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Open Innovation and Innovation Intermediaries in Sub-Saharan Africa

Bertha Vallejo [1,2,3,*], Banji Oyelaran-Oyeyinka [4], Nicholas Ozor [5] and Maurice Bolo [6]

1 Tilburg School of Economics and Management, Tilburg University, 5000 LE Tilburg, The Netherlands
2 UNU-MERIT, 6211 AX Maastricht, The Netherlands
3 Social Studies Department, El Colegio de la Frontera Norte, 22560 Tijuana, Mexico
4 African Development Bank, 01 BP 1387 Abidjan 01, Cote D'Ivoire; banjioyeyinka@gmail.com
5 African Technology Policy Studies Network, 00100 Nairobi, Kenya; nozor@atpsnet.org
6 The Scinnovent Centre, 00100 Nairobi, Kenya; bolo@scinnovent.org
* Correspondence: bvallejo@tilburguniversity.edu or vallejo@merit.unu.edu

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Abstract: This study explores the innovation intermediaries' landscape in sub-Saharan Africa, considering Science Granting Councils (SGCs) as the key intermediaries in the system. Based on extensive desk research, personal interviews, and an online survey, the study discusses the roles and functions performed by SGCs as intermediators and influences of science, technology, and innovation (STI) policy. The results of the analysis corroborate the need for institutional and systemic changes to enable SGCs to perform their role. The realities, resources, and constraints at the local level cry out for the adaptation of current and future partnerships to the local context. The study concludes that only by tailoring partnerships to the development of capacity at the local level can SGCs perform effectively as influencers of national STI policy and mediators of partnerships with foreign development actors.

Keywords: Innovation policy; innovation intermediaries; science-technology and innovation (STI); open innovation; public-private partnerships in research and innovation (PPPs in RI); Science Granting Councils (SGCs); sub-Saharan Africa

JEL Classification: O19; O29; O32; O38; O39; O55

1. Introduction

This study analyzes the need for systemic change in relation to innovation intermediaries and policy influencers in developing economies. By analyzing the current landscape of innovation intermediaries in sub-Saharan Africa, the study identifies those factors enhancing or preventing knowledge flows through science, technology, and innovation (STI) policy instruments.

The existing literature on open innovation, knowledge management, and innovation intermediaries is mostly based on studies of firms in developed or emerging economies [1–5]. This study presents the STI landscape from the perspective of the United Nations Sustainable Development Goals (SDGs) in sub-Saharan Africa, changing the widely adopted perspective from firms as the unit of analysis, to policy influencers, such as the Science Granting Councils (SGCs). This is particularly relevant in contexts where the private sector is mostly formed by small and medium-sized enterprises (SMEs) concerned with survival, not how to innovate [6,7]. By presenting the case of sub-Saharan Africa, this research increases recognition of landscapes where systems work and are being developed, despite being based on dysfunctions and scarce resources.

Framed within three streams of literature, namely, the literature on innovation intermediaries, open innovation, and STI policy tools, this article presents the relevance of innovation intermediaries in

sub-Saharan Africa in managing open innovation through the brokering of public-private partnerships in research and innovation (PPPs in RI) as an instrument to address the societal challenges identified in the SGCs and to generate broader economic and societal benefits from joint public and private knowledge and economic investments. Addressing the SDGs requires not only a fundamental change in current production and consumption patterns, but, most importantly, a structural change in the way innovation and growth are perceived and designed [8–10]. There is a strong need for transformation-oriented innovation policies focusing on the transformation, and new modes of operation, of entire systems of innovation, production, and consumption [10] (pp. 1037–1038). Therefore, underlying this research is the need for SGCs (as policy influencers) to understand the SDGs as open-ended goals that concern the system as a whole—and not as individual targets—which should be achieved through the systematic linkages between them [11,12]. This paradigm shift in our way of understanding the SDGs embraces the need to transform existing socio-technical systems in more sustainable directions [12]; to create spaces for new innovation actors to emerge [11,12]; and, consequently, to influence STI policy towards new and responsible research and innovation pathways [9]. In other words, understanding economic growth (driven by innovation) as a mean to achieve sustainable development and not as a goal in itself.

The role of innovation in development is substantially supported by the capability building, learning, and innovation literature [13–16]. The innovation systems' framework considers innovation as a continuous process of interactive learning that improves the competencies of system actors so that socio-economic benefits for society can be created from knowledge [13–16]. Innovation theory is a framework based on the realization that social impact is achieved not as a result of the mere diffusion of knowledge and innovation organized by the market, but due to interactive learning among actors that gives rise to collective action. Therefore, institutions and commonly-shared social and cultural values are considered key drivers of innovation [17], while the opposite is true for diverging values and dysfunctional institutions.

The complex intra- and inter-firm business environment brought about by globalization—and by the increasing pressure over the environment—adds the requirement for new innovation directions and combinations of STI policies in accordance with the multicultural and multidisciplinary atmosphere in which firms operate. As firms are the main driving force behind technological change, research and development (R&D), and innovation activities [18], different roles and ways of interacting and collaborating among system actors are needed. Therefore, analysis of the nodes and links in the innovation process associated with the increased levels of collaboration and outsourcing brought about by globalization has become relevant in understanding the complexity of tasks (and roles) of actors within the innovation process [19]. This article explores the status of these nodes and linkages in SGCs in sub-Saharan Africa and other knowledge actors in the system in order to present the STI landscape of the region.

Under today's pressing and rapidly-changing market, environmental, and socio-economic conditions, the collaboration between scientific, industrial, and civil society sectors is increasing. It is now recognized that STI enhances a country's innovative capability and increases the efficiency of production routines and systems [20]. Motivated by the global economic crisis, STI policies have started to shift towards not only promoting cooperation and linkages between science centers and industry, but also enhancing PPPs focused on research application and implementation, in order to address market and coordination failures. Since then, PPPs in STI have become a key element in the mix of tools deployed in the research and innovation policies of many countries around the world. In the last decade, a surge of new innovation actors have emerged and PPPs in RI are one example of the emerging dynamics [11].

The next section presents the conceptual framework of the study, focusing on the role of STI organizations as innovation intermediaries; knowledge management in open innovation; and PPPs in RI and their relevance in STI policy, before introducing the SGCs in sub-Saharan Africa (Section 2). This is followed by the methodology section, which describes how the analysis was conducted

(Section 3). The main results of the analysis in the sub-Saharan Africa context are then presented (Section 4). Section 5 discusses the findings and Section 6 presents the conclusions of the study. Finally, Section 7 outlines the managerial and policy implications of the study.

2. Conceptual Framework

2.1. STI Organizations as Innovation Intermediaries

The innovation systems perspective not only draws attention to the dynamics at play in 'producing' an innovation or solution (among different actors), but also highlights the forces at work in its adaptation, adoption, and embedding in local settings to generate societal impact. In this regard, the centrality of STI as a driver of development has long been recognized in the academic and policy literature [21,22]. As firms find it difficult to generate all relevant knowledge by themselves, networking with STI organizations to pursue knowledge and know-how has become critical for keeping up in a changing market environment [21,22]. Under these circumstances, authors, such as Edler and Yeow [23], OECD [24,25], and Stewart and Hyysalo [26], recognize the role of STI organizations as key innovation intermediaries.

The variety of innovation intermediaries, their roles, and their organizational modes have been explored by authors, such as Bessant and Rush [27], Howells [28], and Landry et al. [29], among others. Although different authors have coined different terms for them, from bridges [27], consultants, and brokers [30] to technology centers and public science-based or research organizations [31–34], this research adopts the term 'innovation intermediaries' to describe the entire range of organizations that play this role. Adopting Howells' [28] definition, this study understands an innovation intermediary to be:

> *[a]n organization or body that acts [as] an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between, [for] bodies or organizations that are already collaborating; and helping find advice, funding, and support for the innovation outcomes of such collaborations* [28] (p. 720).

Innovation intermediaries are organizations that favor association and add dynamism to the STI system. As linkages between the scientific and industrial sectors, they are fundamental in the innovation systems of a nation [16].

Howells [28] classifies innovation intermediaries into four groups, namely, (i) diffusion and technology transfer; (ii) innovation management; (iii) innovation systems and knowledge networks; and (iv) intermediation as a service. He identifies five key functions or roles as the base of his taxonomy, namely: Scanning and information processing, knowledge processing, gatekeeping and brokering, testing and validation, and commercialization [28]. Other authors, such as Stadtler and Probst [30], classify intermediaries as either conveners (connecting different stakeholders); mediators (influencing the interaction between partners); or learning catalysts (helping partners to learn). Others identify the systemic objectives of intermediaries as either knowledge or business oriented. Some of the activities performed by intermediaries in pursuit of these goals are the stimulation and organization of relevant stakeholder participation, the stimulation of interaction among the actors in the innovation system, and the acquisition of financial, physical, and knowledge infrastructure [35].

Table 1 sets out the main roles of innovation intermediaries complemented by type, functions, and activities [28]. Although many of the activities, functions, and types are interchangeable among the columns, they are only presented once to avoid repetition.

Table 1. Classification of main roles performed by innovation intermediaries.

Role	Type	Functions	Activities/Processes
Diffusion of knowledge and technology transfer	Convener	Foresight, forecasting, and technology road mapping	STI information scanning and dissemination
		Scanning and information processing	Supporting STI adoption decision making
		Technology foresight and forecasting	Evaluating technology once in the market
		Articulation of STI needs and requirements	Identifying (potential) partners
			Supporting technology transfer
			Selecting (potential) suppliers
			Technology exploitation
			Formalizing informal collaboration through contractual and licensing arrangements
			Specialist negotiation and contractual skills in knowledge processes
Innovation management	Mediator	Promotion of linkages/bridging ties	Knowledge repository
	Adviser	Gatekeeping and brokering	Providing solutions through combinations of existing ideas to clients
		Facilitators in the process of knowledge and technology transfer	Articulation and diagnostics
			Contracts and negotiations
System and networks	Influencer of STI system	Promotion of linkages within technological systems	Building linkages with external knowledge providers
	Learning catalyst	Promotion of linkages between the policy and operational levels	Regulation and arbitration
		Knowledge processing	Intellectual property (advice, management)
Intermediation	Mediator	Testing and validation	Developing and implementing business and innovation strategies
	Learning catalyst	Commercialization	Accreditation
			Commercialization
			Evaluation of outcomes

Source: Prepared by the authors with adaptations from [28,31,35].

2.2. Knowledge Management in Open Innovation

The taxonomy presented in Table 1 shows the variety of sources from which innovation intermediation is approached. The research conducted by Howells [28] is a pillar work in classifying intermediaries and their role in innovation and technological change. However, it does not address the

implementation of open innovation by innovation intermediaries, nor the managerial challenges that firms face when working with innovation intermediaries.

As highlighted by Nonaka [36], a critical aspect of knowledge creation and innovation is problem formulation. The adoption of proper organizational and managerial practices, particularly knowledge management practices, is crucial to enable firms to explicitly identify and formulate their problems and, consequently, to be able to embrace open innovation [4].

In this study, we understand open innovation as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for [the] external use of innovation, respectively [37]". The adoption of suitable knowledge management practices in the firm are of the utmost relevance to embrace the open innovation paradigm [4]. The literature identifies three main processes through which firms establish these practices, namely, inbound, outbound, and coupled [4,38]. Inbound processes refer to those in which knowledge flows from external sources towards the firm. Outbound refers to flows of internally developed knowledge towards external entities. Coupled processes are those combining inbound and outbound mechanisms. These three archetypes make use of different mechanisms to bring knowledge to the firm. Table 2 presents some examples of mechanisms adopted by firms under each of these three archetypes.

Table 2. Open innovation archetypes and their mechanisms.

Inbound	Outbound	Coupled
Patent acquisition	Commercializing internally developed technologies	Alliances and collaborations
In-licensing	Out-licensing	R&D joint ventures
Buying intellectual property	Selling intellectual property	Research consortia or networks
Crowd-sourcing	Acquisition of technology-based firms	Assigning people to support outside developers to obtain critical assets
Spin-in of external firms	Spin-off of internal technologies	
Early supplier integration		

Source: Elaborated by the authors based on [4,38].

The implementation of knowledge management practices in firms is a recognized pre-condition to internalize the opportunities provided by external knowledge and to integrate it into the internal knowledge base [4,5].

According to Sieg et al. [5], when firms decide to work with an innovation intermediary, at least three common managerial challenges are faced in the search to receive support that will facilitate the internalization of external knowledge. First, internal scientists are reluctant to modify their established working practices and to share an explicit and structured statement of the problems they face with external agents [5]. Second, firms have difficulty selecting the correct problems that required support from outsiders and that could be revealed to agents outside the firm [5]. Third, the formulation of a problem statement is not an easy task for many firms, which should be clear enough to enable the intermediaries to relate it to similar problems and past solutions [5].

Another important element in the adoption of open innovation in a firm is the origin of the external knowledge. The literature identifies different sources, which range from science-based partners to value chain partners and technology service providers [1]. Different sorts of partners bring firms a wider variety of resources for innovation [1]. The two main sources of external knowledge providers are universities and research institutes (science-based actors) and customers and suppliers (market-based actors). These sources of external knowledge bring about positive effects on a firm's innovation performance [1,39]. However, according to Chen et al. [1], collaboration with value chain partners has the strongest effect on innovation performance, more than collaboration with universities or technology service providers. Therefore, innovation intermediaries should be able to advise firms on creating an adequate mix of partners that allows a complementary effect between internal and external knowledge activities [1].

2.3. The Global Need for Transformation

Around the world, governments have realized that they cannot mobilize sufficient resources and capabilities for the attainment of the SDGs on their own. The governance challenge of going back to traditional innovation approaches is highlighted by Kuhlmann and Rip [11], who remark that societal challenges are part of the overall societal development, requiring new innovation actors and dynamics favoring transformation, and not just reformulating priorities settings or addressing the SDGs as individual targets [12].

This need for fundamental change or transformation is called for by authors, like Schot and Steinmueller [12] and Schot, Boni, Ramirez, and Steward [8], who highlight the need for transformative innovation policy as a key success factor in "overcoming the implementation failure of ambitious challenge-driven policy ambitions" (p. 2). Transformative change requires a focus on socially and environmentally sustainable innovations, requiring new forms of organizational change, business models, and collaborative arrangements [12]. They require the acknowledgement that innovation-market economy entanglement could be unsustainable and economic growth should remain a mean and not a goal in seeking sustainable development.

This leads to a new phenomenon whereby different kinds of non-governmental economic actors, ranging from civil society organizations, social enterprises, start-ups, firms, and multinationals, are aligning their strategies to create transformative social innovation through partnerships. The success of these partnerships depends on how they meld with, alter, or even replace existing consumption, production, and innovation trends [10].

2.4. Public-Private Partnerships in Research and Innovation

Collaborations or associations between the public and the private sector on infrastructure and development can be traced back as far as the 18th century [40]. However, in the mid-1970s, the adoption of such arrangements became more common, with public sector firms seeking to promote the development of road infrastructure, as well as health, prisons, water, and sanitation services, and so forth. PPPs complemented the limited available public budget with alternative sources of (private) capital, external knowledge and skills, and risk sharing. By the late 1970s, Europe, Australia, and the USA had already adopted PPPs, in the form of research partnerships, as common practice in the financing of development projects. This type of partnership became an STI policy tool involving universities, research centers, government agencies, and private firms. Research partnerships are defined as "an innovation-based relationship that involves, at least partly, a significant effort in R&D [41] (pp. 567–568)".

In an advanced industrial economy, like the USA, research partnerships helped firms gain technological leadership by improving technology-driven competitiveness. To achieve this aim, the US government has invested considerably in the establishment of institutional structures to facilitate technology transfer between universities and industries [42,43]. Within the European Union, countries promoted research partnerships in the 1980s with the adoption of the first Framework Programmes. These Programmes are policy tools that foster research coordination across the European Union, but, more importantly, they are financial tools that support the competitive capacity of the member states [44]. Through Framework Programmes, the public research organization structures of the European Union are modernizing, avoiding duplication, and limiting intra-community competition. In the South, as a regional bloc, the literature on latecomer firms identifies several case studies, especially from the 1990s, of firms updating their capabilities, not only through informal arrangements, but through formal contractual arrangements, such as research joint ventures [45], cross-licensing, research agreements, direct investment, customer-supplier relationships, R&D contracts, licensing and outsourcing, and other types of research partnership [41].

As globalization increased, non-market coordination and the integration of the national market into more complex systems, such as global value chains, required the adoption of policy instruments that facilitate the management of different interfaces and coordination mechanisms, as well as

dealing with market and system failures [46,47]. Examples of market and system failures include: (i) The absence of key systemic actors and lack, or poor availability, of appropriate capabilities or competences to face technological change; (ii) technological locking hampering the development of new technologies [48,49]; (iii) weak interaction among agents in the system; (iv) inadequate habits and practices for innovation to occur [50,51]; and (v) insufficient infrastructure for innovation, i.e., financial, scientific, and physical [6,52].

As a result, and promoted by the OECD [25,53] and the European Commission through Horizon 2020 [44,54], PPPs in RI have become a recurrent collaboration paradigm between private, public, and civil society organizations. They are a tool of innovation programs in key areas of national STI and growth policies [55], and have become the partnership paradigm of today, particularly in the North.

The inclusion of PPPs in RI in innovation policy has dominated STI policy trends in the last two decades. Increasingly, PPPs in RI are seen as a tool to foster the generation and exploitation of innovation activities, as well as to promote technology transfer from the policy sphere and facilitate innovation-related infrastructure [55].

PPPs in RI are defined as modes of cooperation between publicly-funded research organizations and private firms, characterized by a long-term institutional and strategic formal arrangement in order to achieve complementary goals by jointly operating research activities [56], sharing financial risk, and exploiting research results [57]. They are a top-down STI policy instrument, promoting knowledge generation and entrepreneurial innovation activity within a system of innovation through the coordination of private and public actors [35,58]. PPPs in RI target the changing nature of innovation in order to address societal challenges, such as those identified by the SDGs and the European Commission. This is a key feature that distinguishes them from research partnerships and partnerships for development.

Another characteristic of PPPS in RI is that they not only target pre-market research, but also involve joint-investment in technological infrastructure, the development of human resources, and the development and commercialization of activities [25,53]. Features of successful PPPs in RI identified in the literature are: (i) Geographic and social proximity between stakeholders; (ii) medium- to long-term collaboration arrangements; and (iii) legally-regulated contractual agreements [59,60]. Challenges hampering the successful implementation of this type of partnership include partners' limited experience in cross-sectoral, multi-disciplinary collaboration, poor governance, and complex settings [61].

2.5. Science Granting Councils in Sub-Saharan Africa

Although most studies in the literature focus on universities and their linkages to the private sector [62,63], very few address national research ministries, councils, SGCs, and public technology centers as innovation intermediaries [27,31,64], even though they are recognized as key actors in influencing the policy landscape governing national innovation systems. With regard to technology centers, studies tend to focus more on their intermediation functions and their organizational profiles and less on their research strategies and linkages with the private sector [27]. Along this line, Stezano [31], in his analysis of four public technology centers as innovation intermediaries, classified them according to: (i) Their market orientation adjusted to clients' STI needs, which ranged from basic science approaches more in line with the needs of small and medium-sized enterprises (SMEs) to formal R&D targeting larger firms; (ii) the type of STI service provided (i.e., exploration, technical validation, or commercialization); (iii) the type of firm with whom the interactions took place; and (iv) the price-setting of the STI services provided.

Studies on SGCs or equivalent actors present the need for such organizations to act as intermediaries and to connect other actors in the innovation system. The study of the Dutch Research Council by Van der Meulen and Rip [64] presents an illustration of the intermediary role of SGCs in influencing policy. What is clear from the empirical literature is that the extent to which science and industry are linked, and the role that innovation intermediaries play in strengthening this network,

is associated with the development strategy of the State and the type of interactions taking place among the STI actors. The role or function of the innovation intermediaries is primarily to act as connectors between the policy and operational levels, influencing other actors in the innovation system [64]. The organizational management of STI organizations as innovation intermediaries is defined in the literature according to their impact, via the scientific production of primary and executive research, interpretation and analysis, human resources training, business, and consultancy contacts, or collaboration with other knowledge sectors [31,65,66]. They also play an important role in connecting societal challenges with the relevant policy and regulatory frameworks by identifying operational and research needs.

In adopting the 10-year Science, Technology, and Innovation Strategy for Africa 2024 in June 2014, African countries signaled their commitment to development led by STI. This strategy is the first of five 10-year strategic frameworks under Agenda 2063 to accelerate Africa's transition towards an innovation-led, knowledge-driven economy [67]. This first framework aims at accelerating and developing human capital, innovation, industrialization, entrepreneurship, and value addition to facilitate social transformation and enhance economic development and the competitiveness of the continent [67].

SGCs are critical actors in the configuration of the national innovation system, as they are central agents in funding and they propel STI. While many sub-Saharan Africa countries have long-established SGCs, they have different national structures and, therefore, operate in different ways, with implications for how they are funded and how they carry out their functions. Although, in broad terms, all SGCs in sub-Saharan Africa seek to advocate, fund, and support STI, they differ in their history, setup, level of organization, and presence within the national system of innovation.

According to the African Capacity Building Foundation [68], over two-thirds of sub-Saharan Africa countries have adopted (at different levels of intensity) STI policies and strategies. However, many of these countries still lack the requisite capacity to optimize the potential of STI to enhance the structural transformation of their economy [69]. The majority of sub-Saharan Africa countries have "underdeveloped STI institutions and fail to effectively generate and deploy knowledge and technological innovations for socio-economic growth [68]". Therefore, the critical technical skills and resources to conduct and promote R&D, as well as higher education (which is generally technically weak), are common bottlenecks in much of sub-Saharan Africa [69].

In order to strengthen and support the underdeveloped SGCs in 17 sub-Saharan Africa countries, and under the premise that SGCs are central to funding and catalyzing research and innovation, a program funded by the International Development Research Centre (IDRC), the Department of International Development (DFID), and National Research Foundation (NRF) South Africa launched the Science Granting Council Initiative (SGCI) in 2015 [70]. The main objective of the program is to promote SGCs that strengthen the national innovation system and contribute to the development of sub-Saharan Africa. This is done through the construction of capacities in the participating countries to (i) manage research; (ii) design and monitor research programs and the use of STI indicators; (iii) promote and support knowledge exchange with the private sector; and (iv) establish partnerships with other science actors of the innovation system [70].

A 2017 study by the Science Policy Research Unit and the African Centre for Technology Studies on how political economy factors influence the evolution of science funding in the Science Granting Councils Initiative participating countries provides two instructive findings. First, all five case study countries (i.e., Ethiopia, Kenya, Rwanda, Senegal, and Tanzania) were committed to increasing their STI funding, but, in general, funding levels were still low [71]. In these countries, SGCs have been established, but in varying ways, which has implications for how they are funded and carry out their functions. Second, while there is reference to the role that the private sector can play at both the regional and national levels, private sector funding remains low and engagement "patchy" across the case study countries [71]. The study points out the following:

> *. . . greater involvement from the private sector will take dedicated effort and there is a need for greater communication between private and public sectors about the value of different types of research. Greater consideration could be given to the variety of ways in which the private sector could be encouraged to fund and engage with public sector and joint funding initiatives. The majority of firms will not make use of formal R&D activities and may not identify as innovating companies. The type of engagement and activity will also vary across sectors. However, there will be aspects of research that may have relevance and use and although actual private sector spend[ing] may remain limited, greater involvement will lay the basis for sustained and growing collaboration* [71] (p. 43).

3. Methodology

This study is based on a larger project focused on 15 SGCs participating in the Science Granting Councils Initiative financed by IDRC, DFID, and NRF South Africa. It focuses on 12 out of these 15 SGCs participating countries: Namely, Botswana, Burkina-Faso, Cote d'Ivoire, Cameroon, Ethiopia, Ghana, Malawi, Senegal, Tanzania, Uganda, Zambia, and Zimbabwe. The interviews were conducted at the Annual Meeting of SGCs in Livingston, Zambia in November 2017. Therefore, only participating ministers and SGC representatives were interviewed. When interpreting the results, we should keep in mind that seven of the countries in our sample are considered least developed countries. Thus, our results should not be generalized without caution.

The study explores the existing enabling environment, networks, coordination needs, and systemic failures of the SGCs in the participating countries, as well as the (inexistent) cooperative practices with the private sector, particularly through PPPs in RI, and other system actors. It does this through semi-structured interviews, which were conducted with the 12 representatives of the SGCs that attended the 2017 Annual Meeting. These interviews were complemented by phone and Skype-based semi-structured interviews with the directors of outreach offices, technology transfer offices, and university-industry linkage and technology offices at the selected public universities in the 12 countries studied. This helped us to understand the current practices of the SGCs regarding PPPs in RI and the respondents' personal impressions of these practices (based on their experience).

In addition, three key interviews were conducted with the policy advisors of international organizations, namely, the Netherlands Organization for Scientific Research (NWO), IDRC, and Deutsche Forschungsgemeinschaft (DFG), to complement the analysis. These international experts provided a general perspective on the role that PPPs in RI play in both policy planning and market implementation. Following a data-driven approach in the coding, we conducted content analysis, on which we based the analysis of our results. A survey questionnaire was also sent to a total of 43 individuals across 33 organizations in the countries studied, including 16 organizations associated with the 12 SGCs. In addition, key reports on PPPs in RI in sub-Saharan Africa were identified [71–73]. Interviews were conducted with the corresponding authors with the aim of including their reflections in the research.

This research departs from the typologies developed by Howells [28] and Stezano [31] to establish a general profile of the SGCs in our sample countries. This landscape is relevant in illustrating the feasibility of the successful implementation of STI policy instruments, such as PPPs in RI, in the region. The results will enable us to identify the institutional and systemic changes required to strengthen and develop the STI capacities of innovation intermediaries in the region in order to broker PPPs in RI as a tool to promote the economic and social benefits to be gained from participating in public-private knowledge investments.

4. Results

This section presents the most relevant results from the analysis of information obtained in our interviews and supported by the online questionnaire and desk research.

4.1. Descriptive Information on SGCs in sub-Saharan Africa

The countries analyzed in this article are divided into least developed countries (LDCs) and developing countries. Although they have different characteristics, their economic activities are mostly agriculture and mining activities, with low levels of R&D expenditure (see Tables 3 and 4).

Table 3. Country characteristics.

	Landlocked	Sea Access	LDC
Countries	Botswana*, Burkina Faso*, Ethiopia, Malawi*, Uganda, Zambia*, and Zimbabwe*	Cote d'Ivoire, Cameroon, Ghana*, Senegal*, and Tanzania*	Burkina Faso, Ethiopia, Malawi*, Senegal*, Tanzania*, Uganda, and Zambia*
Main activity concentrating employment	Agriculture and *mining	Agriculture and *mining	Agriculture and *mining

Table 4. R&D expenses as a percentage of GDP.

Country name	Country Code	2010	2015
Zambia	ZMB		
Zimbabwe	ZWE		
Uganda	UGA	0.47	0.17 (2014)
Tanzania	TZA	0.38	0.52 (2013)
Senegal	SEN	0.54	0.75 (2015)
Malawi	MWI		
Ghana	GHA	0.37	
Ethiopia	ETH	0.24	0.60 (2013)
Cote d'Ivoire	CIV		
Botswana	BWA	0.25 (2012)	0.53 (2013)
Burkina Faso	BFA		0.22 (2014)

Source: http://data.uis.unesco.org (extracted on 15 December 2018).

4.2. Identification of Systemic Bottlenecks between SGCs and Other Innovation Intermediaries in Sub-Saharan Africa

Table 5 presents the main challenges to the implementation of PPPs in RI, identified in terms of the four roles of innovation intermediaries presented previously (see Table 1). There are, without a doubt, other constraints faced by SGCs; however, this research only presents those most commonly mentioned by the participants. The bottlenecks that were identified (via interviews, the online survey, and other evidence) are presented in one profile. Nevertheless, they could be further broken down into more specific constraints and, although they are presented in one particular role category, they may also serve as factors influencing other roles. After all, in practice, the four roles presented overlap, as do the organizations' activities.

These constraints provide us with a perspective on the challenges faced by the SGCs in brokering PPPs for RI. Issues, such as corruption (documented by Lilley [74–76]), long administrative processes (documented by Ranjit and Kazim [77]), and political interference (as highlighted by Sader [78]) are also frequently mentioned in innovation studies in sub-Saharan Africa. This poor institutional setting and the inability of local institutions to provide a healthy environment to enable tools, such as PPPs, in RI to be implemented are commonly identified as factors that constrain private participation in the sub-Saharan Africa context [79,80]. Our research found that even when there are policies and programs promoting the interconnectivity of STI across national sectors, the level of coherence between them is relatively weak.

Table 5. Main constraints faced by SGCs in sub-Saharan Africa according to their intermediation role.

Intermediation Role	Administrative Constraints	Financial Constraints	External Factors	Implementation Constraints
Diffusion of knowledge and technology transfer	Lack of openness in the process of the arrangement	Poor access to financing mechanisms	Lack of scientific resources	Insufficient level of STI knowledge
	Many requirements to obtain project approval		Poor communication	
	Poor coordination between government offices			
Innovation management	Lack of (or weak) enabling legal and regulatory framework	Investors' concerns about need for intensive managerial resources	Corruption	Lack of proper legislation
	Political interference in procurement process		Lack of experience in dealing with partnerships and/or the private sector	Legislation regarding intellectual property is not clear
	Lack of or weak political will and support			Lack of skills in dealing with intellectual property regulations and issues
Sti system and networks	Slow implementation of public reforms	Inability of local institutions to provide equity financing	Resistance from environmental groups	Lack of trust between university and private sector
	Foreign ownership restrictions (legal framework)	Poor creditworthiness of loan taker	Resistance from civil society organizations	
			Public resentment	
Intermediation	Lengthy project approval process/lengthy bureaucratic procedures	Restrictions on return on investment		Low level of skills
	Failure of government to honor its contract obligations	Investors' concerns about foreign exchange risks		

Source: Prepared by the authors with information from the interviews and online survey.

4.3. SGCs Profiles for the Implementation of PPPs in RI

The implementation of PPPs in RI as an STI policy tool favors the construction of innovation capabilities, as well as the improvement of the relationships between different stakeholders in the innovation system [53]. Table 6 identifies clear divergences in the perceptions of actors regarding the main function or objective of the adoption of PPPs in RI. While for the universities and national research foundations or programs, PPPs in RI should address issues related to market failures (such as the integration and strengthening of the value chain for a local producer, as well as the development of SMEs), for the ministry responsible for STI and the SGCs they are a tool to produce lessons that should be used in the development of effective STI policies. They also act as bridges in the production of knowledge and its exchange between universities and the private sector.

From Table 6, we can see that SGCs perceive themselves as producers of research and evidence-based policies, rather than intermediaries for other actors in the system. Based on Howell's taxonomy, we could say that they identify their main role as the diffusion of knowledge and technology transfer through the production and exchange of knowledge in alliance with the private sector. Universities and national research agencies see themselves more as innovation managers and intermediaries. Interviews with representatives of universities and national research agencies revealed that their objective with the implementation of PPPs in RI is to solve a market failure, mostly related to value chains. However, when questioned about the reasoning behind actively looking for these type of partnerships, they expressed the large amounts of external revenue that they bring to their centers and universities as the main motivation. In several cases, it was mentioned that these types of associations are a mechanism to compensate for national budget cuts.

Table 6. The main function of PPPs in RI for different actors.

Entity	Main Objective of PPPs in RI		Who Initiates and Leads the Discussions	Main Participants from the Private Sector
STI ministry and SGC	To produce research and evidence-based policies	To support knowledge creation and exchange with the private sector	University or research center	Large (multinational) firms
Public university	To strengthen the value chain for a local product	To integrate and develop SMEs into a global value chain	University or research center	SMEs
National research agency	To strengthen the value chain for a local product		Public sector	Large (multinational) firms

Source: Prepared by the authors from the interviews and online survey analysis.

From the interviews, it was clear that the establishment of a clear intellectual property rights policy is absent for most of the actors in the system. In several universities, it was reported that there were researchers who owned the patents and had trademarks registered. The registration of patents is done at the national level. This is a serious bottleneck in the performance of not only SGCs, but also universities and national research agencies as innovation intermediaries in the role of knowledge diffusion and technology transfer. In addition, our research also found that very few of the universities interviewed have experience in incubation and science and technology parks.

From the discussions with the SGCs and national STI agencies, it was clear that their main target for interactions are large firms and multinationals. However, the directors of outreach centers at universities said that their efforts are focused on partnering with SMEs in the region. Close proximity seems to be an important condition for all stakeholders when engaging in a formal partnership with a firm.

The survey results indicate that it is usually the university that initiates and leads the discussions regarding the implementation of PPPs in RI. From the interviews, it was clear that universities do not have a structured strategy for approaching the private sector. The interviews suggest that the private sector is mainly approached through conferences (where research findings are presented), industrial internships, and grant writing. From our conversations with directors of outreach centers, we found that they frequently call industry associations or email local SMEs (whose information is provided by the industry registers). These efforts are supported by visits from the university staff to firms and small meetings in which the university promotes its services and tries to create a culture of trust with the private sector.

4.4. Key Players in the Implementation of PPPs in RI in Sub-Saharan Africa

During the interviews, and supported by our online analysis, it was mentioned that the main sources of funding for the universities (through the outreach offices) are international non-governmental organizations and donors, such as the Swedish International Development Cooperation Agency (SIDA), United States Agency for International Development, DFID, and Nuffic (the Dutch organization for internationalization in education), among others. This has led to a considerable amount of time at these outreach offices to be allocated to grant writing, which has become the most common activity to compete for external funds.

From our conversations with informants in the main donor groups identified (i.e., IDRC, Nuffic, NWO, NRF, and DFG), we found that the fields of applied research or problems targeted by their grants or calls for proposals are determined in their headquarters based on: (i) The donor country's areas of interest, (ii) the donor funders' areas of interest, and (iii) inputs provided by their embassies in the recipient countries in their assessment of country needs. From a revision of some grants, we identified that a common eligibility condition is the involvement of partnerships between a foreign

entity (university, research center, or private sector), a local science system actor, and a local community (where the implementation takes place). Most of these grants cover projects of three to five years and require the partnership to be formalized by a memorandum of understanding or collaboration agreement, not necessarily a formal contract.

4.5. Private Sector in Sub-Saharan Africa

The private sector in sub-Saharan Africa is mostly composed of small and medium-sized firms in retail trade and low-level services, with a very narrow manufacturing base. This has been widely documented by the empirical literature on sub-Saharan Africa [81,82]. Our interviews show that most PPPs in RI are established in the agricultural, food, water, and health sectors. These are also the sectors targeted in the SDGs and in the societal challenges identified by the European Commission. One suggestion that resonated constantly in conversations with the SGCs is that it is imperative to harness local funds for research and innovation in sectors of national interest, such as agri-business, food processing, seeds, and vaccinations.

5. Discussion of Findings

The five key issues highlighted by our results—in no particular order—can be summarized as follows: (i) Lack of trust between stakeholders; (ii) innovation intermediaries in search of cash instead of long-term relationships; (iii) the atomistic behavior of the local private sector; (iv) weak competences for innovation management and intermediation; and (v) a high dependency on the STI agenda of foreign donors.

Innovation intermediaries have the utmost relevance in current STI paradigms requiring technological collaboration between multidisciplinary actors. The relevance of SGCs as innovation intermediaries is recognized by all relevant stakeholders in the sub-Saharan Africa innovation system. They are central to the long-term development of STI-led and experience-led policies; plus, they play a key role in the successful evolution of PPPs in RI in sub-Saharan Africa. In this context, SGCs should fulfill intermediary functions between actors in the system of innovation, key among which should be the governance of schemes or strategies promoting knowledge and technology transfer among actors in the national system of innovation.

Our results situate SGCs in sub-Saharan Africa mostly in the role of diffusion of knowledge and technology transfer, or as conveners, while the conditions for them to fulfill the roles of innovation management; innovation system and networks influencer; and intermediator of innovation are not yet properly addressed or built. This is mostly due to weak capabilities and scarce financial resources to perform the tasks involved in these roles.

In practice, innovation intermediaries adapt their functions and activities to their environments. Their capabilities and specialization trajectories are related to the sectoral dynamics of their markets. Sub-Saharan Africa's private sector is quantitatively small, and its science and knowledge system relatively weak, both financially and institutionally, as it is mostly formed by SMEs. Local SMEs tend to engage in atomistic and uncooperative behavior due to their struggle to deal with daily routines, including non-availability of public goods that are taken for granted in advanced societies. These small actors also lack information search and knowledge management capabilities.

Our results show that SGCs have more interest in partnerships with large multinationals hosted locally, rather than with the local SMEs. Although these partnerships contribute to knowledge generation and transfer, a major effort in engaging the local private sector is required in order to avoid widening the already existing knowledge and financial gap in the system. Local SMEs require support and interaction with knowledge actors to raise their collective productivity. This should be facilitated by instruments of STI policy, such as PPPs in RI, as it will not happen spontaneously. This also brings up some aspects of the effect internationalization has on innovation performance. As suggested by Kafouros et al. [83], different degrees of internationalization contribute to a higher innovation level

in the firm. By participating in external markets, firms learn and are able to internalize better the knowledge they acquire through this interaction.

Due to their top-down approach, PPPs in RI are used by governments to [re]shape or modify existing growth strategies towards innovations that address societal challenges. In the North, they have become a key instrument for co-financing the creation of new markets towards the creation of new industries and the repositioning of leading competences of the North in key sectors. The strong role played by international donors in the STI direction of the region, as well as the grant application requirements, may (or may not) jeopardize the autonomy of SGCs to define the STI pathways needed to strengthen and build the innovation system of the region. Thus, the governance of STI public policy and the regional development initiatives should be interconnected in a horizontal fashion with the international donors' agenda, and not top-down, as is commonly the case. Therefore, for PPPs in RI to be efficiently implemented, the local stakeholders should have the same understanding of the potential implications of their objectives for the local system—beyond the contractual period of the partnership.

6. Conclusions

It can be concluded that in dealing with STI and research linkage and the construction of knowledge networks in national systems of innovation, the creation and implementation of intermediation offices, such as the SGCs, is about systemic change to facilitate knowledge flows through STI policy instruments. In other words, it is about the regional need for capacity development, multiple structural reforms, long-term trust relationships, and mechanisms to evaluate the effectiveness and applicability of different degrees of knowledge transfer and capacity building in the local context. Hence, the SGCs in sub-Saharan Africa should not only act as diffusers of knowledge and facilitators of partnerships, but they should also establish mechanisms to build long-term strategies, matching or addressing the national and local challenges and constraints. Only by understanding the local context and needs can SGCs be influencers of the national STI policy and mediators for foreign development actors. The results in this study—and the abundant empirical literature in the region—indicate that this is not yet the case in sub-Saharan Africa.

7. Managerial and Policy Implications

The relevance of the study rests on the need for systematic changes in order to bring about innovation, not in a linear fashion (e.g., based on isolated policies or innovation breaks), but as part of a systemic understanding and solutions that target the global sustainability challenges identified in the SGDs and by the European Commission [84,85] The study draws attention to the need for transformative, systemic innovation to influence and align the economic, societal and environmental aspects of development at the local and global levels, particularly in sub-Saharan Africa, towards sustainable development [8]. This implies the formulation or restructuring of STI policies and the reformulation of growth strategies away from the traditional industry and infrastructure towards global societal goals (within an international agenda, but grounded in the local context). However, the results of the study indicate that SGCs and the rest of the actors in the system of innovation in sub-Saharan Africa lack the sufficient capabilities to engage in this type of change.

The need for a knowledge-oriented culture, promotion of linkages between the existing industry and the rest of the actors in the innovation system, and the internationalization of knowledge promoting local ownership are some of the aspects that need to be addressed by the SGCs if they are to be key influencers of STI policies in their countries. The adoption of well-established knowledge management strategies and policies among industry and knowledge intermediaries could potentially increase performance and improve the efficient use of available resources. A fundamental awareness of the shift in paradigm required to target societal issues (such as the ones addressed by the SDGs) through innovation is needed if countries in sub-Saharan Africa are to reframe their development strategies towards a circular, regenerative, and innovative economic agenda supported by STI policies [9].

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