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BRICOLAGE AS A MEANS OF INNOVATING IN A RESOURCE-SCARCE ENVIRONMENT: A STUDY OF INNOVATOR-ENTREPRENEURS AT THE BOP

PAULA LINNA

The aim of this study is to gain an insight on how bricolage is used as a method of innovation in a resource scarce context. Previous studies of entrepreneurship have emphasized the significance of bricolage especially as a way to mobilize resources. Although seen to be essential when entrepreneurs are facing resource constraints, no attention has been paid to bricolage in the context of local entrepreneurs in developing countries. This study is based on the analysis of innovation processes of Kenyan innovator-entrepreneurs who are designing low-cost renewable energy solutions for rural people at the Base of the Pyramid (BOP). In this study, three different types of bricolage were especially recognized: a social mindset combined with resourcefulness; making do with resources at hand; and improvisation as way of proceeding. This research provides empirical evidence on how bricolage is used in different parts of the innovation process. The paper contributes significantly to the emerging discussion on innovation and entrepreneurship in the context of a developing country.

Keywords: BOP, low-cost innovation, business model, resource-scarcity, bricolage.

1. Introduction

Innovations and entrepreneurship are critical ingredients for poverty reduction. Innovations are required in almost all socio-economic and environmental spheres for countries to grow in an inclusive and sustainable manner (Sachin, 2010; Bowman, 2009). Nevertheless, the development of innovation capacity in many low-income markets has been poor. Development efforts continue to rely on inputs from the industrially advanced economies and these are often inappropriate to the needs of low-income people and resource-scarce operating environments. National and international institutions are frequently unable to find solutions for highly location-specific problems faced by people in a given region; instead, it is often a grass root level innovation, whether emerging from communities or individuals (and based on traditional knowledge and resources or contemporary contexts) that solve such problems (Pathak, 2008). Consequently, there is need to be give urgent policy attention to processes of innovation that are efficient and appropriate for low-income developing countries (Kaplinsky *et al.*, 2009). Similar kinds of innovation policy to those practiced in the developed countries are not suitable; instead innovation ecosystems need always to be locally developed to best address the typical stumbling blocks found in each country's environment, albeit with insights from other countries' experiences too (Sachin, 2010).

Recently, there has been increased interest in the market opportunities at the BOP. The BOP refers to the four billion people living with less than \$3000 purchasing power parity per year and frames these low-income people as untapped business opportunities and as active consumers and entrepreneurs (Prahalad, 2005; Hart, 2005; Hammond *et al.*, 2007). Besides market opportunities for companies, recent studies have elaborated the need to view the BOP as a source of innovations. The majority of the previous writing on BOP innovation has mainly concentrated on innovation models of MNCs from developed countries (Prahalad and Hart, 2002; London, 2008; Williams *et al.*, 2011), only little attention is directed to alternative models of innovation offered by local players from emerging markets (Ray and Ray, 2010) especially, concerning innovation activities in resource-poor settings. Hence, there is still much to uncover regarding how to create innovative products and services in the emerging markets context (Chavan and Pradhu, 2011).

The aim of this study is to gain insights on how to design (financially viable) solutions for the BOP. The research is based on studying two Kenyan innovator-entrepreneurs where through meager resources have created low-cost renewable energy solutions for the BOP. The focus of analysis is the innovation process, which is seen in this research as a business model development: how the solutions are created from scratch into profitable business. The more specific focuses are: i) how a technically workable end-solution was created and ii) the design of the business model. When encountering the research, it was possible to recognize the use of bricolage as a means of innovating; therefore, the research question is formulated as: How is bricolage used by developing country entrepreneurs to develop market-based innovations for the low-income people?

The genesis of bricolage in developing countries is intertwined with undisputed fact that a majority of the third world nations struggle to fight off the ever growing levels of poverty. Aspiring entrepreneurs in these countries have intervened through their innovative solutions to in part provide affordable products while at the time availing products that would otherwise been unavailable. More often than not, bricolage behaviors have been unconscious depending on pre-existing environments. And in the developing country context, this cycle of events are also evident in the manner in which diverse and innovative approaches are employed by entrepreneurs who resort to bricolage sources as an immediate means of mobilizing resources locally.

The purpose of the paper is to contribute to the emerging discussion on entrepreneurial ways of innovating in a resource-scarce environment. In the paper, the theme is approached by adopting the concept of 'bricolage,' which has been used in previous entrepreneurship studies to describe how small entrepreneurs are operating in resource trapped environments creatively utilizing the scarce resources that can be easily found.

The paper is structured as follows. First, in relation to an innovation context and bricolage entrepreneurial ways of acting, I briefly review the relevant literature on innovating in resource-poor environments. I then turn to the particular research context and methodology by describing the case studies, data collection and analysis process. The findings section presents how the innovator-entrepreneurs use bricolage at various points of the innovation process. Finally, the last chapter discusses contributions to the innovation and entrepreneurship literature and to BOP research alongside suggestions for further research.

2. Literature Review

2.1 Resource scarcity as a context of innovating business solutions

Resource-driven thinking has dominated the research agenda and a common belief is that innovation is something that occurs when resources are thrown at the problem. This kind of thinking has clouded considering situations in which scarce resources are desirable, offering the potential to lead to break-through performance (Gibbert *et al.*, 2007). In fact, potential resources and opportunities can be underestimated or not even recognized in many fronts. The availability of resources can be viewed from different perspectives, whereby in the presence of resources its use varies unevenly depending on institutional structures at a given set up. In this study, I focused on a 'resource scarce environment' as a main trigger of entrepreneurship along the chain of production. Therefore, resource scarcity does not only affect innovation but also starves certain users of much-needed products at the BOP. Despite that, there are evidently other social consequential effects within which regular environments struggle to ward off, particularly in developing countries, because of scarcity.

Although most organizational entrepreneurship is characterized by severe resources constraints, according to previous entrepreneurship studies, there are differences in resources and infrastructure in developed and developing regions (Torri, 2010; Anderson and Giderson, 2004; Dunn and Holtz-Eakin, 2000). Moreover, BOP markets are characterized by a chronic shortage of resources, which affects production, exchange and consumption. Many important strategic resources may not be available or tradable in markets (Denrell *et al.*, 2003). Scarcity of high-quality raw materials and commodities, such as electricity and water tend to make production sporadic, inconsistent and non-replicable or even reliable. Exchange has high transaction cost resulting from the lack of inadequate financial mechanism, which means purchase power is low and entrepreneurs are lacking the essential capital. Another shortage is inadequate infrastructure, meaning bad quality of physical roads, lack of logistics and storage possibilities and point-of-sale terminals. Some of the innovative products require consistent power supply, which means lack of it may ultimately hinder production process. Another strategic resource is human resources, which are deficient as well: it might be difficult to get trained work force or access to technology and business skills. (e.g. Chandra and Neelankavil, 2008; Kandachar *et al.*, 2009; London *et al.*, 2010; Tybour, 2000). In addition, the political and legal environments have consistently stood out as the phenomenon factor of entrepreneurship. This means entrepreneurs often have to start their business with desperately limited resources and under uncertainty dynamics associated with political and legal environments.

Previous studies have emphasized the role of partnerships as a way of overcoming resource scarcity and the lack of appropriate capabilities (London and Hart, 2004; Klein, 2008; Wynburne and Wilson, 2008). Another view argues that resource-poor settings can in fact drive innovation, demanding indigenous product designs that are less expensive and easier to use, and that require less infrastructure (Kaplinsky *et al.*, 2009). At the personal innovator level, resource constraints can fuel innovations: individuals will innovate by using social rather than purely economic strategies (Gibbert *et al.*, 2007). The use of social resources has been critical to the development of local community business capacity because this can facilitate the learning and innovation processes (Torri, 2010). Hence, an entrepreneur in a resource poor environment can rely more heavily on the social dimensions of entrepreneurship (Diomande, 1990) and social capital can be seen as a collective resource, which exists in the relations among people and facilitates their productive activity by providing access to other resources, such as knowledge and capital (Peredo and Chrisman, 2004). Nevertheless, even social resources are not "given;" they are created, interpreted, differentially applied and spread by people, institutions and technologies. Existing resources can be also seen as "hidden assets;" they exist, but may not yet be recognized or at least it is not always known how to utilize them. These "hidden" assets can be, for example, community members' traditional or indigenous knowledge, which is different from the experts' own scientific knowledge. These kinds of knowledge, skills and experiences are more like practical knowledge about concrete, everyday life or relevant only in a local context (Agrawal, 1995). There is a need to make visible these kinds of variety of skills, talents, knowledge and experience of individuals, as well as the communities' capacities.

Previous research on innovating market-based solutions for low-end markets has stressed that most important is affordability (see Chandra and Neelankavil, 2008; Anderson and Billou, 2007). To make innovations affordable for the

low-income people, it might be necessary to recognize and use locally available resources, which also can be 'hidden'. Such resources can be, for example, neglected physical resources that exist in a given area, such as vacant land, energy and waste resources (McKnight and Kretzmann, 1996). For the process of community business development, it might be a useful starting point to first map different assets and then consider ways of turning them into productive resources.

The field of studying innovating practices in resource-poor environments is relatively unexplored, although some conjectures have been made that resource-poor user-innovators create "resourceful" innovation: people making use of whatever is at hand in sometimes bizarre but innovative ways (Välikangas and Gibbert, 2008). It can be assumed these innovators also need to design their solutions in isolation, for example because of the lack of internet connection, limited access to reference materials, technical advances, international collaborations and specialized expertise (Donaldson, 2006). Ray and Ray (2010) emphasized in scarcity-driven economies, a paradigm shift is required, away from the 'throwaway' mindset prevailing in the developed world.

2.2 Innovating under resource-scarcity: Engaging with bricolage

Resource constraints can lead to entrepreneurial approaches to securing the needed missing resources (Starr and MacMillan, 1990). Gibbert *et al.* (2007) argue that 'would-be innovators facing constraints are more likely to find creative analogies and combinations that would otherwise be hidden under a glut of resource.' Srinivas and Sutz (2007), in their research on scarcity-innovations, note that scarcity conditions affect how problems are defined and solved. Here, the "defining" part concerns needs, wants, demands and constraints; the "solving" part entails ways of addressing them. Searching and designing processes are influenced by "input side" and "demand side" conditions. These authors identified three ways of 'innovating differently': i) searching for different solutions to problems that have been already solved because existing solutions are inappropriate or unaffordable—including the necessity of adaptation stemming from specificities of natural endowments, ii) developing innovative efforts to respond to prospective users who face scarcities of varied types, iii) fostering specific "scarcity-driven" heuristics to deal with well identified but not yet solved problems.

Resource-scarcity innovations have been recognized, but how do they occur? The process has not been scrutinized, but the concept of bricolage may be useful in understanding innovation in a resource scarce environment. The concept of 'bricolage' was originally introduced by Levi-Straus (1966) to describe the characteristic patterns of mythological thought. He contrasted the engineers and bricoleurs: while engineers follow set procedures and have a list of specific tools to carry out their work, in contrast, a bricoleur by definition is someone who uses 'whatever is at hand' and this repertoire of resource elements can be odd and heterogeneous. As a theoretical concept, bricolage has been applied to a range of disciplines and contexts.

During recent years, the interest in bricolage has arisen in the field of innovation management and entrepreneurship studies. Adopting bricolage has been understood as one of those elements that might explain why some entrepreneurs are more successful than others when facing resource limitations; for instance, in the beginning stage of a new industry. Bricolage has been studied among developed entrepreneurs and recently also in the context of social entrepreneurship. For instance, Garud and Karnoe (2003) studied the creation of a new path in the wind turbine industry by Danish companies; an unplanned and underfunded process where entrepreneurs own resourcefulness and improvisation allowed them to develop breakthrough wind turbine products. Baker and Nelson (2005) studied resource-constrained small firms in the United States. They observed how firms were able to create something from nothing by exploiting physical, social, or institutional inputs that other firms rejected or ignored. Based on their study, they proposed the concept of entrepreneurial bricolage, which according to them, occurs when entrepreneurs recombine elements at hand for new purposes and in doing so, exploit contributions unutilized by other firms. Di Domenico *et al.* (2010) studied bricolage in the context of social entrepreneurial action and identified further constructs relating to social bricolage.

Bricolage can be defined as 'making do by applying combinations of the resources whatever at hand to new problems and opportunities' (Baker and Nelson, 2005). Bricolage indicates the activities of entrepreneurs who seemingly create new ventures out of nothing and in doing so, defy conventional assumptions about the role of the environment in determining the success or failure of organizations. Creating combinations of resources for new purposes refers to the use or reuse of resources in ways other than those for which they were intended. Another important aspect of bricolage is the refusal to enact or be constrained by limitations which can be imposed by institutional and/or political settings. (DiDomenico *et al.*, 2010; Baker and Nelson, 2005).

According to Baker and Nelson (2005), entrepreneurs make use of an extraordinarily broad variety of means and resources at hand during and after founding an enterprise: they engaged in bricolage with regard to customers,

financing, suppliers, office space, advice and employees. The 'repertoire' of the bricoleur consist not only of materials but also non-material resources collected independently (Dyumedjian and Rüling, 2010). Non-material resources can be understood as a broad set of inputs, such as skills and knowledge. Bricoleurs have the capabilities to 'make do' with cheap and free resources others regard as useless or substandard and recombine them for new purposes (Baker and Nelson, 2005; Baker, 2007).

Bricolage has also been linked with improvisation; it can be understood as a construct to describe the set of resources invoked by improvisation. Improvisation can be viewed as a tactic of the bricoleur to mobilize resources through an ability to turn material or insights into novel combinations (Weick, 1993), and bricoleurs are seen as tinkers who improve, image, play and search for new, unexpected cultural resources (Miettinen and Virkkunen, 1995). Nevertheless, bricolage itself also depends on a particular worldview and on the existence of knowledge that has been developed over time and accordingly cannot be improvised by another person (Dyumedjian and Rüling, 2010).

Recent (empirical) studies on bricolage have linked the concept with new elements. DiDomenico *et al.* (2010) found empirical evidence of three further elements of bricolage—social value creation, stakeholder participation and persuasion. Creation of social value means setting social goals as a priority. Stakeholder participation in organization's decision-making bodies enables commitment of local actors and persuasion of other actors leverage acquisition of new resources and support. Halme *et al.* (2012) introduced the concept 'intrapreneurial bricolage' in which an essential part of bricolage is a mindset of resourcefulness, which is characterized as the ability and readiness to identify and deploy sometimes unconventional means at hand, to address the problems that person considers relevant.

It can be concluded that previous studies on bricolage have further developed the concept and identified new features. However, there is still a research gap on analyzing bricolage in developing country context where it can be assumed the shortage of resources is even more severe than in developed nations. This paper gives empirical evidence on how bricolage is used by developing country entrepreneurs to develop market-based innovations for the low-income population.

3. Research Context and Methods

3.1 Selection of cases

The original impetus of this study was a research interest in studying the innovation processes of local entrepreneurs at the BOP in resource-scarce environments more preciously. As the research progressed, the focus was narrowed to the use of bricolage as a means of innovating. This research field is still in its infancy and to gain a deeper understanding of this rather new phenomenon calls for case study research that can ultimately be used for theory development. The goal was to find real-life business cases that fit the pre-selection criteria: i) innovation that is developed by a local entrepreneur ii) cases should represent the same industry iii) they should already operate as a profitable business and iv) the development process is not carried out through the support of donor money.

With these selection criteria in mind, I began to search for suitable empirical cases in Kenya where I was already conducting research. I knew these kinds of businesses are not documented so they were not easy to find. The starting point in identifying potential cases was discussions with various local innovation experts and different organization representatives who aim to increase local innovativeness; for example, Kenya Institute for Research Development Innovation (KIRDI), rapid prototyping workshops FabLabs (Fabrication Labs) in Nairobi and Kisumu, officials from the Ministry of Agriculture and Livestock and individuals from the U.N. To identify further cases, I also engaged with several entrepreneurship or social innovation challenge competitions which presented some real life cases.

Through engagement in my larger background research, I become familiar with low-cost appropriate technologies, sustainable product design (e.g. products made from waste material or natural materials), as well as the work of business incubators and other collective efforts to create innovations. As the research process progressed, I noticed there were not yet many business oriented cases; rather, sustainable innovations were easier to identify, but how to turn these into profitable business and scale them up from the pilot stage, seem to be a challenge for the inventors. After a rather long process, I was able to identify two business cases fitting all the selection criteria. Although a large number of cases would have given a more solid basis for research, the use of at least two cases made it possible to make comparisons and generate findings based on those comparisons, and because many of the potential business cases are somewhat immature in that they are still at very early stage and a proven track record of financial profitability has yet to been verified, I decided to settle with two cases that fully met the selection criteria. The case histories are briefly described next.

3.1.1 The biogas innovator-entrepreneur

The biogas enterprise was established in the fall of 2010 by a Kenyan innovator. Currently (spring 2012) it employs four permanent workers and at contact bases, additional individual sales agents. The goal is to expand across the whole of Kenya, and perhaps later to other countries. The main product is a flexible biogas digester that turns human excrement, cow dung, or kitchen garbage into fuel that can be used for cooking or generating electricity. The digester is housed above ground, made of tent material and closed by a zipper, making it easily portable. The digester uses bacteria to break down waste into sludge, which can be used as fertilizer. In the process, the bacteria emit gases, mostly methane, which rather than released into the air, are piped into the kitchen where this biogas can be used for cooking. The enterprise's clientele includes both households and institutions, such as village schools and hospitals. The product could also be used in urban settings, for example, when new apartment buildings are built.

The founder of the enterprise developed the technology behind the biogas digester and patented it in Kenya. The entrepreneur is solely responsible for the manufacturing, marketing and distributing the product. He has his own workshop where manufacturing of all of the products is carried out. His goal is to set up his own production line, which would allow mass-manufacturing. For this expansion he is searching for finance.

The innovator is a self-learner; he has not graduated from any formal college-level education. Instead of formal education, he has been interested in developing practical solutions to everyday problems and making things with his own hands. Besides the biogas solution, he also has developed various other low-cost solutions, such as a malaria net, water purification and a cooler. Nevertheless, he has worked systematically as part of an effort to commercialize his other innovations.

3.1.2 The wind-turbine innovator-entrepreneur

The wind-turbine enterprise was established by its Kenyan founder in 2000. For the first eight years (until 2008) it was only a side-business for the founder; he worked there during evenings after his full-time job. When he lost his full-time job, he concentrated on the business full-time and has been expanding since that time. Currently the enterprise has five full-time technicians and another 25 technicians work on a contract basis.

Within Kenya, the enterprise has been the sole manufacturer and supplier of small wind-turbines. It also served BOP customers and rural communities by offering an affordable wind-turbine made from 'scratch' using purely locally available materials. The pails are made from fiber glass and old car motors are used as generators. A wind-turbine can be sold to community, which owns it collectively and also uses it as an income generating opportunity; for example, creating small business activities in the local around it. The enterprise also installs and maintains solar systems as well as diesel hybrid plants, but its key business is wind power. The entrepreneur plans to expand the business radically in the following year by increasing the kilowatt output from 10 to 15 because of the high demand for electricity.

The innovator comes from the coastal area of Kenya where there is plenty of wind but people have inadequate access to electricity. The innovator built his first wind-turbine for his family when he was at his final year in high school. Although always interested in science issues, after school he undertook a bachelor degree in linguistics. After graduation he worked for a foreign NGO for approximately 18 years before dedicating himself fulltime to his company.

3.2 Data collection and analysis

The empirical research adopted a qualitative methodology and employed a case study design. The empirical data collection began during the autumn of 2010 and continued until the end of 2011. During the entire data collection process I had formal, unstructured interviews and informal discussions with representatives from various institutions that were working with 'grass-root level' innovations in Kenya, such as KIRDI and FabLabs. These discussions, together with field notes, offered valuable data on this research phenomenon. There were a total of ten informants.

The principal informants were the innovator-entrepreneurs themselves. In November 2010, I met the innovator-entrepreneur of the biogas enterprise for the first time and since that period, I have been following his business development regularly. At this stage, the interest was more in the development process behind the solution and what kind of business model the entrepreneur was aiming to create. The second entrepreneur, wind-turbine, was selected during the fall 2011 when I returned to the field to continue my research.

I interviewed both entrepreneurs formally. Besides formal interviews, I met both of them a number of times at different events and had informal discussions several times. In addition, both innovator-entrepreneurs had small workshops, which I visited, and during those visits I met their employees. Concurrently, I was also taking part in agribusiness exhibitions in which the biogas solution was presented to a wider audience and I listened to how the entrepreneur demonstrated the solution and what kind of questions the potential customers had. Regarding the wind-turbine case, I participated in the same workshop in which he talked about his business and his solution to an audience consisting of local and foreign people. I also used secondary data, such as the company's website, newspaper articles

and watching a program about the wind-turbine innovator-entrepreneur shown on Kenyan national television. Detailed information on data collection and methods are presented in appendix A.

The data analysis followed the principles of the ‘general inductive approach.’ The inductive approach is a systematic procedure for analyzing qualitative data where the analysis is guided by specific objectives. The primary purpose of the inductive approach is to allow research findings to emerge from the raw data, without restraints imposed by structured methodologies (Silverman, 2000; Dey, 1993; Miles and Huberman, 1994). To begin the analysis, the transcripts were read several times to identify themes and categories relating to the previous literature of bricolage. Based on this, a coding frame was developed and the transcripts were coded. The purpose was to conceptually categorize the activities of the innovator-entrepreneurs. The two cases were constantly compared against each other and the previous literature. This process was used to develop categories, which were then conceptualized into broad themes. Evidence from data, descriptive codes and interpretative codes are presented in appendix B.

4. Findings: Engagement with Bricolage in Business Development

The purpose of this paper was to analyze how bricolage is used by developing country entrepreneurs to develop market-based innovations for the low-income people. To answer this question, it is necessary to shed light both on the technological aspect of the innovation process and business development carried on by the innovator-entrepreneurs. Technology development and business development occurred more or less simultaneously so it is not possible to distinguish between them. In both cases the innovator was also an entrepreneur and took sole responsibility for the whole value chain: from sourcing the raw materials to production, and from piloting and diffusing the innovation to making it commercially available. It is not possible to separate clearly at what point the innovator-entrepreneurs were involved in product development and when they were designing the business model. Occasionally they were even involved in market creation, because the market conditions for renewable energy solutions had not yet been legitimized in Kenya.

The section is divided into three themes: i) opportunity identification, ii) designing solutions and iii) business development. To illustrate the meanings, quotes from the interviews are used occasionally. Table 1 presents the main findings.

Table 1. Bricolage activities of the two innovator-entrepreneurs and what resources were gained

Bricolage activity	Resource gained with the bricolage activity	
	Biogas innovator	Wind-turbine innovator
Possessing ‘social’ mindset combined with resourcefulness	<p><i>A certain worldview and willingness to tackle societal problems</i></p> <p>Societal problems recognized within own community</p> <p><i>Social value creation</i></p> <p>Willingness to developed affordable energy solution for low-income people</p> <p><i>Resourcefulness as mindset</i></p> <p>Possessing ‘gadget knowledge’: being able to develop low-tech solutions for everyday needs</p> <p>Supplementing own technical knowledge when needed (e.g. by searching for best practices)</p>	<p><i>A certain worldview and willingness to tackle societal problems</i></p> <p>Societal problems recognized within own community</p> <p><i>Social value creation</i></p> <p>Determination by own home-community people to provide access to energy</p> <p><i>Resourcefulness as mindset</i></p> <p>Awareness of using wind power as a source of electricity</p> <p>Possessing ‘gadget knowledge’ and strong interest in physics</p> <p>Supplementing own technical knowledge when needed (e.g. by contacting experts)</p>
Making do with resources at hand	<p><i>Easily available physical materials</i></p> <p>Tent material</p> <p>Bio waste as source of energy</p> <p><i>Non-material resources (e.g. existing personal networks, strengthening social capital)</i></p> <p>Use of ‘idle’ labour force in villages (selling and delivering the product)</p> <p>Young people as company workers</p> <p>Own relatives (as ‘test laboratories’ and giving</p>	<p><i>Easily available physical materials</i></p> <p>Fiber glass</p> <p>Used car engines</p> <p>Wind power</p> <p><i>Non-material resources (e.g. social networks, skills, local people’s knowledge)</i></p> <p>Relying on village elders a) knowledge of the amount and speed of wind b) acting as ‘sales agents’ when raising awareness of wind-turbine in their own villages</p> <p>Training and recruiting local people to be mechanics</p>

	assistance)	
Improvisation as way of proceeding	<i>Technical know-how improves and problems are solved as they emerged</i> Technical solution is developed as ‘trial-and-error’: testing and learning	<i>Technical know-how improves</i> Technical solution is developed as ‘trial-and-error’: testing and learning <i>Business arose slowly-by-slowly</i> Business development occurred ‘aside and as part-time business’ for over a decade before turned into fulltime entrepreneurship and main income

4.1 Identifying opportunities for innovating: Recognizing needs and hidden possibilities

Entrepreneurs operating in developing countries are constrained by scarcity; for example lacking adequate start-up capital, stiff competition, lack of employees with the right skills, difficulty in finding adequate facilities to start their business (Sriram and Mersha, 2010). A ‘refusal to be constrained by limitations’ can be taken as the *de facto* starting point in both cases; both innovator-entrepreneurs were aware of the limited resources, but were not willing to be discouraged under such conditions. A strong driver for action was a personal passion for serving their own home village. This passion is part of a specific mindset that both innovator-entrepreneurs shared; they were willing to begin solving the problems they faced in their own home-communities, which were also problems in the broader scheme. Hence, similar to the observation made by DiDomencio *et al.* (2010) in their study on social entrepreneurs, for these innovator-entrepreneurs, the goal of ‘social value creation’ was a major factor, which provided the motivation to begin to change the prevailing system.

“I built this company from scratch. This is my passion. Am not only making money, but producing something good for society”—Innovator of wind-turbine.

The innovators were resourceful enough to figure out how their own problems could be solved by designing simple solutions; in other words, possessing ‘gadget knowledge.’ The biogas innovator appears to be an example of one of those creative and practical skill-talented people who are easily ignored by the ‘formal education system’: he had not graduated from higher level education, but throughout his life had been interested in doing things with his own hands and fixing machines, such as radios and televisions. At some point, he started to think more systematically about how to serve local communities as the needs were clearly obvious, and yet existing solutions were unreachable to the poor, who are the majority. In addition, the support from his own family background encouraged him to believe in his own skills; his mother, a British woman who had come to Kenya many decades earlier, had been involved in development projects, and his sister was active in the field of wildlife conservation. Perhaps it was this background that encouraged him to believe in his own skills and work toward his mission.

“I see needs everywhere; I just then try to create solutions for the problems. I know it is possible”—Innovator of biogas.

The biogas solution is not the only low-cost solution this innovator has developed. As he states; he is passionate about developing solutions to everyday challenges. His previous solutions are, for example, a solar food dryer, a coal smoker for meat and fish and an evaporating cooler. Nevertheless, the flexible biogas was the first solution he was able to commercialize and he began a more systematic business creation around it.

The wind-turbine innovator-entrepreneur had been interested in science and technology since his childhood. He grew up in a coastal area where there was plenty of wind but people lacked access to electricity. He knew wind can be used for power generation and it was this intimate knowledge of wind’s possibilities that motivated him to construct a workable wind-energy solution, primarily for his own family.

“My area was very windy and my biggest question was how to use the wind. I was looking for something that can produce electricity. That was my driver. My first turbine, I built when I was at class six. That was the beginning; it proved wind can do something”—Innovator of wind turbine.

Although the wind-turbine innovator had developed a workable solution when still in school, he held other professional interests. He studied linguistics and after graduation worked for a foreign NGO as a language editor. Although he spent several years without working on the wind energy idea, he did not forget the topic. During those years he met several people and increased his knowledge of science and technology.

Based on the present empirical observations, it is possible to believe not everybody is capable of promoting innovations by means of bricolage. Individuals might need to possess a particular ability to recognize opportunities and have an internal desire to solve societal problems. In addition, they need to be resourceful enough to advance practical resources based on bundling scarce resources.

4.2 Designing solutions relying on locally available resources

Both innovators knew that to make renewable energy affordable to the poor, the cost of production needed to be kept low, and the design needed to be simple so it did not require maintenance costs and was easy to use. Material choices were essential. In both cases, to create a workable technical solution, the innovators refused to be constrained by limitations, namely not surrendering to the reality they had inadequate access to external knowledge and limited personal professional skills, nor trained employees. In addition, they were lacking high quality materials and facilities to develop their solutions. Instead of being discouraged, they relied on their own resources; they had ‘antennas’ in their head; scanning and searching for new information and resources that might be overlooked by others (Tang *et al.*, 2012). In addition, they were eager to use their skills of ‘doing things with their own hands.’ It was easy for them to adopt new technical knowledge and apply that together with pre-existing knowledge.

Innovators searched for suitable materials, which would be easily available and cheap but still durable. The wind-turbine innovator found suitable materials nearby as he began to collect old car engines, which could be used as power generators. The biogas innovator used tent material to build the digester.

These materials were found after long journeys. During the product development process, the innovator of the biogas system constantly improved his knowledge in those areas he knew his technical knowledge to be insufficient. He emphasizes that there exists plenty of relevant information ‘out there;’ it is just a matter of gaining access to that information and then assembling the pieces of knowledge together. He conducted research on the internet to discover how other people had solved the problems he was facing. He tested what worked and what did not. He conducted research on potential bag materials to find out whether the material was suitable or too light for the weight of the amount of waste needed in the digester bag.

“I would say it’s all about ‘research, research, research,’ there is no need to create the wheel again. It’s like gadget chemistry, a little bit biology and little bit common sense”—Innovator of biogas.

The innovator of the wind-turbine similarly complemented his knowledge whenever necessary. He was also sure of himself in that he would find a workable solution.

“It’s not formal education, just a particular area of interest. If I have to learn how, I’ll learn it. When trying the first time, if it’s not working, I do a modification, if I have difficulty, I can call a guy from the university, he sits with me for a week, I pay him and he tells me how to do these things”—Innovator of wind-turbine.

The innovator-entrepreneurs acted as bricoleurs as described by DiDomencio *et al.* (2010), ‘cobbling things together’ from multiple sources of knowledge. Like bricoleurs, both innovators collected together ‘bits and pieces’ of information they found useful. In this way, they engaged with bricolage; dedicated themselves to solving the problems rather than lingering over questions of whether a workable outcome could be created from what was at hand (Baker *et al.*, 2003; Baker and Nelson, 2005).

This means the innovation processes resembled a ‘trial and error’ approach; experimentation provides new information, which again is used to refine the solutions under development. Progress is made by experimenting and learning toward an acceptable solution (Thomke *et al.*, 1998). The innovator of the wind-turbine recalls the development process:

“And we surely had our share of challenges, when we started with wooden vanes sticks and striking in the sun, their lost their weight and balance, but over time we have learned how to make fiber glass vanes we learned how to use, just like how to make our generators from scratch”—Innovator of wind-turbine.

Indeed, resource-poor settings set constraints on product development. It might not be possible to do any large scale testing, so alternative options were used. In their own way, the innovator-entrepreneurs practiced “resource parsimony” (Gibbert *et al.*, 2007), deploying the least resources necessary to achieve the desired results. For instance, the innovators did not have access to test laboratories or the ability to carry out hi tech scientific estimations of their products. Instead they used their own and relatives’ homes as ‘testing laboratories.’

“My sister was one of my first guinea pigs...and then I just retested again and again if encountered problems”—Innovator of biogas.

The use of existing personal networks that are easily ‘at hand’ are commonly recognized in previous studies on bricolage (i.e. Baker *et al.*, 2003). In the later stage of product development, the innovators used their first customers as ‘learning labs.’

“When we began, people allowed us to run up prototypes because they were so desperate [for access to power] the level of desperation has actually worked in our favor, people said “you can guys, lets run it, we are taking the risks” we say “ok,” and we went there and installed our turbines...”—Innovator of wind-turbine.

This section has illustrated how concrete product development can depend on innovators' resourcefulness in recognizing unused resources or recombining resources for new purposes. This demands both the ability to first recognize these resources but also learning the various ways resources can be applied.

4.3 Business modeling: The art of improvising

In both cases, the innovators wanted to keep the business in their own hands. However, to make the innovation process progress more quickly and later, to commercialize their products, they tried to find external assistance. For example, when searching for funding, the biogas-innovator contacted incubators, funding agencies, commercial banks and private equity firms. Nevertheless, it was not possible to find suitable partners; interest rates in commercial banks were high, private equity firms and incubators wanted to have the majority of the shares, and donor-funded opportunities are more focused on NGO-run initiatives. The innovator-entrepreneurs applied persuasion (see DiDomencio *et al.*, 2010) to convince potential partners to invest in their business. Nevertheless, especially in the early phase of the business, the persuasion tactics were not successful. They were not able to convince 'outsiders' of their business potential so they were forced to search for resources elsewhere. Similar to several other entrepreneurs at the outset of their operation, these innovator-entrepreneurs ended up relying on their own pre-existing networks and personal contacts, mostly family members' support. Similarly, network-bricolage (Baker *et al.*, 2003) was an important resource. Additional key resources were their own patience and perseverance and with regard to finance, their own pocket.

"From my own pocket. Many people say yes, it was fantastic, but they don't want risks...funding that I'm looking for is for R&D not for anything else"—Innovator of biogas.

The innovator-entrepreneurs focused their energy at the beginning on developing the technical solution, while the business development ensued as an aside. They had neither plenty of time nor resources to dedicate to strategic planning. In this respect, creation and execution can be seen to have occurred at the same time. Their way of acting is reminiscent of what Baker *et al.* (2003) call 'improvising firms': the founder does not focus on a business plan, instead he/she simply starts moving toward creating their business and improvising their way toward entrepreneurship.

"So in about 1999, I made my first turbine [after the one made in childhood], I took it home, and it performed very well. I got orders from that area, I created my own website, I put information there and I started to get orders. I used to leave from my daily work around 4:00 so from around 4 until 8:00, I did my wind turbines. I began the business, I bought equipment, I employed guys, I was at the office, but people would be installing turbines out there"—Innovator of wind-turbine.

Social assets are important in business ventures (Starr and Macmillan, 1990), but perhaps they are even more crucial in a resource scarce environment. Especially in a BOP business, it is necessary to engage the local community, which might not only provide customers, but also employees and producers. These innovator-entrepreneurs valued the social resources in various ways:

"I advertise through word of mouth. I can't afford to go to media. I use taxi drivers because they know where people live. Then I have trained borabora guys [cyclist] because the product is so small it can fit on the bike so it is cheap to transfer"—Innovator of biogas.

This section illustrated that in developing a country context, formal business development tools may be nonexistent or reachable by only a limited number of entrepreneurs. Business expansion can happen accidentally and be based on improvisation: problems are solved when they are confronted. Once again, scarcity of resources made the innovator-entrepreneurs search for alternative and more affordable ways of expanding their business. As their examples illustrate, in the BOP context, satisfied customers and a 'word-of-mouth' marketing strategy can spread the entrepreneur's message, and this can lead to a situation in which the entrepreneur needs to carry out more systematic planning concerning the future of the business. Currently both innovator-entrepreneurs are at the stage where they need to think about ways to expand their business. To date, they have done so independently with regard to product development and business modeling, but to reach the next stage, they require additional resources.

5. Conclusions, Implications and Suggestions for Future Research

The purpose of this study was to analyze how developing country entrepreneurs employ bricolage as a way of innovating in a context of resource-scarcity. The study has implications for the innovation and entrepreneurship literature and BOP studies.

5.1 Bricolage in the context of the innovation and entrepreneurship literature

Previous research on innovation management and entrepreneurship has minimally explored innovation practices in resource-scarce environments. This study revealed, in contrast to some previous research (Gupta *et al.*, 2003), that innovators might also be interested in business development; entrepreneurs can be at the same time talented innovators whose driving force for entrepreneurship is a desire to serve poor communities in their country. It is not always possible

to distinguish between innovation and business development because they occur at the same time. Perhaps in a resource-scarce context, it is necessary to understand entrepreneurship in a broader way: entrepreneurship as creating (radical) social change (Spinosa *et al.*, 1977), which is socially embedded (Shane and Venkataraman, 2000). In neither of the cases was the drive for entrepreneurship purely profit making.

Entrepreneurial opportunities might not be sought for in a systematic way. Rather, the process can be about designing the needed solutions for their own communities, which also attracts interest in neighboring communities, and slowly innovators design business around it. As Ardichvili *et al.* (2003) posit, entrepreneurial opportunities require creativity on the part of the entrepreneur, not only to identify opportunities but to make them into actual business concepts. Obtaining adequate financial, physical and human capital from external sources is a vital and challenging entrepreneurial task, especially for start-ups (Martens *et al.*, 2007). Even more challenging is that entrepreneurs engage this process in a resource poor environment. Developing country entrepreneurs might need to develop a variety of unconventional approaches to creating and sustaining their businesses (Diomande, 1990). In this study, both of the innovator-entrepreneurs acted like creative bricoleurs who refused to be constrained by limitations and instead, were able to create 'something out of nothing.'

In addition, their personal characteristics have similarities with the descriptions of social entrepreneurs (Yunus, 2007; Mair and Marti, 2006) who are dedicated and motivated to solve poverty-related problems through entrepreneurial means. This 'social mindset' meant that both of the innovator-entrepreneurs had a desire to develop practical solutions to needs in their own home communities, which they were more than familiar with since childhood. This aim for social value creation made the innovators work hard to develop affordable, good quality solutions for low-income people who were their fellow citizens. Financial profit was not a main motivator; in fact, for the wind-turbine innovator, entrepreneurship was a side business for over a decade, to which he was willing to sacrifice his free time.

This kind of right mindset has been recognized in previous studies on bricolage. Halme *et al.* (2012) argue that a certain kind of mindset is required for bricolage. They characterize this as 'resourcefulness'; the ability and readiness to identify and deploy sometimes unconventional means at hand, to address the problems the person considers relevant. Bricolage can be seen as a particular world view of addressing challenges and opportunities. Duymedijan and Ruling (2010) relate mindset to the bricoleur's knowledge base, and characterized by intimate knowledge of the elements relating to their repertoire and familiarity with the context. As the example of the wind-turbine illustrates, here the innovator held intimate knowledge of both local needs and the technological potential of wind energy. Knowledge of local needs combined with certain personality characteristics, such as passion, energy, persistence and determination, may be important drivers in an uncertain environment, as is the case in many African countries (Sriram and Mersha, 2010).

To be engaged with bricolage, entrepreneurs also need to have the capabilities to use their repertoires. Both innovators in this study developed their solutions independently, without any external assistance; when needed, they found methods to overcome technical challenges (for example: finding new knowledge from research or contacting an expert). They also recognized locally available resources—both material (e.g. waste, used items) and non-material (e.g. community members workforce and their knowledge). Additionally, because of a lack of facilities, innovators manufactured the products themselves from scratch. Such an approach guaranteed their solutions were both practical and economically affordable to fit with local conditions.

Regarding bricolage research, the main contribution of this study is that bricolage was studied empirically in a new context; a developing country, and more precisely in the African context. In these contexts, the resource-constraints small entrepreneurs face are even more severe than in developed countries. In this regard, this study emphasizes that bricolage is not only about resource integration (Baker *et al.*, 2003) but a specific mindset of resourcefulness (Halme *et al.*, 2012). The de facto starting point in both cases was that both innovator-entrepreneurs refused to be limited by external constraints either in terms of creating a workable technical solution or designing the business model.

5.2 Contribution to BOP studies

Prahalad (2005) illustrated the untapped market opportunities at the BOP, emphasizing that several actors could be the suitable players to conquer these markets; e.g. MNCs, social entrepreneurs, local SMEs, or even NGOs. The majority of the previous research has either focused mainly on foreign MNCs or social entrepreneurs, leading to a research gap in which the business activities of local entrepreneurs have been almost ignored. Recently, it has been suggested that local enterprises might be better at serving markets because they are familiar with the local context and adept at working around institutional voids (Ray and Ray, 2010). This paper is targeted at this neglected area of research by providing deeper insights from two Kenyan innovator-entrepreneurs business development processes that are directed at the BOP.

Previous studies have shown that for foreign MNCs, major challenges are related to understanding how to discern local needs and how to manage constraints caused by the external business environment (e.g. Prahalad and Hammond, 2002; Boyer, 2003). Based on this study, knowledge of local needs is not a challenge for local entrepreneurs, indeed local innovator-entrepreneurs are responsive to people's needs, and this is partly because they obtain 'local information' (Luthje *et al.*, 2005). Ideas for solutions can be triggered by their personal experience, and by the problems they have personally encountered. By obtaining local information, they are also familiar with the frames for innovating; not only needs, but how to integrate business activities into local communities and what resources are available locally. By using locally available resources, the innovator-entrepreneurs were also able to design products affordable to the BOP—affordability being another major challenge for MNCs. Local innovators are more alert to recognizing local resources, including both the tangible and intangible, which can be easily neglected by other actors. Especially harnessing intangible resources, such as community members' knowledge and value as a work force, are critical when implementing the business model. I suggest the starting point for BOP ventures should be more oriented to recognizing local strengths and building on them, rather than searching for problems and needs. This research provides empirical evidence on the previous BOP observations that it is necessary to be integrated into the local community and create unconventional partnerships (e.g. Hammond *et al.*, 2007).

Compared to MNCs, local innovators frequently lack or have limited technological knowledge and capacity. This means naturally that the end-products are simpler and low-tech. Nevertheless, local innovators are complementing their limited knowledge by finding methods to gain access to external resources.

5.3 Limitations and suggestions for future research

In this study I have investigated bricolage in the context of innovation for BOP by developing country entrepreneurs. The empirical study consists of two case studies of Kenyan innovator-entrepreneurs and cannot be generalized to a larger population. Nevertheless, comparison of two cases offered rewarding perceptions concerning how constraints of innovation are overcome in resource poor settings by local entrepreneurs and it is possible to propose some assumptions regarding how innovation mechanisms operate in African, resource-scarce contexts.

It has been suggested that in low-income economies will be born the 'new generation in innovation systems,' which will be based on mobilizing local resources at the community level and trying to solve locally specified problems without outside assistance (Kaplinsky *et al.*, 2009). In this regard, local people have strong problem-solving skills that need to be recognized (Pathak, 2008; Gupta *et al.*, 2003). As these two cases point out, bricolage might be one explanation that serves to understand how this kind of 'new generation' operates and how local people solve practical problems. Hence, there may be larger numbers of resourcefulness bricoleurs who employ their own innovation practices, based on 'making do with resources at hand' and improvisation when necessary—these bricolage activities should be made visible and recognized. Innovations at the grassroots, if properly supported by formal science and technology and financial institutions, can provide a basis for achieving competitiveness and excellence as a means of dignified survival (Pathak, 2008). Based on these two cases, it can be concluded that support mechanisms do not always encourage and facilitate the innovation activities made by 'ordinary citizens.' It is worth asking how to design suitable policy-level mechanisms that could support and accelerate innovativeness at the grassroots level. Perhaps, in the case studies presented here, without the persistence and strong passion to serve their communities, the innovator-entrepreneurs would not have overcome all the obstacles they faced.

This research opens up multiple avenues for further research. First, in general, studies on entrepreneurship and innovations in developing country contexts have been limited, although the role of entrepreneurship and innovation as economic drivers has been emphasized. To create an enabling innovation environment, it is not only necessary to know more about the current obstacles but also to realize the existing possibilities and 'hidden assets' that might be left unrecognized in current innovation policies.

Second, to be more detailed, further studies are needed to gain a deeper understanding of the indigenous knowledge and innovations developed by local African people themselves. For this research, I was able to find two African innovators, but certainly there are plenty of talented innovators who remain unrecognized. It is essential to search for and study the practices of successful local innovators who have been able to face resource constraints but yet develop successful businesses under such conditions. By learning about their experiences, it would be possible to spread knowledge and good practices, and perhaps as knowledge increases, the innovations emerging from local people would become more radical. Bricolage might be a suitable theoretical framework to analyze the entrepreneurial behavior of these innovators and entrepreneurs serving the BOP. Hence, I encourage more studies on bricolage in the context of developing country entrepreneurs.

Also, relating to BOP studies, more longitudinal case based research is needed. To date, empirical research has focused largely on describing success stories and the outcomes of innovation processes. There is a clear absence of analysis of long term successes and especially an analytical of its impact. There is no consensus among the researchers on what the actual impacts on poverty alleviation are or how the inclusive innovations have improved the living conditions in the local communities. Another major gap of the research is to analyze what innovations—and how—have been scaled up successfully. Longitudinal research, following different cases over a several year period, would offer us fruitful insights. For this purpose monitoring and evaluation techniques should be designed.

APPENDIX A. Data collection: interviewees and other sources of data

Sources of data	Name and title	Organization
Expert interviews	Dr. Kamau Gachini, Director	FabLab (Nairobi)
	Tom Okite, founder and director	FabLab (ARO FabLab)
	Beatrice Tuwei, District Livestock Officer	Ministry of Livestock Development
	Samwel Kinoti, founder	SkyLinkInnovations
	Paul Njuguna, renewable energy expert	UNIDO
	Agina Rashid Isaac, manager	Kick Trading Limited
	energy advisor	Kenya Industrial Research and Development Institute KIRDI
	Dr. Peter Njau	Ministry of Agriculture
	John Mosonik, secretary	Ministry of Industrialization
	Gem Argwings-Kodhek, advisor	The Africa Enterprise Challenge Fund
Specific case related data	Biogas innovator (<i>Dominic Wanjihia, Biogas International</i>)	Wind-turbine innovator (<i>Simon Mwacharo Guyo, Craftskills East Africa</i>)
Semistructured interviews with the innovator	3 times (1 fall 2010, two fall 2011)	2 (fall 2011)
Visiting in workshop, exhibitions etc	Visited innovator's workshop Several visit in exhibitions where he was presenting his products	Visited innovator's workshop Participated in training which he organized
Discussion with employees of their enterprises	discussion with four employees during few occasion (visit in workshop, talking with them in exhibition)	discussion with one employee in a workshop
Websites of the enterprises	Used for background information of the products (www.biogas.co.ke)	Used for background information of the products (www.craftskillseastafrica.com)
Other	News paper articles	TV document on the innovator

APPENDIX B. Evidence from the data; descriptive code and interpretative code

Evidence from the data	Descriptive code	Interpretative code	
Awareness of the everyday problems and consciousness of the inequalities among people	Social problems (lack of access to electricity) starting point for the innovation process	Social value creation	Social mindset
Knowledge on alternative energy option: wind-turbine innovator grew up in windy hilly area where people did not have access to electricity although source of wind was available. Biogas innovator noticed the amount of dung and wondered why it is not used for biogas	Willingness and readiness to tackle societal problems	Resourcefulness	

Since childhood both Innovators had been building products with their own hands and eager to learn more	Intimate knowledge on locally available resources and for what purposes that can be used for	Making do	Making do
Innovators were familiar with the alternative energy sources (e.g. wind, biomass) and of cheap materials which could be used for manufacturing products (e.g. used engines, durable tent material)	Materials were recombined for new purposes		
Innovators used their families to test and develop the solutions in their homes. Instead of conducting systematic wind measurement, the innovator asked from the communities elders about the wind situation	Utilizing networks a) pre-existing personal, b) community members (both as social resources for labour and valuating 'hidden knowledge that local people posses)		
Business is integrated into the local community by co-operating with the local people: both entrepreneurs have recruited and trained local people to act as their sales agents	Engaging with local communities, building social capital and mobilizing local resources	Stakeholder participation	Improvisation
Neither of the innovators had professional engineering education, instead they used their own skills and motivation as sources for developing technical solution and when lacking information found ways of gaining access to 'external knowledge' (e.g. background research, finding best practices, contacting professional)	Trusting on own knowledge and repertoires Gaining access to lacking, external, knowledge by using creative methods to dig new information		
Both entrepreneurs aimed to attract financiers and partners to invest in their business from the early beginning and especially on business expansion stage	Trying to convince potential partners to believe in their business venture		

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