University-driven inclusive innovations in the Western Cape of South Africa: Towards a research framework of innovation regimes

Grobbelaar, S.; Tijssen, R.J.W.; Dijksterhuis, M.

African Journal of Science, Technology, Innovation and Development

ISSN: 2042-1338 (Print) 2042-1346 (Online) Journal homepage: http://www.tandfonline.com/loi/rajs20

University-driven inclusive innovations in the Western Cape of South Africa: Towards a research framework of innovation regimes

Sara Grobbelaar, Robert Tijssen & Marjolijn Dijksterhuis

To cite this article: Sara Grobbelaar, Robert Tijssen & Marjolijn Dijksterhuis (2016): University-driven inclusive innovations in the Western Cape of South Africa: Towards a research framework of innovation regimes, African Journal of Science, Technology, Innovation and Development, DOI: 10.1080/20421338.2016.1225549

To link to this article: http://dx.doi.org/10.1080/20421338.2016.1225549

African Journal of Science, Technology, Innovation and Development, 2016
http://dx.doi.org/10.1080/20421338.2016.1225549

Routledge
Taylor & Francis Group

University-driven inclusive innovations in the Western Cape of South Africa: Towards a research framework of innovation regimes

Sara Grobbelaar[1,2]*, Robert Tijssen[3,4,5] and Marjolijn Dijksterhuis[6]

[1]*DST-NRF CoE in Scientometrics and Science, Technology and Innovation Policy, Stellenbosch University, South Africa*
[2]*Department of Industrial Engineering, Stellenbosch University, South Africa*
[3]*Centre for Research on Evaluation, Science and Technology (CREST), Stellenbosch University, South Africa*
[4]*Centre for Science and Technology Studies (CWTS), Leiden University, The Netherlands*
[5]*LDE Centre for Frugal Innovation in Africa (CFIA), The Netherlands*
[6]*Stellenbosch Business School, Stellenbosch University, South Africa*
**Corresponding author email: ssgrobbelaar@sun.ac.za*

Inclusive innovation refers to the improvement of living conditions and creation of employment opportunities for the poor through the development or co-creation of new products, services, processes and business models aimed at resource poor communities. Based on an empirical study of 15 university-led inclusive innovation projects in the Western Cape Province in South Africa, using an inductive approach we apply an analytical framework that serves two purposes (1) to describe our empirical findings and (2) to develop a broader research agenda that identifies a number of key research questions on the role of inclusive innovation projects in developing countries, and ways of addressing those questions in future studies. The empirical findings reveal a wide variety of university departments and individual staff members engaging with low-income user groups or entrepreneurs to (co-)create, launch or operate inclusive innovations. Our analysis shows that unravelling the various structural components and functions can provide interesting new insights into the workings of inclusive innovation systems. The findings of our study illustrate the complexity of the subject matter and the urgent need for a 'system of innovation components' approach to enhance our understanding of inclusive innovation projects and to develop appropriate methodologies for measuring their impacts.

Keywords: Inclusive innovation, inclusive systems of innovation, University R&D and community engagement, South Africa, innovation for inclusive development

Introduction and problem statement

The pitfalls of capitalism are well documented, as are trends such as the concentration of capital within an unfettered capitalist system and the resulting perpetuation of inequalities. In this vein, innovation has been associated with economic growth (Leontief 1950; Hagedoorn 1996; Fagerberg 2003), but also with inequality. Although not necessarily the only factor linked to inequality, innovation may play a role through a range of political, economic and social processes associated with the innovation process (Cozzens and Kaplinsky 2009).

Alternative models of innovation have been highlighted as a promising mechanism through which to stimulate growth and specifically improve the living conditions of those whose incomes are lowest. Two major approaches of activity can be identified in the literature in this regard. Firstly, there is the approach where low income markets may benefit from cheaper products with the process of innovation redefined to have efficacy. This tends to be a top-down process with '[i]nclusion … a process of managing and directing innovation undertaken by those external to the context of consumption' (Foster and Heeks 2014, 2; Walsh, Kress, and Beyerchen 2005; Prahalad 2012). Secondly, a more developmental perspective has emerged where a range of activities on the micro-level has been identified. In this perspective, innovation is seen as a bottom-up and emergent process which tends to be localized (Cozzens and Sutz 2012; Foster and Heeks 2013b, 2014).

There exists quite significant conceptual diversity within the latter perspective of innovation and its role in inclusive development with terminology such as 'innovation for inclusive development' (Paunov 2013; Santiago 2014), 'innovation for social inclusion' (Dagnino 2012), 'inclusive innovation' and 'innovation for inclusive growth' (George, McGahan, and Prabhu 2012). In short, these conceptualizations of the innovation model generally imply that the goal is to ensure that the poor may benefit from and be integrated more firmly in the innovation process (Kaplinsky and Morris 2002; Heeks, Foster, and Nugroho 2014). For the purpose of this paper, we make use of the term 'inclusive innovation' and adopt the following definition: 'Inclusive innovation is the means by which new goods and services are developed for and by marginal groups (the poor, women, the disabled, ethnic minorities, etc.)' (Foster and Heeks 2015, 2).

While inclusive innovation has been widely acknowledged for its potential, research about it is still in its infancy. A range of authors has attempted to define research agendas in order to support and direct future research efforts (Cozzens and Sutz 2012; George, McGahan, and Prabhu 2012; Foster and Heeks 2013b; Heeks, Foster, and Nugroho 2014). Of particular interest is the agenda mapped out by Foster and Heeks (2013b) where a focus on the stakeholder, systems and research process level are proposed. Here specific attention is paid to the actors in the system, and the role they may play, to understand the inclusive innovation process, required infrastructure, good practice, scale and evaluation.

Also of interest to the development of a research agenda for inclusive innovation are the suggestions that

have been made, especially by Kuhlmann and Rip (2015) who argue for certain major changes in approaches to the development and implementation of science, technology and innovation (STI) policy. With reference to earlier works, most notably von Hippel's (2005) democratized innovation and Malerba's (2007) observations of co-invention, Kuhlmann and Rip (2015) argue that these phenomena are evidence of a new regime of 'collective experimentation' that transcends a traditional technology-push model. This 'new regime of innovation' is driven through societal concern regarding certain issues or the desire to achieve certain societal goals. Here the trend to define 'challenge-driven' innovation is specifically referred to – an approach where R&D and innovation funding is arranged in response to pull-factors, i.e. societies' greatest challenges, instead of predominantly having a focus on a technology push and developing technologies (Rip, Joly, and Callon 2010).

Kuhlmann and Rip's (2015) suggestion has also been made in the context of our study (which is the Higher Education Sector in the Western Cape province of South Africa) where the concept of a 'Grand Societal Experiment' was proposed. This province is in an interesting position as it has, inter alia, a relatively sophisticated economy and financial sector, good universities and a large number of local and multinational corporations that co-exist in a setting along with a majority of the population that is largely excluded from economic activity, living in poverty and desperation.

In line with these stated possibilities, significant knowledge gaps can be identified as far as the understanding of inclusive innovation in the sub-Saharan context is concerned. As new knowledge and advanced skills increasingly drive economic development, universities are assumed not only to be critical sources for learning and innovation for firms in developed economies, but also for integrating the excluded and poor in innovation systems in developing country contexts (Brundenius, Lundvall, and Sutz 2009; Halme, Lindeman, and Linna 2012). A fair amount of attention has been given to related concepts such as the 'developmental university' (Kezar 2005; Brundenius, Lundvall, and Sutz 2009; Cloete, Bailey, and Pillay 2011; Makhanya 2014), engaged scholarship (Van de Ven 2006; Mathiassen and Nielsen 2008; Furco 2010), and the role of the African university in development and institutional capacity and infrastructure for knowledge utilization (Brundenius, Lundvall, and Sutz 2009; Cloete, Bailey, and Pillay 2011; Sehoole and Knight 2013) . A significant body of knowledge has emerged from the university-community partnership perspective, which considers factors such as the role and nature of partners and partnership, channels of information exchange and the role of interactive learning spaces (Kruss and Moeketsi 2005; Kruss 2006; Kruss, Adeoti, and Nabudere 2012; Kruss et al. 2015; Petersen et al. 2016). An outcome of the UNIID Africa Project entitled 'Linking University and Marginalised Communities' makes significant progress through an exploratory research project on four in-depth case studies towards developing an innovation for inclusive development research agenda. Factors considered were the nature of the innovation; drivers of interaction and participation; organizational arrangements and interface structures and enablers and constraints; the flow of knowledge and skills; the nature and extent of community participation and outcomes and benefits (Kruss and Gastrow 2015).

Despite the advances made in these abovementioned studies, little evidence exists to support the development of contextually appropriate policies that may drive the transformation of innovation systems in a developing country context. The literature on inclusive innovation systems is sparse, particularly in terms of exploring what such systems may look like and in applying such conceptualizations to local contexts. (see the section entitled 'The analytical framework') (Petersen et al. 2016).

We therefore aim to contribute to addressing this knowledge gap by exploring a range of themes in this paper, around *university-supported* or *university-led technology-based inclusive innovation* projects (referred to as 'UTIIs' from now on). The main aim of this analysis is to uncover key characteristics of such projects and to build on that towards an analytical framework to guide future research. The idea behind this is also to explore the idea of how new forms of innovation policies may be created in the African context, specifically to assist in the transformation of the Higher Education Sector (HES) in generating behaviours that will enable collective problem-solving in response to sub-Saharan Africa's greatest challenges.

The following section describes the methodological approach that was followed, after which the analytical framework for organizing and interpreting our findings is presented.

Methodology

The authors have taken an inductive research approach, starting out with an exploratory study of technology-based inclusive innovations with significant university involvement. This means that the study is not statistically significant within the (unknown) total portfolio of research programmes taking place in the universities included in this study since the goal of the study was to include as many projects as possible that qualify and to develop an exploratory, empirical study that would reveal important generic characteristics.

Prioritizing the university perspective in this first study, our structured interviews were conducted only with (senior) academics and principal investigators of these UTIIs.

Projects were selected after desk research was completed to scan for suitable UTII programmes or projects. A total of 46 possible programmes were identified from four universities in the region: 16 at the University of Cape Town (UCT); six at Stellenbosch University (SU); 20 at Cape Peninsula University of Technology (CPUT), and four at the University of the Western Cape (UWC). After a further sifting process involving communication with university representatives the number of projects was narrowed down to 15 projects, each of which satisfied the following selection criteria:

- Technology is a core component of the innovation;

- The university researcher and/or community-based innovator(s) aim to create opportunities that enhance social and economic wellbeing for disenfranchised members of society;
- One or more university representatives (faculty, students, administrators) play a key role in the project, notably a lead role in the combination of resources and possibly a key role in value chain integration (without them, it is likely that the project would not have happened or that it would have looked very different).

A questionnaire was developed and piloted in February 2014 and then sent out in March 2014. Reponses were received from 15 projects by the end of April 2014. The study included a diversity of projects: those with or without active engagement of local resource-poor communities, as well as some in their early stages, some at more advanced stages, and others that were complete. Although not necessarily representative, the mix of projects was deemed sufficiently large and broad to provide a range of UTIIs that could be used to identify the main differences and common characteristics among projects.

The key questions that were posed to the university researchers and academics were:

- What are the UTII project objectives and goals?
- Which institutional actors are involved?
- What are the key operational characteristics of their UTII project?

Follow-up semi-structured interviews were conducted with seven individuals from the four universities, which included interviews with six principle investigators as well as a staff member of a Technology Transfer Office. The interviews were conducted based on issues from the surveys to gain a deeper understanding of project characteristics and contextual factors. The content analysis of the transcripts focused on distinctive features of each project, as informed by the project's main research questions.

Table 1 provides descriptions of the projects included in the study.

The analytical framework

Expanding on Foster and Heeks' (2013) definition of inclusive innovation, we now proceed to adopt the innovation systems perspective as the analytical framework for this study's findings. The general goal is to arrive at a practical framework through which complex, relational systems can be analyzed and through which systems-level problems can be identified, with the aim of formulating policy-level suggestions and recommendations (Smits and Kuhlmann 2004; Wieczorek and Hekkert 2012).

An innovation system generally comprises a range of interconnected 'structural' components: actors, innovation, institutions, interactions and infrastructure. The components-based analytical framework of innovation systems devotes its attention mainly to dynamic interrelationships among those components (Rucker and Trah 2007), which may help identify missing actors or institutions, or assess the quality and capabilities of specific system components. Adopting this framework may provide recommendations for systemic instruments through which the operation of the system, as a whole, can be modified and improved (see Table 2).

The traditional application of the 'national innovation systems' (NIS) framework, especially the OECD-adopted NSI model, has, however, been criticized for falling short in a developing country context. This is mainly because it introduces and implements a descriptive and simplified conceptualization of innovation, which tends to ignore socio-political landscapes and the global context, and is reductionist in its focus on economic growth (Delvenne and Thoreau 2012). Nevertheless, some authors have argued that the NIS framework is useful in a developing country context, although it needs to (a) more explicitly integrate activities and functions beyond adaptation and adoption; (b) focus on the process of learning and the development of capabilities through which knowledge can be developed for the local context (Kraemer-Mbula and Wamae 2010; Wamae 2010).

In light of the above, we now return to Kuhlmann and Rip's (2015) notion of a 'new regime of innovation' and link that to the suggestions made by Foster and Heeks's (2013b) to amend the components-based approach of innovation systems to also include inclusive innovation objectives. Here some interesting possibilities may exist in terms of creating a new form of innovation system where 'collective experimentation' can take place more readily and where more proof-of-concept inclusive innovation projects and programmes can be stimulated.

Table 1: Description of university-led technology-based inclusive innovation projects included in this study

Project	Description
#1	A mobile phone application for collecting and sharing water quality information
#2	Real-time video solutions for lowbandwidth environments
#3	The implementation and testing of a waste-based energy generation system
#4	A web- and mobile based administration system for home-based care
#5	A mobile phone health risk assessment application
#6	A mobile phone application giving healthcare practitioners easy access to South African emergency guidelines
#7	Urban planning for informal community, including re-blocking, breaking down and rebuilding shacks & upgrading shacks
#8	Multi-purpose water platforms for informal settlements
#9	A low cost fire detecting and an early warning system for urban informal settlements.
#10	A fencing material that is 'unstealable' (i.e. cannot be used for fuel, contains no metal – taken for recycling), cheap and safe.
#11	Solution for last mile telephone connectivity for rural areas in South Africa
#12	A solar-based mobile power station
#13	An automated, mobile phone-based treatment adherence support solution
#14	An affordable, energy-efficient and owner building-based housing solution
#15	A simple and safe water purification solution

Such initiatives will need to involve 'new constellations of actors' in the innovation process, drawing on the existing capacity of a mostly sophisticated economy and the traditional innovation system actors but also need to include some non-traditional actors (Foster and Heeks 2013b). These actors will have to engage in new forms of 'collaborative learning' and knowledge production which will require novel approaches to STI policy.

The traditional firm-focused 'top-down' innovation frameworks will have to be augmented (and re-aligned to Kuhlmann and Rip's 'pull factors' approach) while considering how community-driven 'bottom-up' processes could be supported (Kuhlmann and Rip 2015). As Iizuka (2013) proposes, it is about shifting the innovation system's aim from enhancing the productivity of the firm to solving how a better quality of life for all may be achieved. The process of emergence and self-organization is central to the process and therefore the framework needs to allow for consideration of activities from the bottom-up, ensuring the inclusion of not only macro- but also micro-level activities – especially as far as learning and knowledge production are concerned (Iizuka 2013).

Kuhlman and Rip's notion raises some suggestions regarding leveraging non-traditional actors, the development of new capacities in new and traditional actors, and the development of various 'spaces' (physical and otherwise) as well as communication and transfer mechanisms through which these actors may engage constructively and in a productive way (Kuhlmann and Rip 2015). Here the centrality of knowledge and know-how networks is also accentuated with the inclusion of non-traditional actors, the blurring of institutional and social boundaries and the inclusion of multiple dimensions of knowledge creation, development and diffusion (Iizuka 2013).

Indeed, within this context, a small but growing number of studies have adopted 'systems level' frameworks to collect and analyze empirical information on inclusive innovation (and its alternative forms), notably studies on innovation platforms (Swaans et al. 2014), cluster innovation (Voeten 2013), user-producer interaction (Foster and Heeks 2013a), grassroots innovation (Smith, Fressoli, and Thomas 2014) and frugal innovation (Soni and Krishnan 2014). In their discussion of the relevance of a resource-based view for inclusive innovation studies, George, McGahan, and Prabhu (2012) define resources as physical capital, knowledge, partnerships, organizational capabilities and property rights, all of which are aligned with the key components of the innovation systems perspective.

In order to clearly link up with the ideas and suggestions by Kuhlmann and Rip (2015), our proposal for considering the UTII projects was to understand the nature of such projects and to start developing an overarching analytical framework to meaningfully describe the UTII projects in this study. We argue that the components-based approach suffices in this respect, specifically since it does address the key components of the inclusive innovation process, a new constellation of actors, the new regime for interaction, and new capabilities and institutions.

Drawing on the work of Foster and Heeks (2013a, b, 2015) we present the main differences between traditional innovation systems and the (still theoretical) attributes of inclusive innovation systems. Although in practice innovation systems are not likely to be purely either 'traditional' (such as NIS) or 'inclusive', it is useful to consider the additional aspects to be integrated if inclusive innovation objectives may be included. We add the actor's perspective (i.e. the higher education system) for our analysis to this (see Table 2). next section discusses and describes the individual UTII projects and presents findings from our research study against this framework.

Analysis

The nature of inclusive innovation at universities

Our exploration of technology-based inclusive innovations at universities in the Western Cape gave us some preliminary insight into the nature of such innovations. One aspect that defined these inclusive innovations was the intention behind them. In some cases, inclusive innovation was first and foremost a vehicle for student education. In others, it was primarily a platform for academic research. Some projects foregrounded community outreach – the third university mission – but always with an element of education and/or research.

Two other aspects that emerged from the data were the types and degrees of innovation. As for types, our sample consists of product or service innovations, process innovations, and combinations of those. Kruss and Gastrow (2015) argue that the distinction between product/service and process innovation may be too simplistic for informal settings. In our study, the distinction helped draw attention to the fact that quite a few projects involved product/service as well as process innovations. The combination of different types of innovation is possibly what helps to produce solutions suitable for these complex environments.

In terms of degrees of innovation, our findings support the point made by other inclusive innovation scholars around the relative prominence of incremental innovation and low-tech solutions (Cheng and Bradley, 2014; Kruss and Gastrow, 2015). The majority of projects in our study showed a modest degree of new technical knowledge. Innovation was more a matter of the context in which the technology was applied and how it was made suitable for this context. A good example is the fence developed for a low-income setting. The researcher involved identified possible ways to provide a preschool with low-cost fencing that would not be at risk to be stolen or vandalized, i.e. used as fuel (such as wood used for heating), had no scrap metal value (such as steel or wire which could easily be stolen) and the material would not block visibility (which might hide criminal activity in the area). While the technology (i.e. materials) existed already, new thinking was required to create a solution that was suitable. In other words, existing technical competency had to be combined with new contextual knowledge – and this is where the innovation resided. If we take this somewhat broader definition of innovation, a typology like Henderson and Clark (1990)'s framework of incremental, modular, architectural and radical innovation can have relevance for research on inclusive

Table 2: Highly selective comparative analysis of traditional and inclusive innovations systems based on the components-based approach (draws inter alia on Foster and Heeks. 2013b, 2015)

Component	Traditional innovation systems	Inclusive innovation systems	Higher Education sector considerations
Goal	Focused on macro-level and business sector	Socio-economic focus with some focus on the micro-level and improving livelihoods and quality of life	Enhancing the presence of university in supporting or leading inclusive innovation system
Actors	Often higher income markets, formal sector participants, strong role for intermediaries	Often includes lower income participants, also informal sector participation; traditionally big focus on demand stimulation but increasingly also other aspects of the value chain	Non-traditional actors included; new roles of actors in the system; type of partners; competences and capabilities; community leadership engagement
Innovation	Growth oriented innovation; often supply-driven; located in all parts of production processes	Often incremental and focus on diffusion; focus on solving local problems or meeting local demand; inclusion of marginalised in innovation process; reverse engineering also plays important role	Type of innovation; business models; sustainability and scaling-up; synergies and conflicting interests between university core missions
Learning	Learning by doing through production and implementation; Profit maximization goals	Contextualised learning, focus on diffusion and needs; learning about social processes, process of inclusion and formulation; guided by inclusive development related goals	Type of ideas and skills; type of (co-) creation processes and knowledge use; absorptive capacity by users; knowledge brokerage systems; intermediaries and learning spaces
Interaction	Often formalised and contract-based	Needs to be open and socialised and include participants along value chain	Type of processes and mechanisms; level and nature of engagement; collaborative networks and partnerships; interactive learning spaces; student education; teaching/training of community members
Institutions	Traditional hard (laws, regulations, standards) and soft institutions including trust; regulation	Complex mix of informal and formal; requirement for spaces to engage and build trust with new constellations of actors; regulatory environment crucial for allowing new approaches to traditional activities	Intellectual property rights, laws and regulations; ICT facilities; university policies and initiatives on societal engagement and local entrepreneurship; university incentive and reward systems for researchers; government subsidy systems and support systems

innovation. The fencing solution would qualify as an incremental innovation in this framework.

The water purification solution project would be an example of a modular innovation, which Henderson and Clark define as '…innovation that only changes the core design concepts of a technology…' (1990: 12). The aim of this project was to develop clay pots that could purify water in a simple and safe way. The technology that was developed would transform the use of the pots, but their look and feel ('architecture') would remain the same.

The concept of modular innovation also proves relevant for some of the process innovations in our sample. In the health risk assessment application project, a paper-based risk assessment tool was replaced by a mobile phone application to test its impact on the training of community health workers and the health screening process in a low-resource setting (Surka et al. 2014). Bringing in mobile technology to improve a process while leaving the overall structure of the process intact characterized other projects in our sample as well.

Henderson and Clark (1990, 11) describe *architectural* innovation as '… the reconfiguration of an established system to link together existing components in a new way'. An example of architectural innovative in our study are the multi-purpose water platforms developed by faculty and students at a university's department of architecture. In the Imizamo Yethu community where the platforms were built, an estimated 9464 households make use of shared toilets and taps, with a service ratio of 61:1 households per toilet and 394:3 households per tap. The aim of the washing platforms project was to provide more dignified places for water collection, spaces for the washing of clothes and the integration of these with shared toilet facilities. The platforms also serve as social gathering spaces and clean areas for children to play (Water Platforms, Imizamo Yethu, Hout Bay (South Africa) 2013).

The combination of existing components (taps and toilets) created value for the community (social cohesion, safety).

A few projects in our sample can be classified as *radical* innovations, which involves '… introducing a new concept that departs in a significant way from past practice'(Henderson and Clark 1990: 9). Prahalad posits that the Bottom of the Pyramid (BoP) markets are a new source of radical innovation, as the characteristics of these markets force people to '… rethink the very source, the focus and the processes of innovation' (Prahalad 2012, 6). The fire detector device was developed by a faculty-student team at one of the university's engineering faculties in response to the need for a suitable fire detection technology for townships is an illustrative example. Here the very concept of fire detection had to be rethought as available technologies are very sensitive to smoke, which make them less suitable for a township environment.[1]

Another example of a radical innovation is the real-time video solution for low-bandwidth environments

Table 3: UTIIs included in pilot study by innovation type and degree

	Product/service	Process	Combination
Incremental	• Suitable fence • Sustainable housing	• Emergency guidelines	
Modular		• IT-based home care system • Mobile health risk assessment app	
Architectural	• Multi-purpose water platforms • Settlement urban planning		
Radical	• Last mile voice & data solution	• Water quality reporting app • Mobile-based health treatment app • Low-bandwidth video solution	• Fire detection device • Solar based mobile power statrion

developed by a team of researchers at a university electrical engineering department, which offers a completely new technology to a previously excluded market. The project's commercial spin-off company, uses the platform to new markets and to give smaller content providers access to these markets.

Innovations such as this, which open up markets and have the potential to move 'up market' to change the rules of the game in higher income segments, have been called *disruptive* innovations (Christensen et al. 2006; Hwang and Christensen 2008).

Table 3 provides an overview of the UTIIs categorized according to type and degree of innovation.[2] The majority of the cases we looked at are examples of relatively simple solutions from a technological point of view. However, these solutions can be sophisticated in terms of their design for inclusiveness. The mobile phone-based health treatment adherence solution provides a good example. The software platforms used are open source (i.e. low cost) and widely available, easy to customize and suitable for use by non-technical staff (Bobrow et al. 2014).

The extent to which innovations are useful in contexts, or have 'contextual quality', requires deep knowledge of such contexts (Nakata and Weidner 2012; Prahalad 2012; Mitchell and McGahan 2014). The data from our pilot study, while preliminary, indicate that this is the case in all these UTII projects, irrespective of the degree of innovation either in terms of technical novelty or their social dimensions.

Actors and innovators

If we consider the innovator to be ' … the person or organizational unit responsible for combining the factors necessary … ', where factors refer to ' … different types of knowledge, capabilities, skills and resources' (Fagerberg 2006, 3), the innovators in most of our cases are university students and research staff. Our sample included some projects that were an integral (compulsory) part of the course curriculum and, as such, were the work of entire student cohorts. The majority of student work on inclusive innovation projects, however, was done as individual senior year projects, Master theses or PhD theses. In a few cases the students were the inventors. More often, however, it was faculty who came up with the idea for inclusive innovation or helped to channel the idea into the university. These academics emerge as key catalysts of inclusive innovation in our pilot study, including through their supervision of students' contributions.

The involvement of the end-user in innovation processes has been put forward as an important part of successful innovation (Ansari, Munir, and Gregg 2012; McGahan, Rezaie, and Cole 2014; Soman, Stein, and Wong 2014). Members of under-resourced (local) communities have been acknowledged as innovators in their own right (Prahalad 2012; Cheng and Bradley 2014; Soman, Stein, and Wong 2014), and as key contributors to innovation through the insights they provide into end-user needs and contextual nuances (Ansari, Munir, and Gregg 2012; McGahan, Rezaie, and Cole 2014). As we focused on innovations coming out of universities, these pure 'grassroots innovations' were left outside of the scope of this study.

Community members were, to varying degrees, part of the innovation process in most of our selected UTII projects. However, only in a few projects were they actively involved in design and, as such, able to make a *direct* contribution to innovation. The home care application, developed in a collaborative effort between students and community care takers, is an example. A participatory design approach was also used in student projects at an industrial design department:

A user-centric design philosophy is conducive to co-creation in inclusive innovation, which in this case may have been reinforced by the fact that a relatively large number of students and faculty staff from the university come from under-resourced communities themselves. The relationship between university innovators' background and their approach to inclusive innovation should be explored further.[3]

While low-income populations' contribution to design is more the exception than the rule for the projects in our sample, end-users were involved in the innovation development and implementation phases. Figure 1 gives an indication of end-user involvement for those projects where this information was available.

When we look more closely at our information on project drivers and degree of novel knowledge and know-how, the level of resources at the university emerges as a potential moderator. The size of the academic resource base available to a project, and the quality of those resources (taking level of education as a proxy), seems to be related to the degree of novelty. The suitable fence project, which we see as an incremental innovation, was the thesis work of one student. The low bandwidth

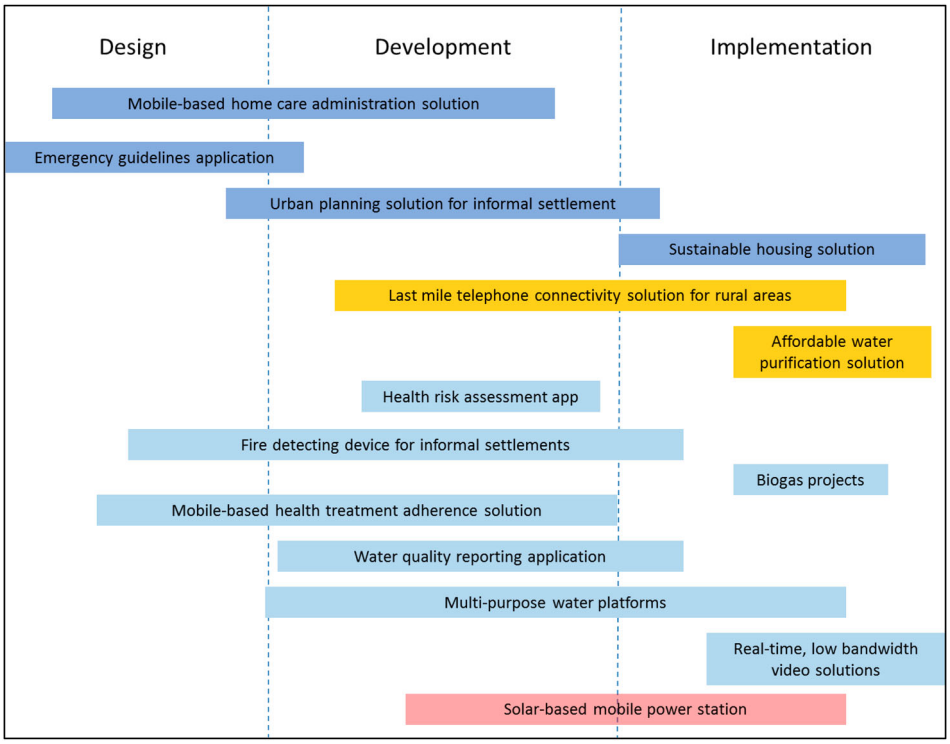

Figure 1: Community involvement in inclusive innovation.

video solution project, on the other hand, which was defined as a radical innovation, had a much more substantial resource base of one PhD student and four Master's students – supervised by two professors – as well as external sources of expertise. Some of the education-based projects, such as the fire detector device and the last mile telephone connectivity projects, had different students involved over time, each representing an opportunity for knowledge contribution to the project.

Interaction and partnerships

We argue that if the input provided by community members is critical to an innovation's ultimate success, these community partners should be considered 'co-innovators' even if they are not the orchestrators of the innovation process. This interpretation fits the notion that inclusive innovation is a process in which multiple actors collaborate in an innovation eco-system to make change happen (Prahalad 2012), a process where one or more partners – in our projects generally the university representative(s) – act as the 'value chain integrator' (Mitchell and Mcgahan 2014).

All UTII projects in our sample involve formal or informal institutional partnerships between the university and partner organizations, either other universities (local or international), communities, government institutions, NGOs or for-profit business companies. George, McGahan, and Prabhu (2012) argue that networks of relationships between actors contribute to the ability of individuals to achieve success. They make special mention of the potential value of networks in resource-limited contexts. Prahalad (2012) discusses partnerships as an essential part of innovation in low-income markets. These partnerships serve as enablers in multiple ways (capital, advice, access and other valuable resources), of which sufficient university and/or donor funding – discussed earlier – is one of the most important organizational conditions (Kruss and Gastrow 2015). The bulk of funding comes in the form of monetary contributions. We observed one example of in-kind funding, in the last mile telephone connectivity, where systems for access to power and a backup system were located at the head office of a partnering NGO.

Partnerships are also a way to access expertise. In line with the study by Petersen et al. (2016), interactive learning opportunities play an important role in the process taking place in formal and informal settings. Powell et al. (1996) argue that 'networks of learning' are the locus of innovation when sources of expertise are widely dispersed. In the projects in our sample, community members and community-based institutions were the main partners of choice for social and contextual knowledge. For example, in the mobile-based health treatment adherence project, researchers from the local university and a European university worked together with staff from a local health centre to develop the solution. The home care mobile app developers worked closely with community care givers to design a suitable care data mobile phone application. Networks of learning can also involve access to experience in the particular area of innovation, as was the case in the biogas project. The university in the Western Cape sought collaboration with a department of physics at another South African university, which had developed some expertise in applying the

technology in rural settings In the water quality reporting app project,the university team brought their experience from a previous project into the innovation process.

Burt (2005) and Petersen et al. (2016) argue that people whose networks bridge different groups have access to a broader diversity of information and are able to move knowledge from one group to the other, thereby driving creativity and new ideas. In our study, university faculties fulfilled this 'brokerage' role within their UTII project(s). There are several examples in our UTII projects of different students or student groups working on parts of the project over time, with a university faculty member ensuring continuity by transferring knowledge between consecutive project members. A final observation with regard to networks of learning involves the role of incubators and other innovation platforms at universities, such as one university's tech incubator and another's electronic database with projects. The existence of such shared physical and/or virtual infrastructures creates ties between projects, facilitating the diffusion of knowledge.

In their discussion of the role of universities in regional economic development, Nelles, Bramwell, and Wolfe (2005) use the notion of 'innovation as a social process' in which users and producers learn from each other through regular interaction. The involvement of end-users in the innovation process is seen as part of what makes inclusive innovation 'inclusive' (George, McGahan, and Prabhu 2012). We mentioned in the previous section that end-users were only involved as co-designers of products or processes in a few projects in our study (notably the narrative around co-design and co-creation at in particular, one of the universities in our sample). It was more common for university innovators to consult end-users at certain points in time during the design and development process than in the final stages and real-life implementation. The degree to which end-users are part of the inclusive innovation process is likely to have an impact on how much knowledge and know-how is exchanged and transferred between the university and the community, and the type of knowledge/know-how involved. When people work closely together, trust can develop. If end-users are able to influence design, they are also more likely to have a sense of ownership over the innovation, which could positively influence innovation adoption and use. Finally, as mentioned before, their input can be expected to increase the chance of the innovative technology being suitable for the context for which it is designed.

Community members might also be involved as production partners. In the fire detecting device project, the product's casing was made by community members. This adds economic value to the innovation's social value, not only by creating an opportunity for people to earn income, but also by giving them practical skills. Partnering with community members on the supply side can also facilitate access of the innovations to the marketplace, as is illustrated by the last mile telephone connectivity project: the proposed network will be installed by the locals, after being trained in basics of wireless networking, VoIP, dimensioning of solar system, and the billing system as a way to increase local buy-in of the network (Roro et al. 2012).

Knowledge and learning

In all projects reviewed, knowledge was a key part of what university representatives contributed to the innovation process. As this study was specifically focused on technology-based innovations, it implies that much of this knowledge was technical know-how and embedded in the innovation itself. This is one 'demand driven' way in which the innovation creates value for low-income or resource-deprived communities – by enabling the development of a technical solution that addresses a need. The direct transfer of knowledge and know-how to community members, to empower them in their role of co-designer, co-producer or consumer, helps engage communities in interactive learning trajectories. In the urban planning project, community members gained knowledge about urban planning and building processes, and learned how to organize and mobilize themselves. Another example is the health risk assessment app project, in which community health workers were taught how to measure cardiovascular risk using a mobile phone application.

An understanding of the social and cultural context in which the innovation is to be used is a second type of knowledge needed in inclusive innovation processes.[4] The three main sources of this type of 'social knowledge' were community leaders, representatives and community end-users, as well as NGOs involved in that particular community. NGOs usually served as an intermediate, offering the university students or researchers the opportunity to build on and extend an already established relationship with members of the community.

The ability of innovation partners to incorporate and use external knowledge and know-how is critical, and is often referred to as 'absorptive capacity' within the traditional NIS-type innovation models. Relevant prior knowledge determines the absorptive capacity of an organization or unit or, in our case, an innovative UTII project. It is what allows the project's decision makers to recognize the value and applicability of the UTII. Some of the projects were standalone 'ad hoc' UTIIs; others were linked into 'innovation-hub' infrastructures As the data indicate, this is not necessarily a guarantee for success in terms of smooth implementation or creation of socio-economic impacts, but it could provide easier access to relevant prior experiences and thus add to the ability to absorb new knowledge. Learning processes are usually cumulative. Consequently, projects undertaken as standalone, one-off initiatives, are likely to benefit less from existing external sources than projects firmly embedded in a support structures or with relatively long timeframes. Although by no means conclusive, the results of our first study give the impression that many projects were being driven by individual university staff at their own discretion. If these individuals are involved in multiple projects over time, their ability to acquire, incorporate and transfer knowledge will add to the absorptive capacity in these projects and related infrastructures.

The ultimate success of an inclusive innovation project often depends on the creativity, ingenuity and persistence of key individuals. In addition to learning and knowledge-sharing capabilities, innovation scholars have argued that

the ability to inspire others and gain their commitment ' … by actively and enthusiastically promoting [the innovation's] progress through the critical stages' (Achilladelis, Jervis, and Robertson 1971, 14, quoted in Howell and Higgins 1990) positively affects innovation performance. The person bringing these qualities into the innovation process has been referred to as a 'project champion'. The champions in our UTII projects were often university faculty who had been instrumental in their project's origination and then became project leaders ensuring its continuation. This is important, for example, when various students contribute to the project over time. When a student leaves the project, the champion can help keep the momentum going and minimize 'knowledge leaks'. In innovation literature, a distinction is made between champions 'formally appointed' and 'emergent informal' champions. Contextual factors, such as the level of decentralization of decision-making authority, have been said to be a potential influence on the role and impact of innovation champions.

Economic factors

Property rights

Intellectual property rights, as legal privileges, are usually considered in the context of commercial technology development and university-industry partnerships (Henderson, Jaffe, and Trajtenberg 1998; Mazzoleni and Nelson 2007). The economic and commercial notion of exclusive rights to particular resources seems to be at odds with the objective of social development, which is about providing people with as much access to resources as needed. There are some projects in our study in which intellectual property rights play a crucial role. The fire detector software code is copyright protected and the team has applied for patents, with the help of the university's technology transfer office. The project has spun off into a company through which the innovation is being commercialized. In the case of the real-time, low-bandwidth video solution project, where the university researchers contributed to intellectual property, a license was provided to an outside entrepreneur for its commercialization (Barnard 2012). In these cases, the social impact of the innovation is realized primarily through its use. The opposite happens as well, where innovators give non-owners free access to their intellectual property. The water quality reporting app team applied an open source approach to the part of the project they were responsible for. It was funded by a large NGO.[5] The health risk app was developed using an open source platform, through which mobile health innovations are created and shared with a community of m-health innovators and users across the globe. Social value is realized through the use of these innovations, but potentially also through their development and manufacturing/delivery when learning is shared freely.

This does not mean that an open source strategy is necessarily superior in terms of inclusive innovation performance. Commercialization requires the application of business principles. The fire detector device team leader mentioned that having to write a business plan to obtain university seed funding made the team aware of aspects they had not yet considered. As referred to earlier in this paper, the lead faculty involved in a university's innovation hub mentioned that a clear business model or business case would have been of value to projects she discussed in the interview. More research is needed to understand what makes university innovators choose a commercialization versus an open source/development strategy, and how this decision impacts on the innovation process and performance (implementation, use, scalability). While patents have been used as an indicator of commercial technological innovation (Archibugi 1992), the study of inclusive innovation will require broader indicators to accommodate for processes with a developmental focus.

Economics

In terms of project funding on our UTIIs, there is a divide between projects that are relatively well funded and those done on a shoestring. Research-driven innovations in our study are often the former, while most of the education-based projects fall within the shoestring category.

There is an example of university seed funding, but sizeable funding mostly comes from government research funding agencies like the Technological Innovation Agency and the National Research Foundation, intergovernmental organizations and non-governmental organizations. Universities may be cash-strapped, especially in an emerging economy such as South Africa, but are eligible to funding UTII projects to support social and economic development in their role as research partners in inclusive innovation. While the majority of survey

Table 4: UTII projects by university missions and inclusive innovation regime

	Developmental	Hybrid	Commercialisation
Student education	Mobile-based home care admin solution, multi-purpose water platform; affordable water purification solution; urban planning solution; sustainable housing solution; last mile telephone connectivity solution; water reporting app; health risk assessment app	Solar-based mobile power station; fire detector	Real-time, low-bandwidth video solutions
Academic research	Health risk assessment app; mobile-based health treatment adherence solution		Real-time, low-bandwidth video solutions
Community engagement	Last mile telephone connectivity solution; water quality reporting app; suitable fencing solution; health risk assessment app; mobile-based health treatment adherence solution; multi-purpose water platform; affordable water purification solution; urban planning solution; sustainable housing solution	Solar-based mobile power station; fire detector	

Table 5: UTII research agenda framework

Component	Themes of importance extracted from our project
Innovation	The nature, drivers, strategies and innovation processes: • Types of innovations (product, service, process, new markets, new input factors, new production techniques, organisational innovations, business model); • Nature of innovation (incremental, modular, architectural and radical, - recombinant) • Strategies for the innovation process (developmental, hybrid, commercialisation) • Product characteristics and adaptation to local infrastructure and context; • Manufacturing and distribution (delivery and distribution, localised collaborative value chains); • Business development (managing eco-systems, scaling up and diffusion).
Actors	The institutional background, incentives, resources and capabilities of contributors: • The role, range and presence of actors involved in the process (university, knowledge brokers, intermediaries, cooperatives, NGOs); • Capabilities / competence of actors (e.g. knowledge, partnering, communication, technology, management, marketing, manufacturing, lobbying);
Interaction	The major focus for interaction is the nature of partners, engagement and partnerships: • Inclusiveness to be considered at level of networks and level of individual contacts; • Level of inclusiveness and nature of engagement, level of engagement and inclusiveness; • Modes of and mechanisms for organisation of community interaction e.g. cooperatives. • Capabilities in the linkages and partnerships for forming networks of learning, and sustaining partnerships; • Roles, forms and nature of partnerships as enabler
Knowledge and learning	The role of knowledge and learning play a central role in inclusive innovation projects and we therefore suggest future work to be focused on: • Role of actors in the knowledge development and learning process; • The mechanisms for knowledge development and learning and refinement of ideas and projects • Types and forms of knowledge e.g. technological, business, tacit and codified knowledge • Management of, drivers, types and forms of the development of knowledge e.g. "co-creation" • Developing and characterising capability to learn and adapt through e.g. absorptive capacities in actors;
Infrastructure (Knowledge, Physical and Financial)	Infrastructural components are important within innovation studies and we therefore suggest future work to be focused on: • Innovation platforms and learning spaces • Management and organisation infrastructure (project management expertise, cooperatives, clusters, M&E); • Knowledge infrastructure (expertise, know-how, strategic information); • Physical infrastructure (connectivity, roads, water electricity); • Financial infrastructure (funding availability of seed funding, mechanisms to support access to funding, grants, micro-financing).
Institutions	In order to design a process that is not extractive but seeks for the engagement to increase in value and depth over time, we propose that the following is considered: • Intellectual Property (IP) and models of ownership • The development of trust between teams and communities (social capital) • Co-creation models of knowledge and implications for IP ownership • Organising the UTII projects and engagement with community (cooperatives, church, community centre etc.)

respondents indicated that their project received financial support from the university, it was not necessarily a large amount of money nor easy to obtain. For example, in the urban planning solution project, getting funding was perceived to be a struggle and the small amount eventually received from the university critical to the project happening. Even though our empirical data are not conclusive, it is worth noting that all projects with a substantial budget came out of one university, while the projects from one of the other three universities had relatively limited financial resources. According to a faculty member from this university who was involved in a few of these projects, limited resources are dedicated to fundraising and marketing at her institution, requiring her to work

harder for funding and partnerships than faculty at better resourced and networked universities in the region. She linked availability of resources to the likelihood of project implementation. A colleague of hers also makes this connection. In his opinion, the funding and university structure needed to implement projects does not exist.

With lack of funding getting in the way of project implementation, it is important to understand what it takes for inclusive innovators at universities to secure financial resources and how institutional factors such as reputation and innovation structures influence this process.

Given these economic constraints, pricing and product cost management are important considerations in most projects in our sample. The developers of the fire detector decided on a maximum price for their product based on interviews with potential users, which then became a product development parameter. Like the mobile-based health treatment adherence solution project team, the last mile telephone connectivity project leaders used low-cost technology and open source software to allow for the development of the system on a relatively small budget. Low set-up costs also facilitate replication of the innovation.

Discussion

Based on our findings, we can distinguish three dominant 'inclusive innovation 'regimes':[6] 'developmental', 'commercialization', and a combination or hybrid of both. Developmental regimes are traditionally the domain of non-profit and intergovernmental organizations, whereas commercialization is traditionally the focus of for-profit business enterprises. Where development and profit meet, social entrepreneurs are at work. These entrepreneurs can be associated with, or employed by, public sector organizations (such as academic entrepreneurs) or active in private non-profit organizations.

Inclusive innovations at the four universities in our sample follow any of these three regimes. In some UTII projects, the strategy is more premeditated and targeted, while in others, they are more *ad hoc* and evolve over time. It is at this stage still unclear which conditions shape and drive the different strategies and which pathways lead to successful innovation with positive impacts on the community. In a next phase of the research, the authors could further investigate the relation between the drivers behind inclusive innovation, the likelihood of its implementation and the socio-economic impact through its use.

The inclusive innovation strategies and multiple university missions (teaching and training, research and science, knowledge transfer and community engagement can be organized in a matrix as presented in Table 4).

Further research is needed to assess the external impacts of UTII projects and related innovation regimes. A more formal approach to impact assessment (IA) allows for structured learning and identification of good practices. A fully fledged IA should incorporate the analysis of key inputs, project implementation processes, and environmental factors that affect the level of innovativeness, innovation adoption and usage. For this we need to create a broader analytical framework and research agenda for understanding and surveying UTII projects in general. Adopting our 'system of innovation components' approach, these research themes are numerous and varied (see Table 5). Our follow-up project, focusing on UTII impact measurement and classification, will be the first study to test and apply this comprehensive framework.

Funding

This work was partially supported by LDE Centre for Frugal Innovation in Africa (universities of Leiden, Delft, Rotterdam) in The Netherlands; DST-NRF CoE in Scientometrics and Science, Technology and Innovation Policy, Stellenbosch University, South Africa.

Notes

1. Francois Petousis quoted in Turner (2013, August 5).
2. As disruptive innovation refers to market-related performance rather than degree of innovation, it is excluded from this overview.
3. Research questionnaire (2014).
4. The degree of new technical knowledge associated with the innovation (e.g. incremental, modular, architectural, radical) does not necessarily correlate with the degree of new social knowledge. The successful implementation of a low-tech innovation may require a high level of new social knowledge.
5. Interestingly, the water test kits developed elsewhere in the research consortium were taken to market, but unsuccessfully.
6. We define a 'technological innovation regime' as a fairly stable configuration of mechanisms and goals, which are based on institutionalized patterns of innovation practices and knowledge diffusion processes.

References

Ansari, S., K. Munir, and T. Gregg. 2012. "Impact at the 'Bottom of the Pyramid': The Role of Social Capital in Capability Development and Community Empowerment." *Journal of Management Studies* 49 (4): 813–842. doi:10.1111/j.1467-6486.2012.01042.x.

Achilladelis, B., P. Jervis, and A. Robertson 1971. "A Study of Success and Failure in Industrial Innovation: Report on Project SAPPHO to SRC." Sussex: University of Sussex.

Archibugi, Daniele. 1992. "Patenting as an Indicator of Technological Innovation: A Review." *Science and Public Policy* 19 (6): 357–368. doi:10.1093/spp/19.6.357.

Barnard, P. 2012. *Research Contracts and Intellectual Property Services Office*. University of Cape Town Research Report.

Bobrow, Kirsty, Thomas Brennan, David Springer, Naomi S Levitt, Brian Rayner, Mosedi Namane, Ly-Mee Yu, Lionel Tarassenko, Andrew Farmer. 2014. "Efficacy of a Text Messaging (SMS) Based Intervention for Adults with Hypertension: Protocol for the StAR (SMS Text-message Adherence suppoRt trial) Randomised Controlled Trial." *BMC Public Health* 14: 28, 9 pages.

Brundenius, Claes, Bengtåke Lundvall, and Judith Sutz. 2009. "The Role of Universities in Innovation Systems in Developing Countries: Developmental University Systems – Empirical, Analytical and Normative Perspectives." *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting* 311–333.

Burt, Ronald S. 2005. *Brokerage and Closure: An Introduction to Social Capital*. Oxford: Oxford University Press.

Cheng, Y. L., and B. Bradley. 2014. "Appropriate Technologies for the Global South." *Innovating for the Global South: Towards an Inclusive Innovation Agenda* 47–68.

Christensen, Clayton M., Heiner Baumann, Rudy Ruggles, and Thomas M. Sadtler. 2006. "Disruptive Innovation for Social Change." *Harvard Business Review* 84 (12): 94–101.

Cloete, N., T. Bailey, and P. Pillay. 2011. "Universities and Economic Development in Africa."

Cozzens, Susan E., and Raphael Kaplinsky. 2009. "Innovation, Poverty and Inequality: Cause, Coincidence, or Co-Evolution?" *Handbook of Innovation Systems and Developing Countries* 57–82.

Cozzens, Susan, and Judith Sutz. 2012. "Innovation in Informal Settings: A Research Agenda." *IDRC, Ottawa, Canada* 1–53.

Dagnino, R. 2012. "Why Science and Technology Capacity Building for Social Development?" *Science and Public Policy* 39 (5): 548–556. doi:10.1093/scipol/scs068.

Delvenne, Pierre, and François Thoreau. 2012. "Beyond the "Charmed Circle" of OECD: New Directions for Studies of National Innovation Systems." *Minerva* 50 (2): 205–219. doi:10.1007/s11024-012-9195-5.

Fagerberg, Jan. 2003. "Schumpeter and the Revival of Evolutionary Economics: An Appraisal of the Literature." *Journal of Evolutionary Economics* 13 (2): 125–159. doi:10.1007/s00191-003-0144-1.

Fagerberg, Jan. 2006. "Innovation: A Guide to the Literature." In *The Oxford Handbook of Innovation*, 1–26. Oxford: Oxford University Press.

Foster, Christopher, and Richard Heeks. 2013a. "Analyzing Policy for Inclusive Innovation: The Mobile Sector and Base-of-the-Pyramid Markets in Kenya." *Innovation and Development* 3 (July 2015): 103–119. doi:10.1080/2157930X.2013.764628.

Foster, Christopher, and Richard Heeks. 2013b. "Conceptualising Inclusive Innovation: Modifying Systems of Innovation Frameworks to Understand Diffusion of New Technology to Low-Income Consumers." *The European Journal of Development Research* 25 (3): 333–355. doi:10.1057/ejdr.2013.7.

Foster, Christopher, and Richard Heeks. 2014. "Nurturing User–producer Interaction: Inclusive Innovation Flows in a Low-Income Mobile Phone Market." *Innovation and Development* 4 (2): 221–237. doi:10.1080/2157930X.2014.921353.

Foster, Christopher, and Richard Heeks. 2015. "Policies to Support Inclusive Innovation." *Development Informatics* 61. doi:10.1016/0736-5853(84)90003-0.

Furco, Andrew. 2010. "The Engaged Campus: Toward a Comprehensive Approach to Public Engagement." *British Journal of Educational Studies*. doi:10.1080/00071005.2010.527656.

George, G., a.M. McGahan, and J. Prabhu. 2012. "Innovation for Inclusive Growth: Towards a Theoretical Framework and a Research Agenda." *Journal of Management Studies* 49 (4): 661–683. doi:10.1111/j.1467-6486.2012.01048.x.

Hagedoorn, J. 1996. "Innovation and Entrepreneurship: Schumpeter Revisited." *Industrial and Corporate Change* 5 (3): 883–896. doi:10.1093/icc/5.3.883.

Halme, Minna, Sara Lindeman, and Paula Linna. 2012. "Innovation for Inclusive Business: Intrapreneurial Bricolage in Multinational Corporations." *Journal of Management Studies* 49: 743–784. doi:10.1111/j.1467-6486.2012.01045.x.

Heeks, Richard, Christopher Foster, and Yanuar Nugroho. 2014. "New Models of Inclusive Innovation for Development." *Innovation and Development* 4 (2): 175–185. doi:10.1080/2157930X.2014.928982.

Henderson, Rebecca, and Kim B. Clark. 1990. "Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms." *Administrative Science Quarterly* 35 (1): 9–30. doi:Article.

Henderson, Rebecca, Adam B. Jaffe, and Manuel Trajtenberg. 1998. "Universities as a Source of Commercial Technology: A Detailed Analysis of University Patenting, 1965–1988." *Review of Economics and Statistics* 80 (1): 119–127. doi:10.1162/003465398557221.

von Hippel, Eric. 2005. "Democratizing Innovation: The Evolving Phenomenon of User Innovation." *Journal Fur Betriebswirtschaft* 55 (1): 63–78. doi:10.1007/s11301-004-0002-8.

Howell, Jane M., and Christopher A. Higgins. 1990. "Champions of technological innovation." *Administrative Science Quarterly*:317–341.

Hwang, Jason, and Clayton M. Christensen. 2008. "Disruptive Innovation in Health Care Delivery: A Framework for Business-Model Innovation." *Health Affairs*. doi:10.1377/hlthaff.27.5.1329.

Iizuka, Michiko. 2013. "Innovation Systems Framework: Still Useful in the New Global Context?" 31. *Innovation*. http://www.merit.unu.edu/publications/wppdf/2013/wp2013-005.pdf.

Kaplinsky, R., and M. Morris. 2002. *A Handbook for Value Chain Research*. Ottawa: IDRC. http://oro.open.ac.uk/5861/.

Kezar, Adrianna. 2005. "Redesigning for Collaboration within Higher Education Institutions: An Exploration into the Developmental Process." *Research in Higher Education* 46 (7): 831–860. doi:10.1007/s11162-004-6227-5.

Kraemer-mbula, Erika, and Watu Wamae. 2010. "Adapting the Innovation Systems Framework to Sub-Saharan Africa." *Innovation and the Development Agenda* 65–90. doi:10.1787/9789264088924-7-en.

Kruss, G. 2006. "Creating Knowledge Networks: Higher Education, Industry and Innovation in South Africa." *Science Technology & Society* 11 (2): 319–349. doi:10.1177/097172180601100203.

Kruss, Glenda, John Adeoti, and Dani Nabudere. 2012. "Universities and Knowledge-Based Development in Sub-Saharan Africa: Comparing University–Firm Interaction in Nigeria, Uganda and South Africa." *The Journal of Development Studies* 48 (4): 516–530. doi:10.1080/00220388.2011.604410.

Kruss, G., and M. Gastrow. 2015. *Linking University and Marginalised Comunities*. Cape Town: Human Sciences Research Council.

Kruss, Glenda, Simon McGrath, Il-haam Petersen, and Michael Gastrow. 2015. "Higher Education and Economic Development: The Importance of Building Technological Capabilities." *International Journal of Educational Development* 43 (July). Elsevier Ltd: 22–31. doi:10.1016/j.ijedudev.2015.04.011.

Kruss, Glenda, and Letseka Moeketsi. 2005. "Special Issue: Higher Education-Industry Research Partnerships and Innovation in South Africa: Introduction." *Industry and Higher Education* 19 (April): 104–108.

Kuhlmann, Stefan, and Arie Rip. 2015. "Evolving Concertation – New Constellation of Actors Addressing Grand Challenges." In *The 2015 Annual Conference of EU-SPRI Forum: Innovation Policies for Economic and Social Transitions: Developing Strategies for Knowledge, Practices and Organizations*, 124–26. Dublin, Ireland.

Leontief, W. 1950. "Joseph A. Schumpeter (1883–1950)." *Econometrica: Journal of the Econometric Society* 18 (2): 103–110. doi:10.2307/1907263.

Lucas, P. (2012, July 19). "UCT team awarded R2.5m NRF Grant for SA Biogas Projects." http://www.uct.ac.za/usr/press/2012/biogas_projects.pdf.

Makhanya, M. 2014. "The Role of Higher Education in a Developmental State Prof Mandla Makhanya , Principal and Vice Chancellor , University of South Africa Wednesday , 25 June 2014." 1–20.

Malerba, Franco. 2007. "Innovation and the Evolution of Industries." *Innovation, Industrial Dynamics and Structural Transformation: Schumpeterian Legacies* 7–27. doi:10.1007/978-3-540-49465-2_2.

Mathiassen, Lars, and Peter Axel Nielsen. 2008. "Engaged Scholarship in IS Research." *Scandinavian Journal of Information Systems* 20 (2): 3–20.

Mazzoleni, Roberto, and Richard R. Nelson. 2007. "Public Research Institutions and Economic Catch-Up." *Research Policy, Elsevier* 36 (10): 1512–1528. doi:10.1016/j.respol.2007.06.007.

McGahan, Anita M., Rahim Rezaie, and Donald C. Cole. 2014. "Embedded Innovation in Health." In *Innovating for the Global South: Towards an Inclusive Innovation Agenda*, edited by Soman, Dilip, Janice Gross Stein, and Joseph Wong, 94–113. Toronto: University of Toronto Press.

Mitchell, Will, and Anita M. Mcgahan. 2014. "Inclusive Innovation." In *Innovating for the Global South: Towards an Inclusive Innovation Agenda*, edited by Soman, Dilip, Janice Gross Stein, and Joseph Wong, 168–174. Toronto: University of Toronto Press.

Monday Paper. (2008, October 6). "Come Dirty Water." http://www.uct.ac.za/mondaypaper/archives/?id=7126.

Nakata, Cheryl, and Kelly Weidner. 2012. "Enhancing New Product Adoption at the Base of the Pyramid: A Contextualized Model." *Journal of Product Innovation Management* 29 (1): 21–32. doi:10.1111/j.1540-5885.2011.00876.x.

Nelles, Jen, Allison Bramwell, and David A. Wolfe. 2005. "History, Culture and Path Dependency: Origins of the Waterloo ICT Cluster." *Global Networks and Local Linkages: The Paradox of Cluster Development in an Open Economy* 227: 252.

Paunov, C. 2013. "Innovation and Inclusive Development." *OECD Publishing* 67. doi:10.1787/5k4dd1rvsnjj-en.

Petersen, I., G. Kruss, M. Gastrow, and P. Nalivata. 2016. "Innovation Capacity-Builing and Incluisve Development in Informal Settings: A Comparative Analysis of Two Interactive Learngn Spaces in South Africa in Malawi." *Journal of International Development* 1: 10–14. doi:10.1002/jid.

Powell, Walter W., Kenneth W. Koput, and Laurel Smith-Doerr. 1996 "Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology." *Administrative Science Quarterly* 41 (1): 116–145.

Prahalad, C. K. 2012. "Bottom of the Pyramid as a Source of Breakthrough Innovations." *Journal of Product Innovation Management* 29 (1): 6–12. doi:10.1111/j.1540-5885.2011.00874.x.

Rip, Arie, Pierre-benoit Joly, and Michel Callon. 2010. "Reinventing Innovation." *Maarten Arentsen Governance and Innovation* 2006: 1–13. doi:10.1108/eb039924.

Roro, Z., Rey-Moreno, C., Tucker, W. D., and M. Jay Siya. 2012 Socio-economic aspects of Voice-over-IP technology in Rural SA. Department of Computer Science, UWC, Bellville. Report, available at http://repository.uwc.ac.za/xmlui/bitstream/handle/10566/594/RoroRey-MorenoTuckerSiya-SATNAC2012.pdf?sequence=1&isAllowed=y

Rucker, A., and G. Trah. 2007. *Local and Regional Economic Development Local and Regional Economic Development*. Eschborn.

Santiago, Fernando. 2014. "Innovation for Inclusive Development." *Innovation and Development* 4 (1): 1–4. doi:10.1080/2157930X.2014.890353.

Sehoole, C., and J. Knight. 2013. "Internationalisation of African Higher Education."

Smith, Adrian, Mariano Fressoli, and Hernán Thomas. 2014. "Grassroots Innovation Movements: Challenges and Contributions." *Journal of Cleaner Production* 63 (January). Elsevier Ltd: 114–124. doi:10.1016/j.jclepro.2012.12.025.

Smits, Ruud, and Stefan Kuhlmann. 2004. "The Rise of Systemic Instruments in Innovation Policy." *International Journal of Foresight and Innovation Policy* 1 (1/2): 4. doi:10.1504/IJFIP.2004.004621.

Soman, Dilip, Janice Gross Stein, and Joseph Wong, eds. 2014. *Innovating for the Global South: Towards an Inclusive Innovation Agenda*. Toronto: University of Toronto Press.

Soni, Pavan, and Rishikesha T. Krishnan. 2014. "Frugal Innovation: Aligning Theory, Practice, and Public Policy." *Journal of Indian Business Research* 6: 29–47. doi:10.1108/JIBR-03-2013-0025.

Surka, S., S. Edirippulige, K. Steyn, T. Gaziano, T. Puoane, and N. Levitt. 2014. "Evaluating the use of mobile phone technology to enhance cardiovascular disease screening by community health workers." *International Journal of Medical Informatics* 83 (9): 648–654.

Swaans, Kees, Birgit Boogaard, Ramkumar Bendapudi, Hailemichael Taye, Saskia Hendrickx, and Laurens Klerkx. 2014. "Operationalizing Inclusive Innovation: Lessons from Innovation Platforms in Livestock Value Chains in India and Mozambique." *Innovation and Development* 4 (2): 239–257. doi:10.1080/2157930X.2014.925246.

Turner, F. (2013, August 5). "Fire Detectors Can Help to Prevent Shack Fires." http://www.groundup.org.za/content/fire-detectors-can-help-prevent-shack-fires.

Van de Ven, A. H. 2006. "Engaged Scholarship: Creating Knowledge for Science and Practice." (unpublished manuscript). University of Minnesota, Rochester.

Voeten, Jaap. 2013. "Internal Regulation of Innovation Externalities for Development : Lessons from Vietnam." July: 1–18.

Walsh, James P., Jeremy C. Kress, and Kurt W. Beyerchen. 2005. "*Book Review Essay: Promises and Perils at the Bottom of the Pyramid*: The Fortune at the Bottom of the Pyramid: Eradicating Poverty through Profits: C. K. Prahalad.." *Administrative Science Quarterly* 50 (212): 473–482. doi:10.2189/asqu.2005.50.3.473.

Wamae, Watu. 2010. *Innovation and the Development Agenda*. *Development*. doi:10.1787/9789264088924-en.

Water Platforms, Imizamo Yethu, Hout Bay (South Africa). 2013. liveprojectsnetwork.org/project/water-platforms/.

Wieczorek, Anna J., and Marko P. Hekkert. 2012. "Systemic Instruments for Systemic Innovation Problems: A Framework for Policy Makers and Innovation Scholars." *Science and Public Policy* 39 (1): 74–87. doi:10.1093/scipol/scr008.

WWF South Africa. 2014, March 7. "WWF-SA Awards Recognise Climate Innovations." http://www.wwf.org.za/what_we_do/climate_solver/?10381/WWF-SA-awards-recognise-climate-innovations.