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A Conceptual Framework for Analysing
and Fostering Innovation in the Water Sector



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Analysing Frugal Innovation Incubation Programmes: a Case study from the Water Sector

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Abstract

The perceived positive implications on sustainable global development have triggered a variety of programmes to foster frugal innovations. To increase the impact of these programmes, it is important that we are able to understand how they function. In this paper we develop a conceptual framework for the analysis of interventions that foster frugal innovations through incubation. Drawing on relevant theories and concepts in the field of innovation and related literatures, the framework identifies and describes two major categories of factors influencing the nature and outcome of frugal innovation incubation. The first category relates to the incubation process, the second to the innovation environment. The proposed framework is illustrated by a case study on VIA Water, a Dutch programme to foster water innovations in African cities. The framework and the case study material presented in this paper demonstrate the complexity of a frugal innovation incubation process and thus the need to take a holistic approach when designing and /or analysing related interventions.

Key words:

Conceptual framework, frugal innovation, incubation, water sector, VIA Water

1. Introduction: Frugal Innovation and Sustainable Global Development

Frugal innovation has gained popularity in both academic, policy and business arenas over the past years. The concept refers to a new approach to innovation: one that uses resources economically across the whole innovation value chain and results in products, services, and systems that are environmentally sound, of high quality and affordable to resource-constrained customers (The Economist, 2010; Bhatti, 2012; Radjou and Prabhu, 2015). Originally, frugal innovation is associated with emerging markets that are characterized by large numbers of consumers who move from the bottom of the pyramid (BoP) segments to the middle class, thus becoming potential customers (Zeschky et al., 2011). Although the income of these people has increased, they still cannot afford the products and services developed for customers in developed countries. So they need products which fit with their aspirations and purchasing power. Emerging markets are also characterised by institutional and infrastructural constraints that make Western innovations unable to reach out to emerging customers (Bhatti, 2013). Therefore, the main idea underlying frugal innovation was initially to develop solutions that fit emerging markets' peculiar problems (Wooldridge, 2010).

Today it is believed that frugal innovation can help to serve the four billions consumers living at the BoP in both emerging and developing countries (Prahalad, 2005; Hammond et al., 2007). Demand for frugal innovations is also on the rise in developed countries due to factors such as the economic crisis which has increased the number of poor customers in these countries, environmental constraints requiring companies (and societies as a whole) to go frugal, etc. (Angot and Plé, 2015). In this context, many people see in frugal innovation the potential to simultaneously create economic, social and environmental benefits and, therefore, associate it with sustainable global development (Prahalad, 2005; Sharma and Iyer, 2012). There is no unanimity on this question though, as sceptics believe that frugal innovation is likely to increase inequalities among people rather than addressing the structural drivers of poverty (Schwittay, 2011; Dolan, 2012). With regard to this debate, Knorringa et al. (2016) suggest to adopt an evidence-based approach in order to explore the developmental relevance of frugal innovations. A practical way to do this is perhaps to assess how frugal innovations promote the Sustainable Development Goals (SDGs) (Levänen et al., 2015).

As with any innovation, a variety of actors are involved in the development of frugal innovations (Zeschky et al., 2011; Soni and Krishnan, 2014). In emerging markets, frugal innovations have largely been dominated by local corporations. However, due to the recognition of the market potential and rising competition, Western corporations (e.g., General Electric, Unilever, and Phillips) are nowadays engaged in frugal innovation as well. There are also frugal innovators at grassroots level, generally operating in the informal sector (Bhaduri, 2016). Universities are also increasingly involved in frugal innovation, either through research (e.g., Centre for Frugal Innovation in Africa, CFIA) or by developing frugal solutions that can be commercialised.

Due to their perceived potential, frugal innovations are increasingly promoted through specific initiatives across different sectors and countries. Granqvist (2016) identified and analysed 15 public funding schemes that specifically aim to stimulate frugal innovations. A characteristic that is common to many of these frugal innovation support programmes is that they generally tend to function as incubators. Given the increasing interest in this type of incubation-like initiatives, it is salient to study and understand how they function and the factors determining their outcomes. Only then can we influence frugal innovation systematically and effectively. However, we observe that the frugal innovation literature is still characterized by a lack of theoretically sound frameworks to do this kind of analysis. This paper aims to bridge the gap by proposing a conceptual framework for the analysis of interventions that foster frugal innovations through incubation. The framework draws on relevant theories and concepts in the field of innovation and related literature. Two major categories of factors are distinguished (and described) that influence the

nature and outcomes of frugal innovation incubation processes. The first relates to the frugal innovation incubation process, the second to the innovation environment. The remainder of this paper is structured as follows. Section 2 distils the key determinants of frugal innovation incubation processes and their outcomes. Section 3 presents results on a case study from the water sector. Section 4 concludes the paper.

2. Determinants of frugal innovation incubation

2.1. Determinants related to the innovation process

A closer look at interventions to foster frugal innovation reveals that many of them function as innovation incubators. An incubator is often described in the literature as a place where new firms are nurtured to help them survive and grow during their uncertain start-up phases (Fry, 1987; Peters et al., 2004). According to this literature, three main elements serve to capture the essence of an incubation facility: the provision of office space to incubatees (or tenants), provision of professional support, and provision of access to networks. The development of the internet has triggered the emergence of “*virtual incubators*” or “*incubators without walls*” (Nowak and Grantham, 2000) which allow the provision of services to incubatees without them actually being located at the incubator site. Many of the programmes to foster frugal innovation can be characterized as virtual incubators. Therefore, the literature on incubation helps to distil some of the characteristics and features that need to be looked at while exploring these interventions.

2.1.1. Three phases of the innovation process

The incubation process is acknowledged as critical for achieving positive outcomes (Patton et al., 2009). In this regard, Lalkaka (1996) argues that an incubator’s performance depends on “the careful planning and implementation of the incubation process” (p.270). In his extensive review of incubation process models, Gertner (2013) concludes that incubation involves two major processes: a selection process and a (business) support process. The former uses appropriate criteria and actors to recruit suitable incubatees, the latter involves providing a variety of services to incubatees. The European Commission (2010) adds a third phase and describes the innovation incubation process as consisting of three major stages: pre-incubation, incubation and post-incubation. In studying frugal innovation incubation programmes, we propose to look at the incubation process as involving three major and interdependent phases: the *selection phase*, the *project support phase*, and the *scaling phase*. In the *selection phase*, we include two sub-processes: (1) the process through which strategic innovation areas are defined and creative ideas with potential are mobilised (idea generation) and, (2) the process through which these ideas are screened and incubatees selected, based on pre-defined criteria. The incubatee selection process has been acknowledged as an important determinant of the incubation outcome (Merrifield, 1987). In the *project support phase*, the analysis focuses on the tangible and intangible resources (or services) needed and received by frugal incubatees from the incubator. The range and quality of these services decisively drive incubation performance (Smilor, 1987, Rice, 2002). It is therefore critical to ensure a good fit (or match) between the services offered and the needs of incubatees (Autio and Kloftsen, 1998). In the *scaling phase*, the analysis focuses on the strategies adopted to ensure the spread of frugal innovations.

2.1.2. Actors and their interactions in the innovation process

Incubation models underscore the role of actors involved in the process and their interactions as important drivers of incubation outcome. A distinction is generally made between internal actors (e.g., the incubatees, the incubator management) and external actors (e.g., consultants, venture

capitalists) (Rice, 2002, Bergek and Norrman, 2008). In the context of frugal innovation, the resource-constrained customers should be considered as a distinct external actor. Frugal innovators ought to interact with and learn from these customers, which arguably allows to produce value-sensitive innovations. Active involvement of customers in innovation processes is referred to in the literature as co-production or co-creation (Brandsen and Pestoff, 2006). This concept is further explored section 2.1.5.

Thus, the following four major types of actor interactions can be distinguished and analysed: interactions between (1) incubator management and incubatees, (2) incubatees, incubator management and external organisations, (3) incubatees and other incubatees, and (4) incubatees and their customers. The intensity and quality of such interactions can influence the incubation outcome to a significant extent. For example, Rice (2002) describes how the time and intensity of the intervention by an incubator's manager, coupled with the breath of support and readiness of the incubator manager to engage in the process, influence the success of the incubatees. He further argues that the incubation process is affected by the readiness of both, the incubatees and of the incubator, to engage in the support process. Readiness is therefore another important characteristic to look at when studying frugal innovation incubation initiatives. The readiness of the incubator can be understood by analysing its objectives and resources as these are expected to affect the incubation process (Gertner, 2013). The readiness of incubatees, respectively, can be understood by investigating their ability to acquire and utilize the resources obtained from the incubator. Insights from absorptive capacity and innovation capabilities of the firm literature (as summarized in section 2.1.4) can be used for this analysis.

2.1.3. Knowledge co-creation flows during the innovation process

Part of the resources provided to frugal incubatees consists of knowledge which is continuously co-created and used across all stages of the innovation incubation process. Knowledge flows and learning mechanisms that occur during this process are therefore important influencing factors. These flows can be best analysed using insights from the knowledge management and learning literatures (Senge, 1990; Nonaka and Takeuchi, 1995). In particular, the distinction often made between two categories of knowledge - tacit knowledge (i.e., difficult to formalize and share) and explicit knowledge (i.e., easily expressed, codified and shared) (Polanyi, 1966) – are relevant for the analysis of frugal innovation incubation programmes. Of particular importance here is also the knowledge transfer process itself. Research shows that this is a complex and lengthy process as it usually implies integration of new knowledge into the already existing knowledge base before it can be used and affect performance (*in casu* of frugal incubatees) (Nonaka and Takeuchi, 1995; Szulanski, 2000; Mvulirwenande et al., 2013). Thus it is important to analyse whether and, if so, what appropriate mechanisms and strategies the incubator and the incubatees devise to ensure that knowledge resources are effectively co-created and utilized to generate value. There are a few efforts in the literature that use a knowledge management lense to analyse knowledge that flows in the incubation process. Rubin et al. (2015) proposed the following three types of knowledge as relevant: technological knowledge, market knowledge, and financial knowledge. These knowledge resources are exchanged internally via direct interactions between incubatees and incubator managers (e.g., through face-to-face coaching), networking activities among incubatees, or, externally through interactions between incubatees and external actors (Bergek and Norrman, 2008).

2.1.4. Absorptive capacity and innovation capability of the firm

The extent to which the knowledge transferred to frugal innovators actually benefits the innovation process is argued to depend on their “absorptive capacity”. Cohen and Levinthal (1990) described this term as a firm's ability to identify, assimilate and exploit knowledge from the

environment. This ability comprises aspects that are distinctly organizational and those pertaining to individual staff members. The literature describes many factors that facilitate or inhibit the absorption of new knowledge by organisations. Internal factors include elements such as prior, related knowledge, level of education, gatekeepers, firm size and age, investment in research and development (R&D), organizational structure and human resource practices, mind-set and power relations. External factors include interaction, cross boundary expertise and the nature of external knowledge. Daghfous (2004) provides insights into the capacities that incubatees should have in order to absorb knowledge resources obtained during the incubation process.

However useful the concept of absorptive capacity might be, we argue that it is externally oriented – i.e., focusing on the ability of firms to absorb external knowledge. In order to fully analyse the competences that incubatee firms need to successfully innovate, it might be better to analyse their “innovation capability” which is broader than absorptive capacity. There have been many attempts in the literature to identify the core dimensions of the innovation capability of a firm (e.g., Guan and Ma, 2003; Wang and Chen, 2008; Zawislak et al., 2012). The dimensions proposed by these researchers do overlap to a great extent but they provide sufficient insights into the kind of capabilities a firm needs to innovate. For instance, the model by Zawislak et al. (2012) which appears more neutral and generic than others, distinguishes between four capabilities: (1) development capability – necessary for imagining and building new value solutions, (2) operations capability - the ability to produce products with quality, reliability and competitive cost, (3) management capability – which allows a firm to integrate all internal capabilities in a coherent way, and (4) transactions capability – required to link the firm to its external environment, both through purchasing or selling. The model argues that these four capabilities are both individual and organisational; and they are present in all firms, but they vary according to industrial and sector specificities, as well as the firm’s position in the supply chain and market approach.

2.1.5. Innovation co-production (co-creation)

The involvement of resource-constrained customers in the innovation process can be a source of competitive advantage for frugal innovators. The concept of co-creation (or co-production) is used in the literature to refer to the learning relationship with customers (Brandsen and Pestoff, 2006). According to Chen et al. (2011), there are three major arguments in support of co-production: customers can provide firms with suggestions to improve their innovations; firms can create value by exchanging resources and co-creating innovations with their partners – *in casu* customers; and customers can be a primary source of ideas which innovating firms can apply and turn into products and services. This resonates with the three types of co-creation identified by Voorberg et al. (2015) in the public sector innovation context: customers as co-implementers (whereby they implement particular tasks), as co-designers (when customers participate in the design process) and as initiators of innovations. Co-production is associated with many positive outcomes such as effectiveness and efficiency gains, higher service quality and greater satisfaction of innovation users (Pestoff, 2006) but entails time and resource investments of all involved actors.

2.1.6. Adoption of frugal innovations

Once frugal innovations have been successfully tested and or piloted, the challenge becomes how to ensure they are adopted widely. From the perspective of innovation diffusion, Rogers (2003) argued that the adoption and diffusion curve is S-shaped, implying that innovations are hardly adopted instantaneously. He proposed a model with five categories of variables to explain how innovations are diffused: the attributes of innovation, the type of innovation decision involved, the nature of the communication channels used, the nature of the social system in which innovation is diffused, and the role of change agents. Greenhalgh et al. (2004) conceptualize innovation spread

out strategies as a continuum, ranging from pure diffusion (in which the spread is unplanned, informal and mediated by peers) to active dissemination (where the spread is planned, formal and often centralized). The market perspective emphasizes the fact that both supply and demand should be effective for an innovation to get diffused (Mulgan et al., 2007). Westley and Antadze (2010) acknowledge the importance of market theory in making social innovations work, but they propose to couple it with the institutional change perspective to ensure that such innovations benefit many people on a lasting basis. Thus, Westley et al. (2014) differentiate between two possible strategies to spread innovations. *Scaling out* strategy emphasizes affecting more people and covering a larger geographic area through replication of successful innovations. *Scaling up* strategy focuses on affecting everybody who is in need of the innovation by addressing the broader institutional or systemic roots of a problem (e.g., by changing laws and policies). The importance of these two strategies is nowadays increasingly acknowledged in the scaling up literature (Moore et al., 2015; Davies, G., 2016; Ubels and Jacobs, 2016).

These views hold for the spread of many frugal innovations as well. Thus, our conceptual framework considers that creating transformative impact from successful frugal innovation pilots depends on a combination of the following two mechanisms: (1) replication of innovation – ensuring adoption of a particular frugal innovation by an increased number of potential users, and (2) institutionalisation of innovation - ensuring that the frugal innovation becomes the norm (e.g., at regional or societal levels), which can be done through changes in the form of legislation, policies, development plans and or programmes.

2.1.7. Innovation sustainability

Frugal innovations that have reached a satisfactory level of performance as a result of the testing and /or piloting stage must be sustainable if they are to be implemented on a larger scale and benefit great numbers of users. To be sustained, frugal innovations must meet a number of conditions. First, the innovation must be more cost- effective both financially and environmentally than alternatives in addressing the challenges at hand. This is achieved partly by focusing on core functionalities and by using local resources in the production process. In the case of a market-based frugal innovation, this should be able to provide sufficient returns so that market actors (either innovators themselves or other entrepreneurs) are interested in sustaining and expanding its provision – a sound revenue model is thus needed. Otherwise, the frugal innovation may be a good candidate for integration into public policy where it can benefit from existing funding schemes or attract new ones to be sustained. Second, frugal innovations must be socially desirable, technically appropriate and accessible, and financially affordable for the targeted resource-constrained customers. This requires the innovation to be inclusive both, in terms of the production process and business model development.

2.2. Determinants related to the innovation environment

The analysis of the innovation environment is informed mostly by the innovation systems literature. The systems approach to innovation became popular in the 1980s as an alternative to the linear model of innovation and through seminal works by researchers such as Lundvall (1992) and Nelson (1993). The systems perspective pulls away from the view that innovation is necessarily and primarily related to research activities and acknowledges the role of other players in the innovation process. Innovation is seen as involving a variety of actors, networks and institutions, and thus a complex and interactive process (Edquist 1997). Finally, any innovation system is embedded in a much wider system in which socio-economic, political and cultural conditions determine the direction, scale, and relative success or failure of innovative activities, both at national and

organisational levels (Freeman, 2002; Mueller et al., 2013). The following sub-sections discuss the key characteristics of the external environment that influence frugal innovation innovations.

2.2.1. Innovation institutional framework

The present conceptual framework considers a country's institutions as an important determinant of frugal innovation. Institutions consist of formal and informal rules that govern behaviour and structure social interactions (North, 1990). However, the analysis here focuses on formal institutions as informal rules can be analysed under other key components such as culture. There are different types of regulations that can help to foster innovation activities in a country. Notably, an appropriate intellectual property rights system can be a strong incentive for frugal innovation activities. Suitable regulations on appropriability of innovation outputs and distribution of profits from innovation are equally critical (Teece, 1986), particularly in the context of frugal innovations where multinationals increasingly co-create innovations with local enterprises. Innovation policies are another enabler of frugal innovation activities in a country. It should be emphasized that frugal innovation can also benefit from institutional deficiencies. For example, when firms operating in institutional weak environments perceive these as an opportunity, they can come up with unconventional, yet effective, ways to deal with them (Radjou et al., 2012). Needless to say that frugal innovations generally make their way easily in less regulated markets – e.g., where environmental standards are either absent or not strictly enforced (van de Beers et al., 2014).

2.2.2. Culture and frugal innovation

Over the past decades, empirical studies have shown that culture¹ determines a country's innovation rates to a significant extent (Shane, 1993; Sun, 2009; Efrat, 2014). National culture also influences innovation practices and behaviours of organisations and individuals (Hofstede, 1997). For example, Hofstede (1997) argues that in large power distance societies, organisations tend to be characterized by limited informal communication between managers and employees, centralized decision making structures, and extensive use of formal rules. Such features are expected to constraint knowledge and innovation activities and they are often analysed as part of organisational culture. In the context of frugal innovation, some researchers argue that collectivist societies with a higher tolerance for uncertainty (such as India) would encourage a frugal mindset. Customers in such societies would also be more comfortable with frugal innovations than in other societies (Krishnan, 2010; Soni and Krishnan, 2014). There are many other aspects of regional or national culture that can affect frugal innovation activities. For example, the importance of entrepreneurial culture (e.g., risk taking attitude, passion for business) as a driver of innovation activity is well known (Spilling, 1996; Shepherd et al., 2010). Places where the entrepreneurial spirit is low are generally associated with low entry of new innovative businesses (Nijkamp, 2003). In liberal systems, open competition is generally accepted as beneficial to the economic activity and firms are expected to work hard to attract customers through innovative products (Schumpeter, 1934). This suggests that regions or countries that are driven by free-market capitalism and a competitive culture are more likely to foster innovation activities. Earlier, we already elaborated how Western multinationals started engaging in frugal innovation once they realised that there was increasing competition for emerging markets.

2.2.3. Historical factors

There is evidence that historical factors can influence innovation activities in a country. One such factor is the institutional legacies of colonialism that continued to affect the development of

¹ Many of these studies have used Hofstede's (1997) four dimensions of national culture: uncertainty avoidance, individualism, masculinity, and power distance

former colonies in the post-colonial period (Miles, 2014). For instance, colonial legacies of the British and French are acknowledged to still have a large impact on education, science and research, and innovation activities in Africa (Okey, 2014). With regard to frugal innovation, it seems that countries or regions with a strong history of entrepreneurial bricolage (or the art of making do with what is at hand) are expected to lead. It is not by accident that economies like China and India are considered as lead markets for frugal innovations. Not only do the entrepreneurs and companies in these countries have a long history of circumventing their resource constraints and finding ways to solve societal problems, but consumers in these emerging markets are also historically used to products and services that are practical and 'good enough' (as opposed to word-class). Another historical factor that is likely to affect frugal innovations is the legacy of traditional Western innovation practices. For instance, with their long history of capital intensive innovation, many multinational companies find it challenging to innovate (for emerging markets) with limited resources at hand. So, as a first step, they have to leave behind their traditional methods which is not easy (Govindarajan et al., 2012).

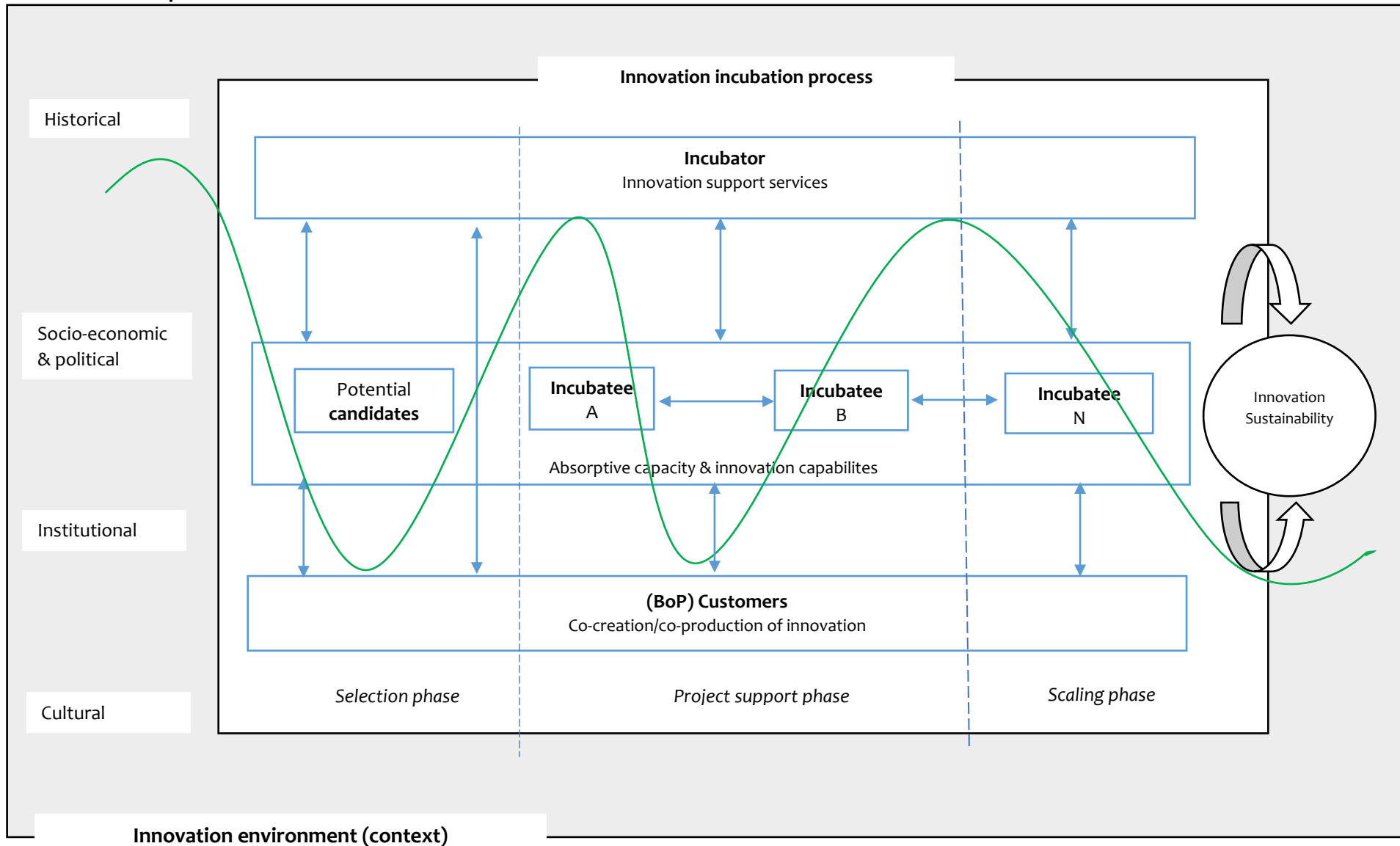
2.2.4. Socio-economic and political factors

The literature suggests a number of socio-economic and political conditions that decisively determine the innovation process and its outcomes. On the economic side, the role of financial instruments (e.g., venture capital networks, guarantee schemes, capital investment grants) in fostering innovation and entrepreneurship activities is critical (World Bank, 2010). A country's business and market environment (rule of law, level of corruption, availability of credit, access to the international market, etc.) can also encourage or constraint local and foreign motivation to innovate (Dutta et al., 2016), including for resource-constrained customers. On the social side, the innovation community – or the network of actors and how they think and interrelate - is extremely important for promoting any type of innovation activities (Gregersen and Johnson, 1997). For a frugal innovation incubation process, rich networks of actors benefit both the incubator and the incubatees by providing them with opportunities to access the resources they need to perform. On the other hand, the human capital stock – the extent of which depends on a country's education system - is indispensable for innovation to thrive (Barro and Lee, 2000). The availability (or lack of) talented people in a country or region will decisively influence its frugal innovation potential (e.g., the ability of multinationals to find competent local partners with whom to co-create frugal products). On the political side, innovation in any context is shaped by the quality of government institutions (Huang and Xu, 1999). In this regard, Rodríguez-Pose and Di Cataldo (2014) provide strong evidence on how ineffective and corrupt governments constrain the innovative capacity of the periphery regions of the European Union.

2.3. Towards an integrating framework

In the previous section, we discussed relevant concepts and theories that inform the present conceptual framework. By doing so, we identified and described key factors or variables that are conceived to determine frugal innovation processes in the context of incubation programmes. Figure 1 schematically presents these variables and their presumed relationships. The figure delineates two major categories of variables: those relating to the innovation incubation process and those pertaining to the external innovation environment. They can be used as a theoretical tool for analysing interventions to foster frugal innovations. Annex 1 describes the operational elements for each key variable of the framework.

Conceptual framework



- Actors
- ↔ Actors' interactions
- ~ Knowledge co-creation flows

3. Case study : The VIA Water Programme

3.1. Introduction

The potential of frugal innovations to tackle water-related challenges in emerging and developing countries is increasingly being acknowledged. Some multinational companies have already started investing in frugal water innovations, with promising results. *Swatch* and *Pureit*, two water treatment devices developed by Tata Chemicals and Hindustan Unilever respectively, are perhaps the most well-known of these frugal water innovations (Levänen et al., 2015). Nevertheless, compared to other sectors, the water sector is characterised by low innovation dynamism (Wehn and Montalvo, 2015). In order to accelerate frugal innovation in the water sector, there is a need to also encourage local companies – particularly small and medium enterprises (SMEs) - and grassroots innovators to develop and / or scale up their potential frugal ideas. There are already some initiatives in the water sector that aim specifically at fostering frugal innovations, notably through incubation-like programmes. In this section, we apply the conceptual framework described above to analyse one such intervention, the VIA Water programme. Financed by the Dutch Ministry of Foreign Affairs, VIA Water supports innovative projects in cities of seven African countries: Benin, Mali, Ghana, Kenya, Mozambique, Rwanda and South-Sudan. In addition to investment capital, innovators receive other support services (e.g., coaching and mentoring) to help them successfully implement their pilots and eventually bring them to scale. The analysis conducted here draws mainly on secondary data, exploratory visits to VIA Water project owners in Ghana and Kenya (conducted in July and September 2017 respectively) and preliminary discussions held with 4 VIA Water managers in September 2017.

3.2. VIA Water configuration and modus operandi

3.2.1. Goals and configuration

The mission of VIA Water is to contribute to the achievement of Sustainable Development Goal 6 on water and sanitation by promoting innovations. This is achieved through two concrete objectives: (a) creation of a virtual water learning community in the cities of the seven target countries, and (b) realisation of pertinent innovations which have been developed by or in co-creation with African partners. The programme consists of a network of actors, with complex relationships (see Figure 2). The core of the network comprises actors who are directly involved in the programme, with strong ties, and whose relationships are managed and coordinated through formal contractual arrangements. These network members are IHE Delft Institute for Water Education which hosts the programme's secretariat, Aqua for All - the Fund manager, the Dutch Ministry of Foreign Affairs, VIA Water project owners, the Steering Committee, the Advisory Committee (VAC), country liaisons, and the coaches. Finally, the core of the network involves VIA Water full-time staff members (5 in total). The programme office team consists of the Programme manager, the knowledge management and learning coordinator, and the communication officer. The fund management team consists of two people.

The VIA Water network comprises also peripheral members: those actors who are loosely connected (weak ties) to the core layer. These are notably organisations with an interest in VIA Water's agenda and who can synergize their initiatives with the programme's activities. Examples of peripheral members are: the Netherland Water Partnership, the Dutch embassies in target countries, the Centre for Frugal Innovation in Africa, etc. The relationships between these actors and the core layer can be managed through formal or informal contracts depending on the situation. This wide network of relationships provides VIA Water with the resources and information channels it needs to perform as a virtual incubator.

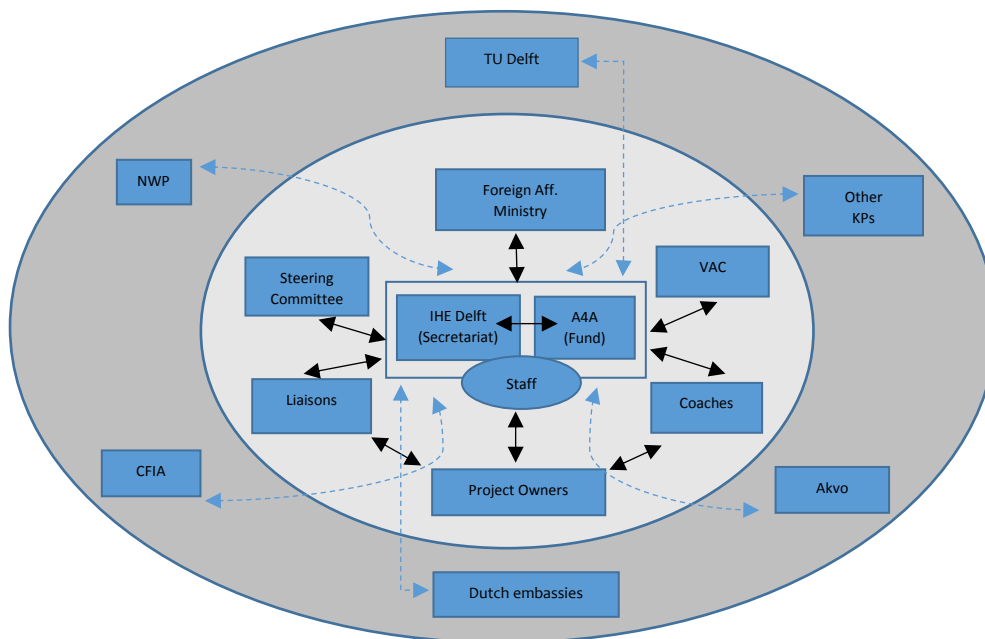


Figure 2: VIA Water network (source: authors)

3.2.2. The incubation process

3.2.2.1. Incubatee selection

The innovation incubation process as conceptualised by VIA Water considers the three major phases (selection, support and upscaling) outlined in the conceptual framework. The programme focuses on twelve strategic innovation areas, the so-called *pressing water needs* (see Figure 3). The latter were defined through a consultation process with the water sector experts and professionals in the Netherlands and in Africa. To stimulate innovative ideas on how to solve these needs, VIA Water organises idea campaigns in target countries – notably through workshops, competitions, and calls for proposals. From there, interested people can submit a “teaser” in which they briefly describe their innovative idea. VIA Water managers then fast-screen the teasers and provide the first feedback to the applicants: those with promising ideas are invited to develop and submit full project proposals. Each proposal is jointly studied by the VIA Water secretariat and Fund manager, with the support of two external experts to ensure objectivity of the selection process. Unlike many incubators, VIA Water does not rely on a fixed team of experts. Due to the wide variety of strategic innovation areas, the programme selects relevant specialists from its wide network on an *ad hoc* basis. The proposals are judged and scored against a variety of criteria. These generally relate to the *innovation itself* (e.g., level of innovativeness, potential for scale-up, sustainability) and the *capacity of the innovator* (e.g., partnerships, expertise to manage the project, readiness to learn). The proposal review is usually an interactive process in which applicants receive feedback in a Q&A format. Once VIA Water is satisfied with the quality of the proposal, the Fund manager and Programme Coordinator jointly take the funding decision. A contract is then signed, which marks the start of the project implementation phase. Since 2015, VIA Water has contracted 63 water innovation projects. Table 1 provides a few examples of water frugal innovation projects supported by this programme.

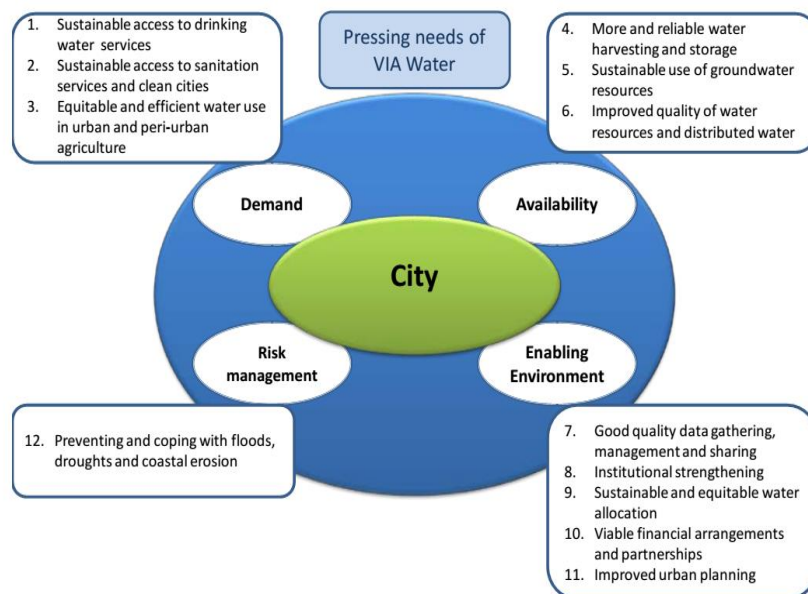


Figure 3: VIA Water strategic innovation areas (source: VIA Water, 2015)

Table 1: Examples of water frugal innovations supported by VIA Water

Name of project	Short description of innovation	Innovator(s)
1. Severe Weather Warning for Musanze (Rwanda)	The project implements a <i>frugal weather</i> system which generates weather predictions and information that is made available to a wide variety of users through phone and web applications. The system also issues alerts on flood and lightning.	TU Delft, TAHMO, Severe Weather Consult
2. Scaling up household water treatment [try and buy] (Ghana)	The project tests a new <i>business model (try and buy)</i> for the large scale commercialisation of household water filters. Families try filters for free and decide whether to buy them after the trial period.	Basic Water Needs
3. Mobile Desludging Device production (Ethiopia)	The project develops a <i>frugal desludging device</i> , with local materials and expertise	WASTE Advisers, Yassin Industries
4. Closing the water loop for car washing stations in Kumasi (Ghana)	The project develops a <i>frugal technology for recycling wastewater</i> from car wash stations	NHance Development Partners

3.2.2.2. Innovation support

In addition to capital investment, VIA Water provides knowledge and network resources to its incubatees. To start with, relevant knowledge – both tacit and explicit – is exchanged during the Q&A feedback on teasers and full proposals. At this level, it is also common that the programme decides to strengthen the capacity of some applicants (mainly Africans) and helps them to bring their projects to maturity. This is usually done through individual coaching sessions or through so-called Innovation Challenges in which a group of potential applicants are trained on relevant

subjects (e.g., proposal writing, business models, marketing, and finances). During project execution, VIA Water continues to provide expert advice to project owners through its managers, local liaisons and coaches. The online learning community created by VIA Water is another knowledge sharing channel. VIA Water project owners and managers are the core members of this community; but it is also open to anyone with knowledge and interest in urban water issues in Africa. The community members interact primarily via the internet, but the programme organises physical encounters from time to time to increase the level of trust among participants. The physical learning opportunities are so far highly appreciated by project owners, but it appears that the virtual approach has not yet generated the expected learning dynamics. With regard to the provision of network resources, it is expected that through the learning community project owners can naturally link up with potential partners. Besides, VIA Water aims to help its project owners showcase their innovations at strategic events (e.g., international conferences), which is expected to attract the attention of potential partners. The so-called “Bidbook” which was launched in June 2017 is expected to have similar effects.

3.2.2.3. Innovation upscaling and sustainability

In the VIA Water context, innovation sustainability is assessed on five dimensions: financial, institutional, environmental, technical and social. During the proposal review and pilot implementation processes, many questions are raised (on these dimensions) which help innovators to realise (and act upon) potential threats to their projects. From this perspective, the pilot phase of an innovation project lays a strong foundation for its future larger scale commercialisation. On the other hand, the knowledge and network resources provided to project owners during the incubation process are meant to help them sustain their innovations in the real market.

3.3. Other factors affecting VIA Water incubation

3.3.1. Weak innovation capabilities of applicants

The experience of VIA Water suggests that potential frugal water innovators in Africa face innovation capability challenges. The importance of this problem is best illustrated by the low rate of African applicants who manage to sign a contract with VIA Water. As shown in Table 2, up to July 2017, African lead partners submitted 399 applications (81% of all applications), but only 35 contracts were signed (56% of all contracts). This low rate is associated with a lack of knowledge in project management and other soft skills (VIA Water, 2016). That is why the programme committed to strengthen the capacities of African applicants as explained above. These findings suggest that programmes like VIA Water should not presume that innovators already have all the required human capacity to innovate. Thus, rather than capacity development of innovation incubatees to emerge as a by-product of the incubation process, it should be at the centre of the process and considered at the design phase of the intervention. From a different perspective, one could argue that VIA Water implicitly attempted to circumvent the innovative capability problem by emphasizing innovation partnerships (e.g., between African and foreign organisations) as a selection criteria. So far, it appears that this “polycentric innovation” approach has allowed VIA Water co-applicants to strengthen each other’s capacity to innovate. As demonstrated in Table 2, up to July 2017, the consortia scoring best (those with higher success rates²) in terms of obtaining a contract from VIA Water proved to be those involving Dutch/foreign and African partners (VIA Water, 2017).

² Success rate here refers to the contracts/applications ratio

Table 2: Success rates of applicants for VIA Water incubation as of July 2017

Consortia	Number applications	Contracts signed	(%) appl	(%) contr	Success rate
1. Dutch/Foreign main applicant, rest Southern	46	13	9%	21%	28%
2. Dutch/Foreign main applicant, more Dutch partners, rest Southern	45	15	9%	24%	33%
3. African/Dutch/Foreign main applicant	14	3	3%	5%	21%
4. African main applicant, rest Dutch/Foreign	10	2	2%	3%	20%
5. African main applicant, more African and Dutch/Foreign partners	58	12	12%	19%	21%
6. African main applicant, no other	189	5	39%	8%	3%
7. African main applicant, other African partners, no Dutch	120	13	24%	21%	11%
8. Other	8	0	2%	0%	0%
Total	490	63			13%
Dutch-led consortia	91	28	19%	44%	31%
African-led consortia	399	35	81%	56%	9%

Source: VIA Water (2017)

3.3.2. The role of contextual factors

There is evidence from the VIA Water programme that country context influences the innovation incubation process. At the moment, this can be illustrated by the performance of applicants from each VIA Water country represented in the application process. It is reported that – as of 2016 - Kenya and Ghana had the highest number of applications (82 applications in each case), winning 13 and 8 contracts respectively (i.e., a success rate of 16% and 10%). Applicants from countries like Rwanda and Benin were performing very badly. For example, of the 49 applications that were received from Rwanda, none had yet reached the contract stage as of December 2016; while applicants from Benin had only obtained 1 contract out of 36 applications. Interestingly, as of July 2017, 7 applicants from Rwanda had obtained contracts (out of 71 applications, i.e. 10% success rate), while 5 applicants from Benin have contracts (out of 45 applications, i.e. 11% success rate). These findings suggest in the first place that the time it takes between submitting a teaser and signing a contract vary from country to country – on average 7 months. The differences could be attributed to many factors, notably the wider innovation context in each country, the approach taken by VIA Water managers for specific countries, the calibre of co-applicants, etc. For example, Kenya is indeed one of the innovation hubs in Africa, with significant talent potential and growing entrepreneurial spirit and activity. A lot of frugal innovations such as M-PESA (a mobile payment solution) and M-KOPA (a home solar solution) started in Kenya. Thus, it makes sense that Kenyan applicants take less time to reach the contract stage than those from Benin – for instance - who reportedly have required a lot of support and coaching from VIA Water. The national culture of the target countries could also explain the aforementioned performance differences to some extent. Following Hofstede’s (1997) analysis, Kenya appears to be a low power distance country, with a more individualistic culture, as compared to Ghana and Mozambique, for instance - which would accordingly explain its relatively higher application rate.

4. Conclusion

This paper aimed to develop a conceptual framework for the analysis of interventions that foster frugal innovations through incubation. Drawing on relevant theories and concepts in the field of innovation and related literatures, the framework proposed here identified and described two major categories of factors that influence the nature and outcomes of frugal innovation incubation processes. The first category relates to the frugal innovation incubation process and includes factors such as how the process is conceived and implemented, the readiness of both the incubator facility and incubated innovators to positively engage in the process, and the nature and quality of support services directed to incubatees. The second category relates to the innovation environment and comprises factors such as the institutional framework, national culture, and the wider socio-economic and political conditions.

The application of the framework on the VIA Water case confirms the relevance of virtual incubators as a mechanism to foster frugal water-related innovations. The findings reveal that the innovation capabilities of potential frugal water innovators in Africa are problematic. Hence the need to develop and implement a sound capacity development plan as part of the incubation process. Besides, the case study findings confirm that country innovation environment matters, implying that frugal innovation incubators should align their support (to incubatees) with a country's specific needs and challenges. Finally, the framework and VIA Water case study material presented in this paper demonstrated the complexity of the frugal innovation incubation process and thus the need to take a holistic approach when designing and / or analysing related interventions.

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Annex 1: Detailed list of potential determinants of frugal innovation incubation

Dimensions	Sub-dimensions	Determinants
Innovation environment		
Contextual factors	Cultural	<ul style="list-style-type: none"> • Entrepreneurial culture/spirit • Language • Culture to compete
	Historical	<ul style="list-style-type: none"> • Colonial legacies (e.g., British and French colonial legacies) on education, research and innovation • Legacies of traditional societies' views on knowledge and innovation issues – e.g., on knowledge and power/age • Legacies of local and or traditional practices of urban water management
	Institutional	<ul style="list-style-type: none"> • Formal innovation rules and regulations • Innovation policies
	Socio-economic & political	<ul style="list-style-type: none"> • Regional or national organisations and networks • Supply of talent (human capital stock) • Business and market environment, risky economic environment, availability of credit • Stability of government • Governance (quality of public service, corruption)
Innovation incubation process		
Selection phase	Idea generation	<ul style="list-style-type: none"> • Definition of innovation strategic areas – the process • Idea campaigns (to foster generation of new and creative ideas)
	Screening and selection of innovation projects	<ul style="list-style-type: none"> • Selection process • Selection criteria • People involved and their roles
Project support phase	Incubator	<ul style="list-style-type: none"> • Configuration • Objectives and assumptions • Resources (internal and external)
	Innovation support services to incubatees	<ul style="list-style-type: none"> • Knowledge and capacity development • Networking–mediation • Learning • Funding support
	Interactions among actors	<ul style="list-style-type: none"> • Interactions between incubatees and incubator • Interaction among incubatees themselves • Interaction between incubatees, incubator and other external actors • Interactions between incubatees and their customers (including BoP Customers)
	Incubatees' absorptive and innovation capabilities	<ul style="list-style-type: none"> • Capability to acquire, assimilate, transform and exploit new external knowledge • Innovation development capability (imagine and build new value solutions) • Operations capability (manufacturing capability)

		<ul style="list-style-type: none"> • Managerial capability (integrate internal capabilities in a coherent way) • Transactions capability (relate with external stakeholders)
	Innovator-entrepreneur characteristics	<ul style="list-style-type: none"> • Entrepreneurial experience • Industry experience • Education • Family background
	BoP customers	<ul style="list-style-type: none"> • Degree of involvement • Stage of involvement • Ability to express needs and provide feedback
Scaling phase	Replication of innovation (increased number of adopters)	<ul style="list-style-type: none"> • Resources (financial and human) • Innovation champions and/or early adopters • Business models in use • Empirical evidence that innovation works
	Institutionalisation of innovation (through policies legislation, plans)	<ul style="list-style-type: none"> • Alignment on innovation as solution to issues at hand • Innovation champions within the elites • Changes in institutions and policies (in favour of innovation) • Shift in people's attitudes vis a vis innovation
<p>Innovation sustainability</p> <p>The following criteria are conceived to be relevant for analysing the sustainability of a frugal innovation:</p> <ol style="list-style-type: none"> 1. Desirability and appropriateness – fit with local needs and circumstances (<i>technological sustainability</i>) 2. Accessibility and affordability of innovation - to resource constrained customers (also those in the Bottom of the Pyramid segments) (<i>social sustainability</i>) 3. Cost-effectiveness: a market-based innovation must be able to provide sufficient returns so that market actors are interested in expanding the provision of that innovation. Otherwise, the innovation must be a good candidate to be integrated into public policy and benefit from existing funding schemes or attract new ones to be sustained (<i>financial sustainability</i>) 4. Institutional embedding - 5. Environment-friendly – economic use of resources, minimal negative effects on environment (<i>environmental sustainability</i>) 		