

A quadruple helix framework for university-led community innovation systems in Africa

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Introduction

This chapter is an offshoot of a doctoral study supervised by Professor Holtta, which investigated the role of higher education in poverty reduction in Africa (Doh 2012). The study found the necessity of a university-led community innovation system (CIS), of a quadruple structure in complementing the lack and weaknesses of national university systems in most developing countries. Indeed, gone are the days when the university was an ivory tower, disconnected and distanced from the realities of its environment. Today, the university is undergoing a second revolution, which involves a third mission of economic development, including poverty reduction. This revolution is leading to a search for the most appropriate frameworks within which the university will perform and contribute most effectively. While the triple helix of the university, industry and government partnership, (Etzkowitz & Leydesdoff 1997) and the national innovation system (NIS) (Lundvall 1992; Lundvall et al. 2002) seem to be developing as the way to strengthen the role of universities in economic

development, developing and least-developed countries are generally lagging behind. Most African countries lack the appropriate frameworks to organise the systemic connection and role of their universities. Universities are often disconnected from their societies, local contexts and environments, either due to NIS that lack “systemness” (Doh 2012) or the sheer lack of frameworks. Whereas we will be portraying the NIS within which the triple helix operates as a starting point, this chapter presents the CIS as a framework that is likely to strengthen NIS in developing African countries because of its ability to more appropriately capture the local realities and innovations in these countries. This has been termed a university-led CIS of four helices.

The chapter is composed from a desk review of literature on different dimensions of national innovations and frameworks on how universities respond to the economic development needs of their immediate environment. The chapter draws analogies and most of its data from a qualitatively conducted study on the roles of the university in economic development and poverty reduction in Africa, specifically a case study of Cameroon (Doh 2012). The systemic perspective of this study was built on national innovation system theory and the institutional adaptation perspective on the concepts of the entrepreneurial university and the third mission as the means through which the university responds to such economic development commitments. The chapter (as per the study) is theory driven, whereby the theoretical and conceptual issues are important in propelling the analyses and conclusions (Marshall & Rossman 1999). In the chapter, two questions are raised to address the research gap in terms of the role of universities in NIS and of the absence of frameworks that appropriately address the weaknesses of Africa’s innovation systems, such as: What is the university-led CIS, and (2) What factors and elements explain the relevance of the quadruple helix approach as a framework for CIS?

The community innovation system in the national innovation system

Muchie et al. (2011; 2003) summarise the CIS as a system's capacity to mobilise and use resources, organise knowledge and human capital training and deploy institutions, put in place incentives and regulations to carry out favourite experiments on activities and functions that are undertaken by citizens at the grassroots and local communities. In effect, this CIS is supposed to be there as a director of attention to local innovation. By the same token, the university-led CIS conveys how the university interacts in the CIS, how it is steering the processes leading to a responsive CIS and how it is interacting with grassroots community actors. This refers to how communities and their universities respond to the innovation challenges they face and how they are accommodated in their responses.

Doh (2012) situates the CIS as operating within a NIS, on a smaller geographical scale than the regional innovation system, to address the innovation needs and challenges of local communities. According to this perspective, the CIS is the means and framework reinforcing the effectiveness and responsiveness of the national and region innovation systems. Innovation is seen to refer to change, inventing something new as well as adding a new developmental stage to an existing product. An innovation system is, more or less, a system constituted of elements which interact in the production, diffusion and use of new and economically useful knowledge (Lundvall 1992).

Misleadingly, most of the literature on innovation systems has misconstrued these systems as science-based technological systems. These assumptions challenge perspectives on different innovations, especially those relating to developing countries, whose economies are mostly informal, with significant innovations taking place in grassroots communities. Innovation does not pertain only to "new to the world" innovation and could be the absorption of technology and competence. It could simply result from "doing, using and interacting-DUI" (see Chimnade et al. 2010, 3; Jensen, Johnson & Lorenz 2007). It is important to underscore the NIS scholars project as relevant for developing countries in the broad approach of the innovation system, rooted

in the activities of firms and the competences and capabilities of people, and not necessarily in terms of research and development (R&D), high tech and science-based industries (Lundvall et al. 2002). However this broad approach can be observed to have endless limits, with the elements and determinants of innovation difficult to define. The broad approach does not provide a place for the university. Doh (2012) postulates the triple helix as a starting point in conceiving a CIS since it is simpler and contains a leading role for universities. All the three actors in the triple helix are clearly defined. According to Doh (2012), university-led CIS are necessary to strengthen regional innovation systems. With the example of South Africa as an apparent leader in the innovation system approach to development in Africa (Netshiluvhi & Galada 2012), the regional innovation systems are still under development, that they are weak and that they seldom reflect a strong role for the university. The CIS concept, which is also taking shape in most of Africa, is still highly informal and does not enjoy national visibility (Netshiluvhi & Galada 2012). The emerging innovation systems do not articulate how the NIS is linked to communities at the local level. Finally, the sectoral innovation system approach (Brechi & Malerba 1997) has either been built on the formal science and technology-based approach of rich industrial countries, and not on the likes of social innovation in most developing countries.

The university-led community innovation system

It is possible to draw from the South African practices a geographical (regional) resource-driven approach, whereby the CIS is perceived from the perspective of a resource intensive economy in the region, which, if well nurtured, will lead to sustainable economic growth and social development (Netshiluvhi & Galada 2012). This dominant resource perspective is buttressed by the fact that very few of the regional innovation plans in South Africa have articulated the importance of the university. While the resource-based perspective cannot be completely ignored, Doh (2012) has maintained the importance of a knowledge-based approach, which is driven by the university. In fact, the figure

depicting the CIS in Netshiluvhi and Galada (2012, 17) only identifies the government, parliament, ministries, provinces, councils, private sector, NGOs and community entrepreneurs as potential actors, without the university as a knowledge institution. Despite this weakness, what is common with the perspective adopted in Doh (2012) is the importance of involving all members of society in playing an active role in innovation, where especially the grassroots communities in the case of Africa are also responsible partners in the national innovation process, including all kinds of innovation, but especially social innovation. Social innovation has been defined by Netshiluvhi and Galada (2012) as any broad-based innovation (formal/informal, technological/non-technological) that is social, both in its ends and means in terms of existing and new ideas, products, services, processes and models that more effectively meet social needs on a sustainable basis. Within this social innovation perspective, the CIS can be targeted at solving and mitigating particular development challenges at the grassroots, such as food scarcity, social pathologies, tropical disease and land erosion.

Doh (2012, 192) has observed the innovation scholarship community as many analyse the role of the university in economic development as a *fait accompli* on the basis of macroeconomic theories, which seem to be built on the notion of the trickle-down effect of national innovation to the entire population, subsequently alleviating poverty. Such approaches fail to capture and systematically address the specific needs of socially inclusive and poverty-reducing innovations, including the distributional effects. Drawing on Altenburg (2009, 33–34), national innovation and economic policies may often be overly biased in addressing selective measures to deal with certain market failures and may end up with inappropriate conclusions. Doh (2012, 193) points out the phenomenon that poor developing countries operate on the premise that the poor in grassroots communities are only recipients of government planned activities because they are often considered ignorant, with nothing to offer. According to the Bertelsen and Muller (2003), paradoxically, it is the policymakers who are ignorant and usually know very little about these grassroots communities, for they are “highly knowledgeable and skilled and

certainly not ignorant as the public often thinks” (p. 23). The consequence of this unfortunate perception is that significant social and production potential in poor rural communities is often disregarded, with significant innovation and economic development potential abandoned. Scholars have argued on the importance of mainstreaming poor rural communities and their related technologies in the national innovations of Africa. This then forms the basis of CIS conceived here as a (formal) framework on how grassroots innovations, knowledge and technologies are harnessed and transformed into national innovations (see Muchie et al. 2003; Altenburg 2003, Nji 2004; Bertelsen & Muller 2003, 123).

A quadruple base of the community innovation system

Considering which schools of thought which of the schools of thought grants a conspicuous position to the university in national innovation (see 2.1), Doh (2012) projected a community university as an extra angle in the triple helix, whereby the first three angles which make up the triple helix—university, industry and government—relation are complemented by a fourth angle for the community, as follows:



(Doh 2012; 2017)

The above quadruple approach was adopted to construct a university-led CIS for several reasons. First, the other models and NIS scholarly community

(the case of Lundvall 1988; Nelson 1993) believe that it is either the firm or government play a leading role in national innovations (Sabato & Mackenzie 1982) but the triple helix centres on the leading role of universities. This is important to the community of higher education scholars, especially in developing countries where the university is a key knowledge institution. However, Doh (2012) goes further by suggesting that the triple helix is not sufficient for the development strategies of developing countries, in the sense that it focuses more on the university's role with "formally established industries", whereas industrial innovation and most of the economic activities in developing countries are highly informal (Gu 1999; Arocena & Sutz 1999). This weakness was demonstrated in Doh (2012), whereby universities in developing countries mostly go after formal and major industries. Doh (2012) highlights a gross lack of indicators such as budget lines, streams of income or memoranda of understanding in the universities in relation to activities with small and medium-sized enterprises (SMEs) or generally in the local communities, whereas the universities in developing country contexts are surrounded much more by SMEs. A quadruple helix involving a community angle with a leading role of universities was likely to be more appropriate for a CIS, especially in terms of social innovation. This requires an understanding of this adapted version of the triple helix to a quadruple helix that is similar but peculiar to those of other NIS scholars. Carayannis et al. (2009), for instance, have introduced the notion of "civil" society to the triple helix, which is related to the additional angle herein (the community). However the emphasis herein is on the local grassroots community and the role of the university as the main driver is peculiar.

Major actors of a university-led community innovation system

According to the preceding analysis, the community angle constituting a quadruple helix-based CIS becomes a full-blown sub "national" system with connections to the major actors such as the university, government, industry and the local community. Since this CIS is built from the triple helix, the first

three helices maintain roles similar to those of the triple helix, with connection to the local councils and communities:

Table 1. Expected roles of the major actors in the quadruple helix
(contextualised from the triple helix role analysis to a quadruple helix; Doh 2012, 126).

Actor	Role (s)
1. The Government	Connecting the university to the local communities, designs university community innovation support programmes Connecting the local communities and universities to the industries Funding the connections Facilitating access to the markets Coordinating and regulating the interactions between the three
2. The University	Knowledge, skills creator and supplier to industries and society A physical environment for research and teaching on local innovations Transmitting and disseminating the knowledge to industries Integrating the community knowledge into R&D and science and technology Providing incentives for academics to interact and cooperate with local communities and industries Academics constantly seek to relate to the knowledge and innovations from local communities Academics design the projects, apply for funding and link the innovations to industry
3. Community (Council)	With local councils officials coordinating structures for local community innovations Connecting the local community to universities and industry Where the grassroots population is active in proposing its knowledge and innovations to universities Where councils are capable of linking innovations to the global market Where councils substitute the government as the designer and executor of national innovation policies and funder and regulator at the local level
4. Industry	Cooperating with universities Providing resources to stimulate interaction between universities and the grassroots population Providing feedback to universities Linking interactions and the products of local innovation to the market, society and the global knowledge economy

A few observations ought to be made from the above four actors of the quadruple helix. Although by deductive reasoning, CIS can be understood as the smaller spatial and local component of national and regional innovation systems, during the analyses, we found that the national government remains the major and largest actor in designing university-local community innovation activities, governing and regulating them. This suggests that an innovative entrepreneurial local community should reflect and translate the innovative capacity of a nation, the NIS and vice versa. Consequently, there was no obvious reason to alter the position of the government in the hierarchy of the four actors. In fact, innovation processes that take place at the local community level do not necessarily operate in a vacuum at the basic special units of the nation. They could be the results of system-wide innovation policy, structures, cultures and incentives. A second observation draws on the fact that the role of the university as a major actor and a knowledge, research and training institution does not change as much as in the triple helix. What changes is the importance of the innovative and entrepreneurial academics at the basic units of the university, who are likely to be involved in the informal processes and contacts with the local communities. They are also important in the identification of community knowledge and the development and transformation of these knowledge and technologies to economically useful knowledge. Drawn on Doh (2012), the (local) community actor(s) is understood as comprising a variety of sub-actors such as individuals with local grassroots knowledge, micro businesses and SMEs, councils, civic organisations and other development agents in the local communities. These are community-based organisations and social entrepreneurs that are active in innovation as well as in promoting local innovations and linking them to university actors. There is the need to highlight, within this community perspective, the importance of local councils as formal structures that could be charged with connecting grassroots community innovations to universities, industries and even the market. The observation was that the role of the council was not dramatically different from that of the government since local councils as governors and regulators of local innovations could be carriers to national

innovation policies, especially within more decentralised and autonomous politico-geographical entities.

Local councils can also be strategic in outsourcing funding from government and industries. In fact, there was also the thought about designing the local community councils as a separate main actor, leading to a *quintuple helix*, since it could be clearly distinguished from community-based individuals and organisations as well as social entrepreneurs that are active in the innovation processes. However, the council was retained as part of the local community on the grounds of every innovation system having a defined spatial and geographical connotation. Although the industry actor was altered from the triple helix to become the fourth and last actor, it remains the last important point for the actualisation and materialisation of economically useful knowledge from the communities. The industry is an important funder and provider of feedback. It links final innovations and products to the market.

The proactive African university in its community innovation system

The entrepreneurial university pathway and its limits

In a rhetorical question as to which type of university is relevant in the innovation system, Doh (2012) affirms an “entrepreneurial university” (Clark 1998; 2004) as embracing the “third mission” of economic development (Etzkowitz & Zhou 2008, 629) as the best institutional framework. These have been maintained for the CIS, essentially because of the same reasons. The entrepreneurial university frameworks implicitly stimulate external collaboration between the university and its external economic development environment. The entrepreneurial university is, according to Etzkowitz and Zhou (2008, 629), “*a means to promote economic growth*”. Economic growth nowadays, especially with regard to developing countries, requires greater interaction and collaboration from universities (Etzkowitz & Zhou 2008; Etzkowitz et al. 2008; Clark 1998; 2004). Zhou and Peng (2008, 638) perceive

the entrepreneurial university as the best tool for indigenous innovation because of its stronger service function and influence on the economy. However, in two other articles, Doh (2016a; 2016b) highlights several contextual limitations of the entrepreneurial university in terms of developing countries. These are expounded below.

The entrepreneurial university framework views entrepreneurship merely as an institutional characteristic, not taking into consideration that entrepreneurship could be stimulated from an upper layer of the university and that entrepreneurship does exist in micro units (Azele 2008). As a result of system-wide policy designs and funding, Clark (1998) does not situate the entrepreneurial university within a systemic framework. The entrepreneurial university, even entrepreneurship education at the basic unit, could be related to a particular funding scheme or policy designed beyond the basic unit and beyond the university, and vice versa, where policies are designed on the basis of the entrepreneurship education practices at the basic unit. Moreover, although the entrepreneurial university might have viewed partnerships and activities with industries as a characteristic, it focuses more on the extra second and third stream income and funding dimension and not on the economic role as a trigger of the entrepreneurial university, as Ezkowitz and Zhou (2008) postulate. One of the fundamental weaknesses of the entrepreneurial university framework, as observed by Doh (2012), is that most of its related studies have concentrated on research and technological and applied institutions in high income and highly industrial environments. Meanwhile, its conceptual glasses can be applicable to universities of all types, from those with an intensive research tradition to comprehensive ones in all contexts (Gibb, Haskins & Robertson 2009). Also, it can be observed that entrepreneurship education strategies in many European universities have been developed separately from the institutional aspect. Doh (2016a; 2016b) argues for the necessity of a multilevel framework that connects the two dimensions. Lastly, the entrepreneurial university framework does not pay sufficient attention to scientist-led entrepreneurship. University professors are very important actors in the informal networking that grants business to the university and are more strategic in the CIS, in the

developing countries connecting the university to the grassroots population and in local innovations.

Entrepreneurial professors in community innovation

It is important to present a separate account of entrepreneurial professors in this subsection because the employment of the entrepreneurial university concept in the case study of higher education and poverty reduction strategies (Doh (2012) generally showed a weak institutional support system (e.g. no discretionary funding, poor understanding of entrepreneurship, etc.). However, despite the generally weak institutional framework in response to the entrepreneurial university pathways, some departments and professors continue to stand conspicuously and tall in interactions with an effective university-led CIS.

A principle example of this interaction in the case study of Cameroon, which, like most of Africa, is in the medical, pharmaceutical, chemical and life science fields. Respondent Number 16 (R16) (Doh 2012) of the University of Buea, Cameroon (Doh 12), was involved in pharmacological validation towards drug discovery. This entails meeting charlatan traditional doctors (most likely less educated) in order to acquire knowledge of certain medicinal plants which the doctor in the grassroot community claims cure certain diseases. R16 (the principal investigator) then conducts scientific research in the lab to validate whether the traditional medicinal plants actually cure what the (charlatan) traditional doctors claim that they cure, then examines prospects for drug discovery from the contents of the plants. In a well-structured NIS, which encompasses a CIS with appropriate incentives and an inclusive intellectual property regime, it could be possible for the traditional doctor to be integrated as part of the drug discovery. The cycle of the CIS is completed once the results of the potentials of the medicinal plants are affirmed, with patents and drugs put on the market, and the charlatan doctor, most often from a rural area, being part of the proceeds. Respondent R12, from the Physics Department, develops prototypes that can be used to electrify rural areas (R12). The respondent

believes that the micro hydroelectricity and wind turbine generation of electricity can help reduce cost and extend and improve the generative capacity in Cameroon. R18 does research and advocacy on gender, women and land ownership and believes that for women to contribute to poverty reduction, they must own factors of production in the society, one of which is land. The respondent argued that within the current dispensation, the customary laws have tended to disfavour women and that this is a major handicap to poverty reduction strategies. Other university departments in the case study were seen to provide continuing education, adult and lifelong learning to improve the analytic and innovative capacities of the grassroots population.

Drawback to the university in the innovation system

The first challenge—which was observed to undermine the role of the university in most of the national or community innovation systems in most African countries, for example, the case country Cameroon—is the absence of a NIS. Most innovation systems in Africa, like most developing countries, are marred by weak linkages and low levels of interaction between actors, elements and institutions. These weaknesses manifest in the form of lack of funding and lack of internal or interface structures to connect the university to the society and the market. For instance, the principal investigator (R16) above (Doh 2012) revealed that once he had done the pharmacological validation and obtained the results, it became very difficult, if not impossible, to go from there to develop products that could be taken to the market. The respondent observed that more capital was needed to carry out the formulation and registration of the product but that the “national environment just ignores” them at this point. This is exemplified below:

Our activities are handicapped by the fact that there is no structure, means and prospects to take us from scientific results to product development. We could have more direct relevance and impact on poverty with products in the markets if (1) we start manufacturing the drugs; (2) if those drugs get to be used; (3) if you start working with a particular medicinal plant and you can

demonstrate scientifically from the lab that the plant can generate income, you are directly impacting on poverty. Most often, our work does not go out of the laboratory, “nobody takes us out of the laboratory”. (R16)

R12 (Doh 2012), who was producing prototypes of electrification for the community, believed that if the university researchers have the proper government or systems (institutional/financial) to support the country, then its citizens would be able to benefit more directly from what they were doing. Rural electrification, for instance, is one of the main developmental challenges of Cameroon (R12). The potentials of drug discovery for health and the national economy cannot be over-emphasised. Given a strong innovation system with interconnectedness and linkages, the results of electricity and drug discovery of the two respondents above would be taken over by the related ministerial departments in Cameroon for exploitation, sponsorship and commercialisation and dissemination. Respondent R12 argued that if there were sufficient funding and systemic support, their activities could be scaled up to help the national electricity corporation (SONEL) to produce power plants of a higher capacity instead of using smaller ones for rural areas

From the above example, it can be argued that the NIS, among others, can enhance the university’s contribution in the CIS and, thus, poverty. Doh (2016) notes other weaknesses affecting the university in the NIS and CIS, such as the lack of a national strategic plan, insignificant systems culture for research and poor understanding by the population and politicians of the activities of universities. The low R&D potential of local firms and the country at large can also affect the performance of the university in the CIS. The absence of key facilitators to link universities’ potential and results to potential users is a significant impediment. The low degree of networking and weak educational and analytic capacity of the grassroots population affect universities’ interaction and connection with the local community; both academic and grassroots communities are likely to “speak different languages” and have different world views.

Conclusion

This chapter has demonstrated and presented elements of the aloofness of universities in developing countries to their grassroots communities as a huge limitation, both in the roles of the universities and in the economic development processes. This aloofness to the local community is a major weakness for developing countries' universities, such as those in Africa, because more than 70% of the countries' potential and activities are in the informal sector. A significant amount of the riches are in indigenous and grassroots knowledge and technology. The chapter has proposed the importance of a university-led community innovation built on the basis of a quadruple helix framework, composed of a coordinated relationship between the university, government, local community and industries. This implies a broadened innovation system to capture the rural community and articulate both the commercial and non-commercial and social aspects of innovation. Rather than focusing mostly in terms of the "rich" forms of innovations and becoming globally competitive, it is necessary to see innovation from the perspective of being locally adapted, embedded and socially inclusive. Within this quadruple helix approach, the university plays a lead role in scanning the environment and identifying convertible economically useful knowledge in its grassroots community. The university converts tacit and explicit knowledge from the local communities into innovation, then it passes this on to industry and products in the market. The government is, above all, coordinating, funding and linking the other three actors. Local councils become a very important constituted and organised body, which can substitute the government, and vice versa, as the coordinator, regulator and funder of innovation processes. It is important to note that the conceptualisation finds equally important the formal (established) industry as final end points, relevant for bringing the products of local innovation to market. Studies on formal policy approaches and frameworks that link the university to local community innovations, especially in Africa will yield very interesting results in terms of economic development and poverty reduction.

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