee: Okay, with intellectual property, what we do is, we create awareness because it seems a lot of people within the university either are not aware of what intellectual property is about or they are aware but they don't seem to appreciate it or its benefits. So, some of the things that we do, initially we use to do a lot of sensitization programs but now we've slowed down a little bit because our staff strength have reduced drastically so occasionally, we'll do a workshop but purely what we do there is to sensitise the university community, staff, students, through workshops, seminars, we use to develop information materials… and distribute them to the university community. So, basically, what we do is, we also review research contracts. So, normally when a funder is funding a research, they will come up with a grant agreement and our colleagues in Pre and Post award team will review the contract but they also share it with us so that we review to see if the IP clauses are in line with what the universities intellectual property states and if it's favourable to the university. So, we review that and we also engage faculty who we know are doing research basically to find out about what they're doing and to sensitise them about the need to avoid the disclosure of their work. Particularly, the ones that we think are very innovative. Because the IP system is such that, when you publish your work, it may affect the grants of the texture. But this is the challenge we are having with faculty, some of the people that we are talking to, we are engaging, before you know it, they have disclosed. So, that is where we are trying to come in because we are trying to let them understand that they don't have to wait for the IP system to end before they can publish their work. Once we file for protection, we can file for protection today, you can publish your work today, but if you publish your work without the protection, it won't be won't be protected. For the IP system rewards

novelty, if you publish your work, the work is in the public domain so it's no longer new. So, that is where we're now driving our sensitization programs to. So that people can understand that you don't need to wait for the patent to be granted before you publish your work.

Interviewer: besides sensitization, do you actually facilitate the acquisition of the patent?

Interviewee: oh yes, we do that. But before we do that, the faculty will have to disclose what he or she has done. So, we have disclosure forms that they have to fill. So, those disclosure forms, we have a number of them, we have one for inventions, so the invention may either be a product or a process, then we have one for the copyright kind of things, literary and artistic works, then we have one for designs and we have one for Logos, slogans, etc., a trademark. Depending on what you have done, you have to fill one of those forms and then we provide the necessary supporting documents. So, when we receive the documentation, we'll screen it at our office. Basically, we need to ensure that all the information on the form has been provided. If something is missing, we'll get back to you. Once we have everything then we would assign your disclosure and your unique identification number. That is what we use in all correspondents with the faculty. So, when we screen and we realise that it's okay, for example, with the... please let me take the types of IP one by one. Because the processes are different. So, with the copyright, we don't do a lot about it because with the copyright, once you create the work you have automatic protection. So, with that one, once you create your work, it is found out that the work is original and then the work has also been expressed in a tangible medium of expression. So, for example you can write a book, you can write a song, it's expressed. So that one, it's usually not a big deal. That one too, the cost of protecting it is not so high but it'll still go to the IP committee because based on the provisions we have in the IP policy now, it's the committee that must make a recommendation as to whether the university should protect it or not. Then the same for the trademark. you'll fill a trademark disclosure form, you'll submit whatever you've done whether it's a logo, it's a slogan, it's a symbol, that one too it has to be new and it should be distinctive. So, if you say you have a trademark that is called maybe Apple for example. Then the intention is that that trademark called Apple is not going to be used to market Apples, the trademark should not describe the product that it is going to use to market. That is usually a bit, I won't say difficult but the process is a bit more robust, it's when you have an invention, the patents, because it's expensive, it costs a lot of money to protect and also it costs a lot of money to move it from the research stage to the market. Again, with that one, it'll go to the IP committee, so, the committee is made up of reps from all the colleges in the university. Then, you have a ref from our legal council office, the finance department, business school, so, business school is part of humanities but we made a special case for them because we wanted somebody from the department of marketing and entrepreneurship to enumerate the evaluation process

and depending on the field of the invention, we call out persons, and their usually in the university community because of the diverse background of the faculty. So, we normally call out 2 persons who have expertise in the field of invention to join the committee to do the evaluation. So, we have a guideline that we share with the inventor to help them prepare a brief presentation. So, at the committee meeting, the inventor will come and talk about what he or she has done, the committee members will ask questions, clarifications and all that then each member would complete an assessment form. There are certain things we look out for on the form so they will complete and everybody would recommend, give his or her opinions as to whether for example, the inventor needs to do additional research to support the case or we can go ahead to protect it or the school needs to protect it but we should explore commercialization. So far, the committee has evaluated a number of disposers and please let me just add that each member of the committee has signed a confidentiality agreement and even the members of the TTIPS team, we've all signed confidentiality agreements. We also need to give people the assurance that whatever they tell us is safe. So, let's kindly assume that the committee has recommended that the IP should be protected, because if the committee recommends that they have to do additional research, we don't pursue it again until they address that gap. So, if the committee recommends that it should be protected, we now have to engage the services of the patent attorney, these are people who have special skills usually in the field of the invention and also, they have a bit of legal training. Because the patent involves both the scientific and legal aspects, if we have to draft the specifications for the patent. So, we have to go through procurement and then get the services of the patent attorneys draft. I think so far that's where we've gotten to but the process continues so I'll just continue with how it's supposed to be. So, once we have the attorney, the attorney will work closely with our office and the inventor to draft the specifications because the attorney alone cannot do it, the inventor alone cannot do it, it has to be a collaboration between them and the team. Because it's a lot of back and forth, when you draft, the inventor has to verify that this is how it is and in drafting, they call something a claim, that is, a claim to the invention, what it is that if I can say, you're claiming to have done. And how different it is from other things existing and you need to also indicate the technical problem that it's addressing. So, that is called a patent specification. Normally, you would have to file for protection, there are a number of roots, you can do in your country, you can do a regional or you can try also international application but that is all dependent on the nature of the technology and also, we have to do a market research to inform where the potential market is for that technology. IP protection in Ghana is cheap but it's not cheap in countries like the US, so, if really the market for that technology is not in the US market, then it's not worth going for protection because the idea is that, when you file for protection in let's say Ghana and you are given the rights, you're the only person who can commercially exploit the IP, any other person who does it without your permission is infringing. So, intellectual property rights are territorial, so if you file for protection

in Ghana and you're granted in Ghana, it's only in Ghana that you have the right to commercially exploit your invention, all other countries in the world can commercially exploit your invention and it's fine. So, if you don't want people to do it then you need to go and file it in those other countries. So, that is where the market research comes in. so that they have a good basis for wanting to maybe have the protection in the US or maybe China because we'll say that China people are copying people's things. So, actually, China is taking advantage of the IP system by reproducing what other people are doing because they haven't protected it in their country. So, that is something that developing countries can also take advantage of but I think the awareness is low and so... I think I'm skipping some of the steps there but I think at the end of the day even if you feel like some information is missing please feel free to reach out.

Interviewer: please, my last question, once the protection has been filed, assuming this is something your research suggests it can be commercialised in Ghana. So, is this the point at which you're going to look for a collaborator to commercialise with?

Interviewee: yes please.

Interviewer: who is making that contact? Is it the IP, TTIPS or is it me the researcher?

Interviewee: so, actually, the researcher usually will provide a need based on information in the disclosure form, it will give us an idea of who the potential market is or who the potential businesses we can engage. Because, he is the one who created his own space so he has more information about how the space operates, so, with our support, we'll also do our own research, we'll gather information form the internet and based on that we might engage someone in an industry to also find out how the space is operating but normally the researcher would provide the means, but we work closely with them. So, the issue we have with the researchers is that, sometimes they get so excited about what they have done, so, it's like, with all respect, they just talk about what they have done and sometimes they disclose information that is sensitive. Sometimes in their excitement, it won't appear to them that what they're saying is very sensitive and you see, the issue is that we have so many problems, the researcher is not the only person who is trying to find a solution to that problem, maybe the person you're engaging, you're talking to, excited about your project is also doing the same thing. So, sometimes the little information you give him or her will make it complete. So, we try to talk to them about the need for us to put in place non-disclosure agreements with industry partners. So, please, take it as, if we file for IP in the IP office, they also have a number of processes that they also go through, so, the invention has to meet certain criteria, if it's the patent that you're looking forth to an invention, they have to search for a new one. So, even though you're looking for protection in Ghana, we're searching for novelty worldwide. Then the second step is that they have to demonstrate that whatever invention that has been created involves an inventive step. It should represent

sufficient improvement to what is already existing and the third criteria is that it should have an industry value. So sometimes, at the point that maybe the disclosure is made, the invention will not seem to have an industry capability but sometimes later on it becomes important. So, if the IP office, I mean, not us, the national IP office, if they are able to do all these tests and then they find out that the invention meets all the criteria then you'll be granted a patent. What is usually difficult to meet is the inventive step. So, normally when they do the search they'll give you a report, if your report has on it that the invention is inventive or they normally refer to it as non-obvious so if you find that on your search report then the probability that you'll get a patent is 100% because the novelty and industrial capability is easy for us at the University of Ghana to determine but the inventive study you actually need some kind of skill to do that and you also need special databases which we don't have access to.

Interviewer: please, TTIPS are you in contact with others like yourself in other universities or research centres?

Interviewee: yes please.

Interviewer: and how widespread is the kind of office you are across other centres in the country?

Interviewee: I would attempt an answer but if I can say, I think in terms of IP in Ghana, the University of Ghana has taken the lead. It's not because I work there but it's because I know what we've done. So, we actually developed our IP policy even before the national IP policy was finalised and approved. And, we are in touch with them, so there was actually a project that was led by MESTI, Ministry of Environment Science Technology and Innovation, that project was to support a number of universities to set up tech transfer offices. At that time, we had already set up ours. But if I can say, TTIPS is not a unit on its own, TTIPS is one of the operational teams under ORID. So, when MESTI started that project they gave us funding and through that we did a lot of programs that helped to enhance feasibility of the sector. So, we're in touch with the other people, we share knowledge, information and ideas and all that.

Interviewer: and to your memory these other people exist where?

Interviewee: they are in universities. So, Ghana Technology University College, they have a tech transfer office, GAEC Ghana Atomic Energy Commission, they have a tech transfer office, Kumasi Technical University has one and the 5th one is... I can't recall.

Interviewer: does TTIPS have a publication on its own? Do you have a publication that you use to maybe share research findings or the ORID news letters has your details too?

Interviewee: it's the ORID newsletters. Please it wasn't TTIPS who did that and another thing, publications, dissemination and translation.

Interviewer: I know, I just want to know whether there's a separate publication for only TTIPS

Interviewee: no, we used to have one but we stopped. It got to a point the work was just too much so we had to cancel.

Interviewer: what was it called?

Interviewee: it was called Innovation File. We're trying to revive it but it's not going that well. So, basically it was giving information about what intellectual property is, the types of intellectual property…

Interviewer: so, it was educating rather than announcing intellectual property rights we have secured.

Interviewee: yes, it was educating members of the university community about intellectual property. But please, earlier on you asked me something about getting the product onto the market. I don't know if I've addressed that.

Interviewer: I think so but go on. Say what you wanted to say.

Interviewee: so, that is a bit of a challenge we're having now. The challenge is that, some of the innovations or technologies or intellectual properties, please pardon me, we normally use those words interchangeably. Some of those innovations, normally they are still at the, if I can say, the research stage. Usually the inventor needs to come up with a proof of concept to demonstrate that what he's saying about his findings are actually true. But usually, they need some funding support to do the proof of concept and then maybe also move it to a prototype stage. Usually industry or a business would be willing to take this further if they can actually see the proof of concept because it can be that your research findings may not really work. So, they normally would want to see a proof of concept and those are usually at an early stage. Because sometimes, with the proof of concept, you also have to develop it further, it goes through a continuous development process before you can see the final product on the market. The challenge we have at the university is that we don't have a fund that helps these inventors to do a proof of concept. So, it's either you look for your own money to do it or we help you in terms of getting industry but industries are usually not willing to commit if there's no proof of concept. Some people have been lucky, they have been supported by family and friends. In some rare cases angel investors are able to do the proof of concept. You see, it's a big challenge to get a tech transfer at the University of Ghana. So, right now what we have done is, we have put up a proposal to establish an innovation fund, please the

innovative fund thing, at the moment it's just internal matters. So, that one is not public information but those are some of the things that we are trying to put in place to help to move these things to a stage where a business will have the confidence or a potential investor will have the confidence to invest his or her money into that technology. And then again, we should also understand that not all these technologies are successful. You may have the proof of concept and all that but sometimes the market is not ready for the technology. Sometimes it successfully gets onto the market but it fails because now technology is just evolving rapidly. So, even if you're able to get your product on the market, you have to be innovative. You need to be able to follow up with consumers for their feedback and all that to help to enhance your product. If you say that you have products on the market and you're doing well and you sleep, before you know it, you'll have been overtaken by somebody else. Because one thing is that when you apply for IP protection. The national IP office will make your information available on the public database, there are a lot of databases but usually the... all IP applications are fed onto that database for all countries. So, that information becomes public, it's public because they want to encourage people to be innovative. They also want to encourage people to avoid the reinvention of the will. So, use what has already been developed and you innovate around it so that all the time we have a lot of innovations, new and improved products on the market. Please, is it okay? So, the challenge that we have is that to address it, we are setting up innovation funds that will support because financial support is usually challenging but for technical support, normally the IP's we evaluate, student IP's and stuff for example are usually attached with faculty to help them to fine tune their ideas. So, with technical support, we get but with the faculty but financial support is a bit of a challenge. So, it's impeding with the technological setting at the University of Ghana. So, we hope when we establish the innovation fund it'll be addressed and another thing is, another initiative my office has taken is that we have developed another proposal for them to consider IP promotion. This is also internally within ORID, it hasn't gone out yet because we realised that if certain structural issues are not addressed at the university, it'll be very difficult. So, basically that is about it.

Interviewer: Wow, there are a lot of problems in Ghana.

Interviewee: yes, but we'll solve it. It's a step by step process. I think the understanding is also not really there. So, one of the things we've also decided to do is that for the field that we're part of, we want to showcase our researchers. This time not in the research magazine but maybe on our website. So that, when someone is doing something the person will want to talk to us. There are some information on the website that also helps, because usually when someone wants something about IP and stuff and he doesn't know the people to contact, the person goes to the website so, we want to make sure that the information on the website is very good information that will draw people to want to talk to us.

Interview 5

Interviewer: Good morning Dr. Misbawu, please can you tell us your full name and your role?

Interviewee: my full name is Misbawu Adam, I have a PhD in electrical engineering and I'm also a member of Ghana Institution of engineers. So, the whole title is, Engineer Dr. Misbawu Adam.

Interviewer: and you're also with the Kumasi Technical University

Interviewee: also, I'm a member of IEEE

Interviewer: Okay, we can now go into our questions. So, the first question I have is, what are the factors you think affect research and innovation uptake by innovators or how commercialization generally?

Interviewee: okay, first of all, I think it stands to do with funding when it comes to research, because in research you need to get a lot of things like logistics. As an educational institution like this, you need to get maybe machines, instruments, equipment that we will be able to use to undertake this kind of measurements. If there are, we're supposed to also perform experiments to come out with convincing results. So, sometimes you also need to get maybe real time simulation equipment and that is where the issues are because if you look elsewhere, you'll get all this equipment for research so that after the research you will be able to do much with whatever is going on in the industry. The real time simulation that we're talking about is more or less like prototypes of what is at the industry so if you're able to get those kinds of things it really helps but this is where we are now. It is a very big challenge.

Interviewer: so, in terms of that, if we make an assumption that all these things have been provided, what do you think will be needed for uptake?

Interviewee: oh okay, the industries also have to come in because as we sit here, if we don't go to the industries for us to know what problems they are having it'll be difficult for us to know what is going on there. So, even though we sometimes go in there because we take our students there to go and do attachments and the rest and they come and defend whatever they see in the industry. Sometimes we pick some of the issues there, then we give it to them as their project work, then we take it and see how best we can solve the problem. So, if the industries can also come to us and tell us that this is the challenge that we are facing and we need you to research it then I think we can take it up. I'm giving examples like in China for instance, I know for sure there are some automobile industries that may go to universities and fund them for them to undertake

some research on whatever vehicle they want to bring out. I remember, I just forgot the name of that company but one company in Singapore was sponsoring one of the universities like that, that's automotive engineering to come out with some research on things that they do so after that they were able to send it back to them for them to implement.

Interviewer: The next question I'll want to ask is that, infrastructure and facilities both soft and hard in KSTU and maybe the Ghana Institute of Engineers, are there opportunities for or systems setup for you to be able to communicate with friends?

Interviewee: Okay, communication about funding is mostly in publications, that is what we do, that is what we do in publications and sometimes conferences. That's where we get the chance of communicating our findings. Through publication, through journals and also conference proceedings.

Interviewer: Are there resources available to attend the number of conferences you want?

Interviewee: with this institution there are resources available but I don't know because this one too you can take it out.

Interviewer: so, the main infrastructure available or opportunities are through publications and conferences. What is your take in terms of the gap that exists between industry and researcher's, do you think there's a gap and why does that gap exist?

Interviewee: yes, there's a gap because as I said earlier, some of the things that industries need and the things that we researched on here. Sometimes it's difficult because we don't have that logistics which are prototypes of what is happening in the industry. It's very difficult to get the real time issues that are going on in the industry. That is the issue, because if the industries can also come in, at least those things that we use to teach our students, if they can get us a prototype of those machines or those equipment's that we use here, those machines that we use, I think it'll be easier for us to undertake or to bridge those gaps.

Interviewer: so, it's kind of the equipment needed for the level the industry is at is not available yet so you're not able to do a match so there's always a kind of gap between what you know and what they're doing.

Interviewee: so sometimes if even you send students there, they have to go and take a lot of time to train them again but if there's this kind of bridge between us and them, you can just get the student, the moment he gets out, just that maybe some orientation and he's fit to take up.

Interviewer: We visited Imperial College some time ago and one of the things we found was that their chemistry lab was constructed by chemistry manufacturers. So, they have all the latest equipment in one lab, so it helps the students to be at the forefront of the latest research but here we have that gap.

Interviewee: we have that gap and you see, elsewhere, if you want to embark on this kind of research and the rest and it's for a particular industry or institution, some of these things they can even purchase it for you for you to use them so that the moment you finish it'll just fit into what they have.

Interviewer: So that means that, there are significant communication gaps and capability gaps between the industry and us. So, in that situation, how can we break it?

Interviewee: to bridge it, I think it has to go both ways. One, we the researchers approach the industry with whatever we have and the willingness for the industry to also support us and the second one too, the industry also coming out with some of their challenges and also providing funding for us to take up these researches. Then I think if we're able to do that, that's basically to work together, I think that one we'll be able to bridge.

Interviewer: so, more like industry research engagement sections.

Interviewee: yes, that's it. So, they have an issue, they see us with it. These are some of the issues that we have but I think there's one company that came here. He's dealing with this kind of... even though because its with mechanical... that's why, so they need some kind of dryer, he went and bought some but the rate at which the dryer works is not that good for him and even the distance that he wants to reach, so he came to us here and I think some of the lecturers in the mechanical department were selected to go and assess the thing so that they can see how best they can help him with that. Something like that I think if it happens, I think it'll help. So, with that, if we're able to provide this kind of service to them, we research and we provide the service to them. We can equally get some of our students to go and mind those kinds of things for them and you'll see, we'll be having a working relationship all the time.

Interviewer: this is very insightful. So, clearly, you're suggesting that the communication can positively influence that relationship if it's constant communication.

Interviewee: and it's also you see, the willingness of the industries, you know, sometimes you may go there and there are a whole lot of challenges. For instance, if you come out with something and you want to even experiment and since you don't have the equipment here and you go to industries, they're afraid to even give you the chance to experiment some of the things there and sometimes you cannot blame them because I have some experience here, even within, some of these things maybe you can... to

promote our research, I think there's one thing we can do, even though apart from the published work that we do, I think we can be able to create our own website. If lecturers or researchers are able to create their own website and they can advertise whatever they are bringing out, I think that one too... and I think there are a whole lot of things that we can do using the internet. In the form of advertisements also, if we pay for advertisements like what is happening on our phones, maybe you'll be watching YouTube and it'll just stop and a video will come. So perhaps if we pay for those advertisements, social media, so these things can also help to market whatever we have as researchers.

Interviewer: And then the last one I'm going to talk about is, do you feel competent enough to engage in these things you listed above? Social media, marketing, the website, developing policy briefs, running engagement forums with industries, do you feel competent enough or you think that training in that area will help especially as scientists?

Interviewee: yeah, you see, when it comes to those areas, I think it's some area specialisation for some people. So, if maybe here, at least we have an ICT department so if the ICT department can take up these things it doesn't necessarily mean the researcher will do all these things. We can have dedicated people for this social media thing so when you're done you can just submit whatever you have to them and they'll just upload it into the system for you.

Interviewer: so, if I get it right, it is specialised so research communications people are those who should take it and make it?

Interviewee: yeah, something like that because not all of us will even have, imagine, even the time to go on social media to do all these things but at least if you have an office or an officer somewhere who is undertaken these kinds of things, once you finish you just pass it on and the person will be doing that one too.

Interviewer: Do you have anything for me? I'm done.

Interviewee: Okay, basically you've asked almost everything.

Interview 6

Interviewer: if you can introduce yourself and where you work and what type of engineering you specialise in.

Interviewee: alright, I'm Samson Kofi Kyei, currently affiliated to the chemical engineering department of Kumasi Technical University. Professionally, I am an industrial chemist and I've been admitted into the institution of engineers (IET) that's for the past 5 years or so, I do conduct research in environmental monitoring and also industrial chemistry, I specialise in polymers and how to use waste stuff or convert waste stuff to wealth. So that is what I do for now.

Interviewer: you specialise in polymer, right?

Interviewee: yes please.

Interviewer: So, the first question is on what factors you think influence research uptake? When researchers like you, particularly those in the scientific community engage in research, what are some of the things that limit or improve uptake of your findings?

Interviewee: alright, I will take it from this point of view. Normally, you'll get to the field, you'll collect data, but scientists, we normally are in the lab, you conduct your experiments, you get your data, you have actually been able to confirm the authenticity of what you've actually collected or come out with. I think the main challenge I see as far as this particular aspect of your interaction with me is concerned is that the people out there sometimes don't even appreciate the relevance of your research. What you're trying to communicate, how relevant it is to them because most of them may not even understand the language you are speaking. Even if you talk about industry, how many of the industry drivers, the people who are experts in those areas, how many of them may even understand the details of what you're communicating? And even sometimes I think they don't even know where to assess that information. You have your findings that's okay, you claim or you think you've come out with something which is accepted by the scientific community but the industry, how are they going to assess that information? They don't even know and I think apart from the fact that some of them don't appreciate the relevance of the research, some of them, they don't even trust you being an African, a colleague Ghanaian, you have come out with something and some of the comments they make, they kind of don't have any kind of trust in the work you've

done. So, I think these are some things I think if addressed will go a long way to help us resolve that challenge.

Interviewer: But on the issue of trust, where does this problem come from?

Interviewee: yeah, I'm saying that because we have facilities in our institution where we do our work. You've done your work, even there are certain times you may even have to rely on some other institutions to get your data. For example, you want to run some analysis and you don't have the facilities in your lab. you either go to Ghana Standards authority or probably you're going to any of these institutions where they have the facilities. You run, you get the results sometimes you interact with them, "how were these results attained?" Okay, I didn't have this, I had to come to this particular institution for this kind of analysis, "okay so what do you think, can you be so sure of the results?" And because you tell them that you didn't do that aspect yourself because of lack of facility over there in that particular area, they begin to doubt sometimes the authenticity of your findings. That's why I see sometimes trust becomes a challenge.

Interviewer: okay, so if you had your own thing and you could monitor the whole process yourself that could have helped the process.

Interviewee: Absolutely, I quite remember when I was doing my PhD some years ago, I had to come to UG, your institution. I was doing some work and I wanted to know more about scanning electro micro, what we call SIM, so I came to one of the.. I think the geology department or so, I've forgotten and I had to come back to Kumasi because the lady told me that she was so busy and she wouldn't be available to stay in the lab with me to run the analysis. So, I came to Kumasi, I think after a few weeks or so I had to come back then she gave me the results. This one, fine, she has done it, personally I know that the work was not done in my presence. Although the results are there, how are you sure that it is the results of the sample you sent over there? Because she had so many other samples she was working on. So, these are some of the challenges I think sometimes I share in their view when they talk about trust. That's why I had to see it as a challenge.

Interviewer: I think I can also imagine. The next question I want to ask is on infrastructure or opportunities for you to communicate your findings. so, are there opportunities within your institution or within the Ghana Institution of Engineers or any network that you belong to, are there opportunities or infrastructure systems in place that enable you to communicate your findings?

Interviewee: my response to this question wouldn't be a yes. Even if I say yes, I may have to explain. For this institution of engineers, ever since I joined, there hasn't been anything like even a conference where researchers could come and show their research by way of poster presentation you know, or kind of you're given 20 minutes to present so that the people could kind of critique what you've come out with. Number 2, in my own institution, I think it was this year I was privileged to join the conference that was held by the coalition of the vice chancellors of the technical universities in Ghana and I was privileged to present one of my papers there, my research work there. So, I'm of the view that since these conferences are not held on a frequent basis it's a kind of challenge. I'll be very happy because we're researchers in the university and once you're able to project or disseminate what you're finding, it's even a way of learning yourself. Number 2, it even opens ways or avenues for collaboration. For all you know there could be a researcher there who's interested in your work. You could rub your heads together and see how best you can take the work you've done to another level based on the interest he has as well. So, if these conferences or forums are held on a regular basis, I'm very sure it'll actually help us a great deal. Institutionally too, we are yet to come out with something like a journal where we'll have it at the libraries in the regions or any of the other institutions of higher learning so that people can even know our works and appreciate them and even if possible come out with some options as to how we can collaborate or improve on the work we're doing. So, that's why I said even if I say yes, I would have to explain.

Interviewer: so, basically there's limited opportunities for researchers to communicate even through conferences and journal publications?

Interviewee: and even this journal publications you've touched on one other point. Journal publications, that's fine. Some people don't even know where to access the

journals. Even if it's not an open access journal, sometimes accessing the details of the work becomes a challenge and you know now if you want to publish an open access journal like this MDPI and others that are open access, it comes with a huge article processing charges where even sometimes your book and research allowance can not even pay for.

Interviewer: Okay, let's go to the third question. The third question is the gap between innovators and researchers. When researchers engage in their research, the industry people who uptake the research, apart from the issue of trust and communication gaps, what other gaps exist between the industry and researchers?

Interviewee: Okay, many times quite apart from the communication gap, I also touch on one other point that is quite related. That is, collaboration, the industry drivers sometimes are not ready to collaborate so there's no collaboration between the researchers and industry. By the way let's come over and say "okay this is a particular finding, we've already gotten the details so going forward what do we do? Okay we're going to put you guys on projects in the next 5 years there's going to be an MOU, your master students or probably senior researchers could work on this project so that together in the next 5 years we can see how best your inputs can bring progress or development as far as our products here is concerned". So, it's another gap I think as and when addressed will help a great deal.

Interviewer: The fourth one I want to ask about is whether if this collaboration is established or if these communication gaps were bridged, are you of the opinion that it can help to increase commercialization of your knowledge?

Interviewee: yes, I quite remember I worked on a project some time ago, I know one of the main challenges confronting the oil field workers is corrosion. So, I managed to come out with a natural product which is waste, a waste product of course that could be chemically modified and applied as an anticorrosive agent and I know that once I'm able to get an opportunity to collaborate with let's say GNPC and they're ready to invest because they spend huge sums of money to address the issue of corrosion and even sometimes there are some in oil field constructions. So, if I get that opportunity, I bring

my proposal on board then we come out with how we can get this thing commercialised so that we'll even spend less because comparatively, I'm talking about a waste natural product like onion skin, like cocoa pod, the husk, like peanut skin, like orange mesocarp, these are just waste so we could turn them into wealth. So, I'm very sure when the opportunity comes, why not? Because we've already prepared the product, we've of course tried the product and it has worked for us. So, we need money so that it can go into commercialization. Then we went together. So, I think we are ready, we have the men there to rally behind them so that together they'll be able to address that challenge but with a small percentage of what they've been investing all this while.

Interviewer: so, why haven't you been able to communicate with for instance GNPC?

Interviewee: yes, I quite remember there's this thing I'm doing now. At the moment I'm trying to come out with a proposal, it occurred to me some time ago and I understand GNPC, as and when you send proposals, sometimes they'll consider but I don't know, somebody told me that sometimes it's politics so I'm yet to drop my proposal. So, when I drop my proposal and it goes through then I'm sure it'll become a deal then we'll take it from there.

Interviewer: Have you considered doing a policy brief or a practitioner brief of the research to them or doing a workshop for them or a seminar or a media briefing on your findings for instance?

Interviewee: I think that's a very good option. We have a team working on the proposal, I think all these factors will have to be considered. In fact, at the moment we've published some of these works and as I said earlier even sometimes industries don't appreciate what you've published unless you meet them as you're suggesting. So, it's a good idea which if considered I'm sure will boost our chances of getting this dream realised.

Interviewer: One of the things I've realised is that sometimes if you go to them they can push back from you but if you put it out there that a Ghanaian researcher has come out with this and that, everybody wants to be part of the success and then you see them

rushing to come to you. So, what opportunities exist for you to promote your research within your institution or your affiliations?

Interviewee: Okay, our institution here, the only opportunity we have is the conferences we have here. I think next year we're going to host one of the conferences here and the organising committee have called for abstracts to be sent. So, once an abstract and it's accepted, the researchers are asked to come and present it. I think the last time we did a similar one was in 2020, I was privileged to present one of my works over there. So, next year too we're considering giving it another try and there's this kind of journal publications and sometimes they advertise or kind of publish your papers on their websites for people who visit the website to see some of the things we're doing. So, basically that is the opportunities we have here at KSTU.

Interviewer: The last one is, do you as a researcher feel capable of being able to organise workshops for industry players?

Interviewee: yes, once I have my research team, we'll plan, because we've been presenting papers at conferences and I think currently, we don't have much experience but currently as I'm sitting here, I'm part of the team that is organising the next conference that will be held early next year. So, with that experience, I'm sure going forward I should be able to organise these workshops or something like that to help us communicate some of our findings to industry players.

Interviewer: So, if for instance my team wanted to organise maybe research communication or held a research communication workshop whether virtually or physically, it's something you'll be interested in attending?

Interviewee: Sure.

Interview 7

Interviewer: So, with the factors that affect research uptake by industry, the first is financial constraints.

Interviewee: With this, even though research findings or designs are innovative and beneficial to industry, its production or implementation proves to be capital intensive and this is common in the context of small and medium scale industries. And so, without the needed financial support they are unable to latch onto these recommendations made by the researchers. Again, some designs need a considerable amount of both time and money for production to become viable before it generates some profit. Clearly, research of such character would be unattractive to major industries who are risk averse and need profit within the shortest possible time. Another factor is the fact that research is normally generic. So, research output is not tailored to meet specific needs of industry. Research is normally undertaken with assumptions and considerations which do not necessarily fit the peculiar need of the industry and so issues arise when it comes to integration of such findings or recommendations into existing methods or systems within the industry. The next is, the inadequate evaluation of research by research institutes. So, academia sometimes lacks resources to develop, evaluate and implement research hence their output can be validated only as far as their miniature prototypes and demonstrators can provide and this may not be sufficient. So, industry players may tend not to trust the research output. Finally, the lack of awareness. Some industry players are unaware of the findings and the research output by the researchers. Some are aware but do not understand how these outputs can translate into profitability and there are also inadequate platforms or database systems that provide industries with the avenue to pursue these findings and make sense out of them for themselves.

Interviewer: The second question, what infrastructure or opportunities are available to researchers to communicate their findings for uptake?

Interviewee: With this, institutions like the Ghana Institute of Engineering and the Institution of Electrical and Electronic engineering (IEEE) provide platforms for academia to present their findings or their research outputs to industry. Again, IEEE has a database system which contains peer reviewed research papers for all interested parties to peruse. Also, at the departmental level at the universities, there are some visits and some collaborations that go into sharing of ideas and researchers often use this platform to present some of their outputs. At GCTU, the office of research services and

innovation offers support to faculty in administration of research projects and also links with industries.

Interviewer: What opportunities exist for you to promote your research findings?

Interviewee: Various seminars, workshops and conferences that are organised by the bodies such as the Ghana Institution of Engineering and being able to publish in peer review journals. Various peer review journals, the department organising seminars, conferences for us researchers to share our research findings to selected industry players and then the office of research services and innovation at GCTU also providing the needed support and the links with the industry players and people who matter, people who want to engage me in terms of my research findings and then media houses.

Interviewer: Number 4, do you think research communication can influence uptake by industry?

Interviewee: Research communication will be able to influence the uptake of research by industry. As, it will tackle the issues of the lack of awareness and misunderstanding of research output of the researcher as I intimated earlier. Breaking down complex findings into content that can be readily and easily assimilated by industry players will positively influence its uptake so yes.

Interviewer: Do you feel capable of promoting the findings yourself?

Interviewee: Yes, I am capable. As an academic, I am not just supposed to do research, I am supposed to teach, to create the knowledge and then impact the knowledge and so I am capable of doing that.

Useful links

https://www.ug.edu.gh/ugtechonline/

https://coeic.knust.edu.gh/makerspace

https://www.makerspace.ug.edu.gh/

https://kumasihive.com/

https://accra.impacthub.net/

https://www.ghanatechlab.com/