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Published in:
Journal of Cleaner Production

DOI:
10.1016/j.jclepro.2016.07.101

2018

Document Version:
Peer reviewed version (aka post-print)

Journal of Cleaner Production xxx (2016) xxx-xxx

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com

Promoting water-related innovation through networked acceleration: Insights from the Water Innovation Accelerator

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ARTICLE INFO

Article history:
Received 15 June 2015
Received in revised form 18 July 2016
Accepted 18 July 2016
Available online xxx

Keywords:
Acceleration
Entrepreneurship
Incubation models
Networks
Water innovation

ABSTRACT

The current state of the water and sanitation sector has put water-related innovations high on the global policy agenda. However, the systemic complexity that typically surrounds such contexts call for actionable knowledge of how to enable and orchestrate innovative solutions by connecting different players via organized networks. In this study we explore and analyse the Water Innovation Accelerator, which is a virtual network-centred incubator model designed and implemented in Sweden. Framed by theory and research on open innovation, incubation models, and entrepreneurial networks we provide an analysis of the design, working and performance of the Water Innovation Accelerator. In sum, our findings provide empirical support for virtual accelerators as an effective means to aid the development and market uptake of water related innovative solutions. Its overall effectiveness builds on its ability to bring private and public actors with different assets and competencies together via its entrepreneurial network, where the incubator team play a critical role for identifying and encouraging network-embedded innovation opportunities. However, the perceived effectiveness of the acceleration process for SMEs seems to be contingent on whether they are positioned in later stages of the innovation process, as well as their proximity to the incubator network. In these respects, the study provides valuable insights that may aid researchers, incubation managers and policy makers in current and future efforts to accelerate water innovation.

1. Introduction

Water is an invaluable resource for human health and the future wellbeing of modern society. However, as emphasized in the call for this special issue, societal challenges such as urbanisation, climate change, pollution and population growth have put water-related innovations high on the global policy agenda (Partzsch, 2009; UNESCO, 2014). The EU Water Framework Directive identifies the protection of water as one of the great challenges for the European Union where they call for increased involvement by citizens and other actors in finding novel solutions. Likewise, the Horizon 2020 identified the challenge of water innovation as a focus area, with the aim to position Europe as a global market leader in water related innovative solutions. Overall, these challenges require considerable improvements in the state of water resources, both in quantity and quality, and emphasize the need for concerted action among public and private actors to effectively reduce the water intensity of production processes, as well as improving water recycling and water reuse for the benefit of industry and larger society.

The need of water related innovations call for actionable knowledge of how to support the development of new technologies into products, processes and services (Krozer et al., 2010; Hegger et al., 2011). The popularized image of such processes is that innovation happens in a largely linear fashion (Rothwell, 1994) either via *market push*, where scientific discoveries lead to technological developments, which eventually reach the marketplace (Bush, 1945), or *market pull*, where the market is the source of new ideas which direct R&D efforts into novel solutions (Utterback, 1974; Irvine and Martin, 1984). However, modern theories of innovation typically disregard such linear models as they play down the important role of network partners in the innovation process (Fagerberg et al., 2005). Instead, innovation is conceptualized as a highly dynamic and interactive process of co-creation (Nelson, 1993), where technologies are embedded within and commercialized by networks of multiple actors and institutions (Malerba, 2002; Spilling and Steinsli, 2004; Edquist, 2005). Overall, this stream of research emphasize incubation support as a way to provide fledgling start-ups and growth-oriented SMEs with an entrepreneurial environment that facilitates access to external resources, knowledge and legitimacy (Bøllingtoft and Ulhøi, 2005), thereby linking entrepreneurs with local, regional, and global networks of customers, suppliers and other complementors (Caryannis and von Zedtwitz, 2005).

There has been a wide variety of incubation models implemented

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http://dx.doi.org/10.1016/j.jclepro.2016.07.101
0959-6526/

2004; Bruneel et al., 2012; Barbero, Casillas, Wright & Garcia, 2014). A uniting feature in many of these models has been their overall aim to link technological know-how with complementary resources such as business know-how, financial capital and entrepreneurial talent (Grimaldi and Grandi, 2005; Bøllingtoft, 2012). In this respect, much of the literature has emphasized the distinct value of relevant business networks that can accelerate the development and growth of start-ups and SMEs, as these networks encourage them to open up their boundaries and explore a wide range of internal and external sources for spotting and seizing innovative opportunities (Hansen, Chesbrough, Nohria & Sull, 2000; Bøllingtoft and Ulhøi, 2005). This network-centred approach to incubation seems to be especially relevant for the development of water related innovative solutions, given the systemic complexity that typically surrounds such contexts (Partzsch, 2009; Krozer et al., 2010; Levidow et al., 2015).

While past research has reported on various incubation models across a range of sectors and industries (e.g., Grimaldi and Grandi, 2005; Bruneel et al., 2012; Pauwells et al., 2015), there is up to date limited scholarly knowledge informing about how incubation processes can be designed and implemented to create market opportunities for water innovations. Adding to this, previous studies have primarily focused on incubation models that provide physical resources, such as office space and in-house business support services (Bruneel et al., 2012; Isabelle, 2013), while research is very limited on virtual incubation models that stress networked interaction as their primary way to accelerate the development and market uptake of innovations (Nowak and Grantham, 2000; Caryannis and von Zedtwitz, 2005). Based on this observed gap, the aim of the study is to explore the concept of *networked acceleration* for enabling and orchestrating water-related innovations. Within this domain, we analyse the Water Innovation Accelerator (WIN), which is a virtual network-centred accelerator in Sweden. The incubation model of WIN is developed to catch and channel early stage ideas by bringing together cutting-edge academic knowledge with leading actors in the water and sewerage industry, and to provide a platform for early contacts with the market, supply of financial capital and sustainable community building. We use contemporary theory and research on innovation and entrepreneurial networks as a theoretical lens to depict the design, management and organization of WIN. We also analyse and assess the working and performance of WIN with respect to its purpose to connect different players and transfer knowledge via its organized network. Empirical data for this assessment is gathered from observations and interactions with SMEs and partners at network meetings, as well as via questionnaires and personal interviews with SMEs participating in the virtual accelerator.

The rest of the paper proceeds as follows. The next section provides a literature review where we identify current state of the art in research on open innovation, incubation models, and entrepreneurial networks. Using this frame, we thereafter present an overview of the design, management and organization of WIN, which is a novel accelerator program developed in Sweden aimed at bringing technology to market by fostering partnerships among venture teams and facilitate the flow of knowledge and talent across companies. Following this is an analysis and assessment of the working and performance of WIN. The study ends with a discussion of theoretical and empirical insights and its implications for supporting and accelerating water innovation via inter-organizational cooperation.

2. Literature review

2.1. Water innovation and market failures

Efficient and effective water use is one of the greatest challenges on the planet and there is a huge demand on innovations that can support the improvement of water supply and sanitation in society (Krozer et al., 2010). The current situation opens up new market opportunities for private actors when more public and private money will be spent on the water and sanitation sector. However, a main hampering factor for the active engagement in water related innovation is the pre-commercialization challenges of developing new water technologies and the associated risks of scaling up operations (European Innovation Partnership on Water, 2014). This situation results in a classical *market failure* (Arrow, 1962; Hall, 2002) where companies may refrain from investing (enough) in R&D since they do not reap the full benefits of their innovative activities.

Traditional analyses of potential market failures have resulted in policy interventions such as subsidies for R&D within single companies. The underlying rationale of these interventions is that society at large may benefit from such investments in the long run (Hall, 2002). However, modern theories of innovation advocate a more systemic approach to innovation (i.e., Freeman, 1987; Lundvall, 1992; Nelson, 1993; Edquist, 1997). This growing stream of research has resulted in advice to policy makers that emphasize the creation of cooperative networks where a variety of actors, including customers, suppliers, competitors and universities, all play different roles relative to other actors in the innovation process. The underlying rationale is to preserve, retain and transfer knowledge that has an economic value to society, but which due to isolation may not currently be fully exploited.

2.2. Systemic and open approaches to innovation

The systemic approach to innovation emphasizes the interplay of network partners rather than as an isolated process from a single firm's point of view (Edquist, 2005; see also Normann and Ramirez, 1993). This approach is closely aligned with the open innovation paradigm (Chesbrough, 2003; Elmquist, Fredberg & Ollila, 2009; Lee, Park, Yoon & Park, 2010; Clausen and Rasmussen, 2011), as both focuses on knowledge sharing and the expansion of networks for the successful commercialization of technologies, regardless of the path to market. The open innovation approach emphasizes the break up of traditional (or "closed") approaches to innovation, resulting from the increased availability and mobility of knowledge workers, rising costs of technology development, shortening product life cycles, the flourishing of ICT, and the development of new financial markets (Chesbrough, 2007; Elmquist et al., 2009). This has in turn led companies to open up their business models by leveraging their external R&D resources as well as licensing out internal technologies. In this respect, the innovation process has become much more dependent on external (as well as internal) ideas by deploying outside (as well as inside) pathways to the market (Chesbrough, 2003).

The open innovation approach is especially relevant for understanding the acceleration of innovation in SMEs (Lee et al., 2010; Clausen and Rasmussen, 2011). These firms are typically organized and managed in flexible and agile ways that make them particularly open to external influences in their operating environments. However, SMEs have limited capacity to manage the whole innovation process by themselves, especially at later stages where access to marketing and sales become critical issues to handle (Gans and Stern,

2003; Edwards et al., 2005). In this respect, SMEs are more likely to seek non-internal means of innovations, such as via alliances or networks, as a way of extending their technological competencies and accessing complementary assets needed to commercialize innovations (Rothwell, 1991; Edwards et al., 2005). Moreover, research suggests that firms that exploit multiple network ties are more innovative and perform better compared to those firms who only rely on one tie (Baum, Calabrese & Silverman, 2000). Overall, this implies that SMEs may benefit greatly from participating in collaborative networks as a way of building up their capacity to access additional resources and know-how in the innovation process.

2.3. The role of intermediaries for accelerating innovation in SMEs

Research on open innovation in SMEs has emphasized the critical role of innovation intermediaries in providing value-adding networks and services that connect different players in the innovation process (Lee et al., 2010; Clausen and Rasmussen, 2011). A particular stream of research that has focused on the importance of innovation intermediaries for the successful commercialization of technologies can be found in the incubator model literature (Mian, 1996; Aeurnoudt, 2004; Grimaldi and Grandi, 2005; Bruneel et al., 2012; Pauwells et al., 2015), where *incubation* can be understood as a nurturing, instructive and supportive process implemented to accelerate the creation and development of successful entrepreneurial companies (Brooks, 1986). This body of literature identifies a range of basic components typically used by intermediaries in their efforts to provide incubation support to start-ups and SMEs, such as access to physical resources, office support services, access to capital, process support and networking services (Caryannis and von Zedtwitz, 2005; Pauwells et al., 2015).

While early incubation efforts in the 1980s and early 1990s primarily focused on the provision of office space and financial support (Allen and McCluskey, 1990), later models have more increasingly emphasized the provision of entrepreneurial networks as a key defining feature of well-functioning innovation intermediaries (Hansen et al., 2000; Bøllingtoft and Ulhøi, 2005). Recent studies have even started to criticize that the provision of office space and in-house business support services may risk leading intermediaries to merely acting as life support and keeping tenants alive to fill incubation space. As a response to these potential shortcomings, recent incubation models have advocated the provision of specific incubation services during an intensive program of limited duration, within which entrepreneurial teams and their ventures can receive knowledge intensive support services and connect with and access resources from various stakeholders (Miller and Bound, 2011; Pauwells et al., 2015). The critique has also opened up a renewed interested in virtual incubation models (Nowak and Grantham, 2000; Caryannis and von Zedtwitz, 2005). In this latter approach, the idea of a physical location is disregarded and the formation and management of organized networks instead becomes the main centre of attention for the intermediary organization. It is the working and performance of the virtual incubation model and the organized network they provide that we focus on in this study.

2.4. Organized networks for innovation

Organized networks to facilitate and support collaborations and knowledge sharing beyond organizational boundaries seem to be widely recognized in the literature as a critical feature for accelerating innovation in SMEs (Hansen et al., 2000; Lee et al., 2010). A network can in this respect be defined as a set of actors (individuals and organizations) and a set of linkages or contacts between the actors (Brass, 1992). Following this definition, previous research has identified the content, governance and structure of the network as three critical elements for understanding inter-organizational cooperation in entrepreneurial contexts (Hoang and Antoncic, 2003; Billström et al., 2014).

Network content refers to the nature of content that is exchanged between actors. This may include the exchange of tangible resources, such as access to financial capital and attractive locations, as well as intangible resources, such as access to information, advice, emotional support and legitimacy. *Network governance* refers to the mechanisms that coordinate and manage relationships between actors. This can be assessed based on the extent to which resource exchange is governed by formal contracts versus more open-ended relational contracts (Johannisson, 2000). While formal contracts can facilitate resource exchange and orchestrate action in cooperative networks (Young Hoon and Young Jun, 2015) research typically emphasizes the importance of informal network governance when development trajectories are inherently unpredictable (Yli-Renko, Sapienza and Hay, 2001). In addition, entrepreneurs typically rely on trust-based modes of governance in building up networks and relationships (Anderson et al., 2007). *Network structure* refers to the patterns of crosscutting relationships and ties between various actors in the network. One way to assess the structure of networks is the extent to which network ties can be characterized as strong vs. weak (Granovetter, 1973). Strong ties are important for personal and emotional support (Krackhardt, 1992) and can serve as bridge to weak tie actors (Jack, 2005). Weak ties, however, facilitate access to novel information and provide actors with business opportunities, reputation and legitimacy (Singh, 2000; Rasmussen et al., 2015). Hence, both strong and weak ties influence the flow of resources in and around SMEs, which emphasize the need to balance and manage the structure of networks in the innovation process (Gretzinger et al., 2011).

2.5. Summary

Challenges in the state of water resources calls for the need of concerted action among public and private actors to find and implement innovative solutions for targeted customers or end users. We have in the literature review identified the current state of the art in research on open innovation, incubation models, and entrepreneurial networks. This body of literature will be used as a theoretical lens to depict and analyse the working and performance of the Water Innovation Accelerator (WIN) in the remainder of this study.

3. Methodology

3.1. Empirical context and data collection

The empirical analysis is focused on the Water Innovation Accelerator (WIN), which is a virtual accelerator initiated and organized in Sweden with the purpose to aid the development and market uptake of water related innovative solutions by connecting different players via its entrepreneurial network. Following the exploratory approach taken in this study we applied a multi-methodological research design. This also enabled us to combine an accelerator-level of analysis with a firm-level perspective on the accelerator process. We have in this respect employed a mix of observations and personal interactions with SMEs and support organizations at partner meetings, questionnaires and follow up personal interviews with SMEs to capture the overall working and performance of WIN. This data collection has also been supplemented with document and website reviews. Part of

the author team have been involved in founding and managing WIN, which provide in depth knowledge of its history and evolution. Two independent researchers have complemented this constellation in order to balance experience with criticality and enable objective evaluations in the study.

3.2. Questionnaire to SMEs

The study includes an analysis and assessment of the working and performance of WIN from the point of view of the participating SMEs. In this respect, a questionnaire was developed to assess the role that the virtual accelerator has played in developing the business and the advantages gained from being members of the WIN network. The items used in the questionnaire were adapted from previous literature and research on incubation processes (e.g., Scillitoe and Chakrabati, 2010; Clausen and Rasmussen, 2011) and included questions about contacts and interactions between network members besides official partner meetings, the overall experience of the acceleration process, the specific advantages gained from their membership, and the additionality of the virtual incubator. This latter aspect is typically seen as an important assessment criterion when public resources are used to stimulate progress in society (Buisseret et al., 1995). As it is hard to identify a relevant control group in our case we used the "counterfactual scenario" as a comparison base (Rye, 2002; Clausen and Rasmussen, 2011). Following this procedure, additionality was gauged by asking the respondents to assess what would have happened with the SME if the virtual accelerator would not exist.

Once designed, the survey questionnaire was carefully reviewed to ensure the questions and instructions were clear and easy to understand. Pilot testing was however not possible due to sample constraints. The questionnaire was then distributed to the entrepreneurs/managers of 21 SMEs that have participated in the WIN network for at least six months. A total of 19 managing directors responded to the questionnaire.

3.3. Personal interviews

We conducted a number of personal interviews with entrepreneurs/managers from six SMEs in the WIN network. The selection procedure was based on purposeful sampling (e.g., Patton, 1990) guided by the possibility to learn a great deal about issues of central importance to the purpose of the study. The length of the WIN membership was initially considered as to facilitate the inclusion of SMEs who have had opportunities to participate in several network events. Thereafter, the selection was guided by stage of development (early vs. late stage SMEs) and geographical proximity (close vs. distant SMEs). All respondents were guaranteed full anonymity to encourage the sharing of rich information. The interviews were semi-structured and open-ended in order to stay as close as possible to the lived experience as possible (Silverman, 2001).

All interviews were conducted and analysed by researchers not involved in the management of the WIN network. Established recommendations for structuring and analysing qualitative data (e.g., Eisenhardt, 1989) were followed in this process. The procedure started with specific observations in each respective account, then moving towards shared patterns and regularities, and finally ending up in some general conclusions. These conclusions were then used as the primary basis for summarizing and organizing the findings.

4. The Water Innovation Accelerator (WIN)

4.1. Background

Founded in 2012, the Water Innovation Accelerator (WIN) is organized as a part of an Open Innovation initiative at the Ideon Science Park in Lund, Sweden. The concept of WIN is built around the idea of being a network orchestrator in support of water related innovations by sourcing novel products and services to the water market through its network of partners. WIN offers a virtual community that supports SMEs in realizing their growth by providing a market arena, tailored business coaching and assistance with financing. WIN openly invite SMEs who operate in or near the water market into its network to encourage them to go beyond in-house resources and capabilities to successfully commercialize new products and processes. Its coverage includes innovative solutions for drinking water, wastewater, infrastructure, measurements and energy. Since 2014, the accelerator has been financed via The Swedish Agency for Economic and Regional Growth. Additional funding comes from membership fees from partner organizations participating in the WIN network.

4.2. The WIN network

The network that constitutes the core of WIN consists of two layers. The first layer is the core network that is defined by membership. These members consist of a pool of SMEs that receive information, support and assistance via the WIN network. In fall 2015 there were 27 SMEs participating in WIN, with an average membership of about 2.5 years. These members represent a relatively heterogeneous group of companies ranging from small start-ups to established businesses operating across a range of different activity classifications. Overall, the heterogeneity of SMEs participating in WIN signals the value of a virtual accelerator focusing on water business development. A list of the types of water innovations that the SMEs in WIN are working on can be found in Table 1.

The core network of WIN also includes a pool of partner organizations, which consist of larger multinational corporations as well as non-profit organizations such as municipalities, universities. In fall 2015 there were 23 partner organizations actively participating in the WIN network. They contribute to WIN by providing ideas and support to the SMEs, facilitating market access and setting up test beds.

The second layer is the peripheral network that consists of organizations that are loosely connected to WIN in various ways. In general, these organizations are either working regionally, nationally or globally with water development issues, or they are support organizations connected to the entrepreneurial ecosystem surrounding the development and commercialization of new products and processes. Examples of the latter type of organizations include Teknopol and the Technology Approval Group (TAG). The content, governance and structure of the WIN network are illustrated in Table 2.

At the very centre of the network are WIN-staff, which consist of four persons with largely complementary backgrounds and profiles that fulfil roles as managing director, area expert, development manager and communications manager. The incubator team are all actively engaged in water-related business development and since WIN has a fairly narrow focus on such issues WIN staff can be deeply knowledgeable in the fields of interest of the members. WIN staff is however also active in networks or businesses outside WIN. They all run their own companies and have direct experience of consultancy, working in start-ups and with academic research, business develop-

Table 1
Overview of types of water innovations that the SMEs in WIN are working on.

No	Founded	SNI[a]	Emp[b]	Type of water innovation
1	2012	71.122, 72.190	6	Water recycling technology enabling efficient showers (reducing daily water usage)
2	2012	46.710	0	Technology for biopellets combining wood wastes, waste-based energy sources and wash-up detergents.
3	2003	71222	0	Suppression of microbial growth in water pipes
4	In process	n/a	0	Liquid flavor concentrates for water
5	In process	n/a	0	Online monitoring system for detecting toxic substances in wastewater treatment plants
6	2010	46.742, 72.110, 71124	0	Biological on-site treatment of wastewater and water reuse
7	2006	28.290, 46.699	9	Instruments for identifying and measuring chemicals
8	2004	28.990	7	Water disinfection solutions using inline electrolysis
9	2009	72.190	8	Disinfection solutions for livestock farming and food production.
10	2013	70.220	4	Technology for water purification using UV-light
11	2014	72.190, 37.000	1	Method to optimize the chemical precipitation process for water and wastewater treatment plants
12	2012	72.190, 71.200	0	Analytical separation of pharmaceuticals and bio molecules
13	2010	71.122	3	Wastewater treatment
14	2009	72.190	2	Detection of microbial activity
15	2011	27.510, 28.250	1	Solar system technology using existing water heater as storage tank
16	2000	27.110	17	Industrial water treatment
17	In process	n/a	0	Technology for water-reduction
18	1999	62.010, 85.594	2	Business intelligence tools for wastewater treatment and flood risk management solutions
19	2012	n/a	5	Solutions and technologies for the clean water market
20	2011	n/a	3	Automatically self-cleaning cross-flow filtration system
21	2005	58.290	7	Advanced instrumentation and control technologies for the biogas and wastewater industry
22	1987	74.900, 85.600	13	Consultants for investigation, advice and implementation of environmental-friendly solutions
23	1999	62.020	2	IT solutions and related services to customers in the water and wastewater industry
24	2008	n/a	n/a	Water & process-chemical-free textile processing solution
25	2008	02.102, 20.150, 71.124	5	Recycling of nutrients from sewage treatments, plants, biogas produces and farms with surplus manure.
26	2006	37.000	6	Filter bed technology for treatment and recycling of phosphorous from all sources of pollution
27	2015	37.000	0	Disposable floating storm water filter
28	2005	n/a	7	Development and application of technologies and concepts in the field of water technology

[a] The Swedish Standard Industrial Classification (SNI) is an activity classification system based on EU:s recommended standard, NACE Rev.2. See APPENDIX for a description of SNI-codes.

[b] Emp = Number of employees.

ment and communication, as well as seeking or providing funding. Thus, WIN staff gets constant input from networks outside of WIN and can thereby provide different kinds of insights and connections to WIN members. As such, the incubator team seem to play a critical role for identifying and encouraging the exploitation of innovation opportunities embedded in and around the WIN network. A brief account of the background and profile of WIN staff are presented in Table 3.

Table 2
Network elements of the WIN accelerator.

Critical element	Key features
Network content	Provision of business and market information, motivational support, business advice, and access to test beds and equipment
Network governance	Development of trust among network partners as main mechanism for facilitating knowledge transfer and inter-organizational cooperation
Network structure	A mix of strong ties (core network) and weak ties (peripheral network)

Table 3
Background and profile of WIN staff.

Role (activity[a])	Background and profile
Managing director (40 percent)	• Co-founder of WIN • Solid background in venture capital, innovation support and business advice currently works as advisor to two private equity firms operating in clean tech • Has previously worked as business advisor at the Ideon Science Park for its incubator function and for start-ups and small businesses based on new innovative solutions • Worked as head of large organizations and he has founded several companies • Deep experience in what it takes to succeed as an entrepreneur and to start a company around innovations
Area expert (10 percent)	• Co-founder of WIN • Professor of water resources engineering at Lund University • Research director at a municipal company that supplies 13 municipalities with drinking water • Has founded several companies based on innovations in water distribution • Has taken the initiative to form the Sweden Water Research AB (SWR), a joint venture company in which three large municipal water companies (Sydvatten, VA Syd and NSVA) coordinate their research and development
Development manager (50 percent)	• Civil engineer with a PhD in Physics • Works as a consultant in research-related product development and environmental and water technologies as well as with business coaching • Has worked in a couple of start-ups in the water sector as well as with business advice • Experience from work on innovation and business development via publicly funded bodies through Invest in Skåne (the official regional business promotion agency for Southern Sweden)
Communications manager (50 percent)	• Specialized in communications, marketing and public relations • Has worked as a marketing manager for the Ideon Science Park • Extensive experience from business development in both start-ups and complex organizations • Experienced event moderator and runs the WIN partner meetings, where the aim is to bring together public and private actors and connect them based on their specific competencies and needs

[a] Activity is an estimation of the commitment of each role to WIN in relation to full time work.

4.3. The working and performance of WIN

WIN offers highly targeted and specialized meetings for water business development. The main focal events are its partner meetings, which is organized regularly about four times per year. At partner meetings, both innovation companies and partner organizations give short presentations of themselves and present challenges. Organizations that are not yet members are also sometimes invited to present. The presentations disseminate information about potential business models for commercializing water innovation among its network members while at the same time opening up for feedback for presenters from a very qualified and experienced group of persons. This has been very valuable for the SMEs in the WIN network, particularly those who are in the start-up phase. Smaller workshops about relevant topics can also be organized, addressing issues such as business practice in different cultures, sales techniques, what investors are looking for, etc.

Partner representatives at WIN meetings are interested in new solutions to water challenges and are potentially important as customers and/or end users of new products and services. The partners usually have appropriate positions in their organizations, allowing them to communicate directly with innovators and entrepreneurs without the need for redirections within the organization. They also have a significant network of other water experts and businessmen, whom they can share information with and whom they can contact and involve to get more business done. Sometimes, this creates even new business opportunities. Every time such a success story is presented, other less active participants may get an inspiration to be more engaged in the process.

Active match making is a core activity in WIN. A recent development at partner meetings organized by WIN management is the creation of a "mingle map" for the participants. Each participating organization is represented by a dot, with all dots placed in a circle. Between the dots, lines are drawn, where each line represents one or more potential business opportunities identified by the WIN team. Each organization should have at least two connected lines. The map is presented at the meetings and participants are asked to find out which business opportunities have been identified for them. This procedure has been very successful and participants discover even more opportunities during the activity. An example of the "mingle map", with names removed, is presented in Fig. 1.

The basic idea behind the mingle map is to facilitate rapid and efficient meetings between different partners and innovations companies during the WIN partner meetings. In Fig. 1, an example of how this is done in practice is presented. SME1 is suggested to contact BIG3 in order to discuss a topic of common interest, for instance a method to extract phosphorous from wastewater sludge. The result in this case is that BIG3 agrees to test the method for one month at the wastewater treatment plant. Prior to every WIN partner meeting each participant receives a mingle map with suggestions for extended contacts as a means to support and encourage interactions.

The biggest limitation of the WIN network is that the number of persons who are actively participating in meetings and network activities remains limited. Particularly for the larger companies it seems difficult to reach out to all their relevant divisions/departments. At present there are partners representing R&D functions but production, marketing or services remains limited. However, the number of participants has been increasing every partner meeting and the last meeting in 2015 attracted almost 40 participants.

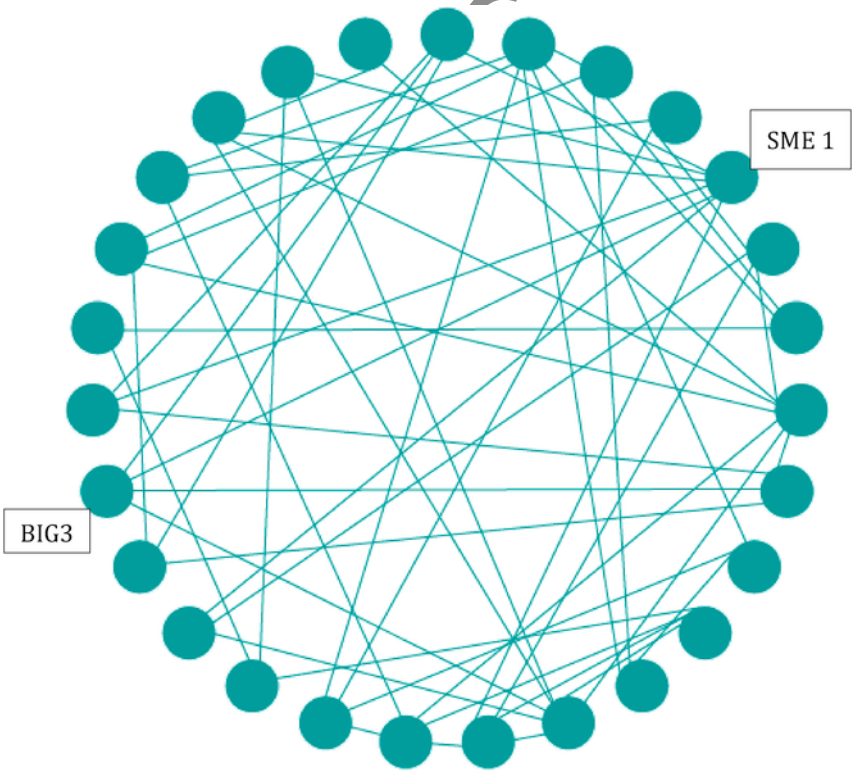

Fig. 1. An example of a "mingle map" from WIN partner meetings.

4.4. The value of WIN for the SMEs

In this section we continue with an analysis and assessment of the working and performance of WIN from the point of view of the participating SMEs. An important aspect of the WIN concept is to encourage the SMEs to go beyond in-house resources and capabilities by connecting to different players via its entrepreneurial network. To assess this, the respondents were asked to report their contacts and interactions via some form of exchange besides the official partner meetings. The results show that the majority of SMEs have some or considerable contact with other WIN members while only a small share of the companies report no contact. With respect to types of contacts we can see that R&D activities dominate, followed by commercial transactions. The average scores reported by the respondents are illustrated in Table 4.

We also assessed the overall experience of the acceleration process by asking the respondents about the role of WIN in contributing to the development of the SME in various aspects. The average scores reported by the respondents are illustrated in Table 5. As can be observed, the most valued aspect of WIN among the respondents was its contribution to the identification of business opportunities (mean 4.3). This is an important and positive outcome given the overall purpose of WIN to aid the development and market uptake of water related innovative solutions by connecting different players via its entrepreneurial network. The respondents provided lower, yet still positive, assessments of the contribution of WIN for increasing the development speed (mean 3.6) and market aspects of the company (mean 3.5). In contrast, the respondents' reports relatively low scores with respect to its contribution to providing access to critical resources (mean 3.0) and developing the technological aspects of the business (mean 2.7). These lower ratings may be related to the development stage of the companies participating in the virtual incubator, where most of them are seeking to expand or scale up their markets rather than building up resources and developing their technology.

The respondents were also asked to assess the specific advantages gained from their membership in WIN. The average scores reported by the respondents are illustrated in Table 6. The most valued advantages reported via the questionnaire were the provision of operational advice (mean 4.3), closely followed by increasing credibility (mean 4.2) and learning from other SMEs (mean 4.0). The relatively high score for these specific advantages provide support for the value of virtual accelerators in increasing the development speed and market uptake of water innovations. The respondents were reporting lower, but still positive, scores for advantages such as constituting a good development environment (mean 3.9) and for help in developing the business model of the SME in a positive way (mean 3.6). In contrast, the respondents reported much lower ratings for specific advantages such as the provision of high quality administrative services (mean 2.9) as well as access to high quality management and technological competences (mean 2.8 and 3.2 respectively). The lowest score in the assessment were given the provision of access to financing (mean 2.2), which seems to be experienced as either an under-developed or less relevant aspect by the majority of SMEs.

Finally, we asked the respondents about the role of WIN for developing the SME, which emphasize the additionality of the virtual incubator. The average scores are reported in Table 7. The overall results of this assessment suggest that the majority of the respondent assessed that WIN has positively affected the SMEs, while a smaller but still significant share of the SMEs did not experience that WIN had any notable impact on the development of the business. In this respect, 4 out of 19 respondents (21 percent) state that the SME would *not* have been developed in a similar way without the accelerator, and 8 out of 19 respondents (42 percent) state that they would have been developed in a similar way, but either in a more limited scale, at a later time, or both. In contrast, 7 out of 19 respondents (37 percent) respond that the SME would have developed in a similar way by the same scale and pace. While these results may be seen as relatively modest compared to similar studies (Clausen and Rasmussen, 2011), it can very well be seen as satisfactory outcome given the heterogeneous type of firms that participate in the WIN network and the virtual character of the accelerator.

Table 4
Contacts and interactions besides official partner meetings.

	WIN staff	Other SMEs	Partners
Extent of contacts			
Considerable extent	16%	11%	11%
Some extent	63%	53%	58%
Not at all	21%	16%	16%
Type of contacts			
R&D-activities	–	38%	38%
Commercial transactions	–	25%	25%
Social meetings	–	19%	13%
Other forms of exchange	–	19%	13%

Table 5
Contribution of the WIN accelerator for the SME.

Please assess what role the membership and participation in WIN has played for the development of your company	Mean	SD
Identifying business opportunities	4.3	2.0
Increasing the development speed in the company	3.6	1.9
Developing your markets	3.5	1.9
Access to resources critical for the development of the company	3.0	2.1
Developing your technology	2.7	1.9

Note: Ratings from 1 to 7, where 1 = totally disagree and 7 = totally agree.

Table 6
Assessment of advantages gained from the accelerator.

To what extent has the membership and participation in WIN contributed with the following advantages for your company?	Mean	SD
Provided operational advice of high quality	4.3	2.1
Strengthened the credibility of the company	4.2	2.0
The company has learned a lot from other companies participating in WIN	4.0	1.8
Provided good development environment for the company	3.9	1.7
Developed the business model in a positive way	3.6	2.3
Provided access to technical competence of high quality	3.2	2.0
Provided administrative support of high quality	2.9	1.9
Provided access to management competence of high quality	2.8	2.2
Provided access to financing	2.2	2.2

Note: Ratings from 1 to 7, where 1 = totally disagree and 7 = totally agree.

Table 7
Assessment of the value-adding role of WIN.

Please assess what would have happened if WIN had not existed	#	%
The company would not have developed the way it has	4	21.1
The company would have developed in a similar way, but in more limited scale and at a later time	1	5.3
The company would have developed in a similar way, but in more limited scale	2	10.5
The company would have developed in a similar way, but at a later time	5	26.3
The company would have developed in a similar way by the same scale and time	7	36.8
Total	19	100.0

A smaller number of additional interviews were conducted to gain deeper qualitative insight from the point of view of the participating SMEs. A general pattern observed in these interviews was that WIN was much valued as a unique network focusing on water business development, which could potentially help SMEs to expand networks and open up for new contacts in the industry. The possibility to receive tailored support and advice via interactions with engaged and knowledgeable WIN staff was also emphasized as a much valued motivating factor for the participation in the WIN network.

The qualitative analysis seems to suggest that SMEs who have been members for a longer time are those who seem to experience higher satisfaction with respect to its value added contribution. The networked character of a virtual incubator may, at least partly, explain this association as the capacity to tap into the potential of a network typically require familiarity and a sense of belongingness (Billström et al., 2014). The analysis also suggest that the active engagement in WIN seems to be influenced by geographical proximity, where the local SMEs who were part of the entrepreneurial community around the Ideon Science Park in Lund were more often regularly attending WIN partner meetings.

Interestingly, however, both geographical closeness and distance seems to be factors that reduce the informants overall perception of WIN as contributing directly to the development of the business, but for different reasons. The SMEs that were geographically close did not experience any considerable impact of WIN on the development of the business since the contacts provided via the network in many ways were overlapping other entrepreneurial networks in the region. In contrast, the more geographically distant SMEs were sharing concerns that they did not experience any considerable impact since they were not as actively engaged in WIN compared to local SMEs. The subjective evaluation of the impact seems thus to be moderated by perceptions of both distance and closeness, which provides additional insights into the issues and challenges with respect to the complexity of adding value to SMEs via virtual accelerators. Overall, the qualitative analysis suggests the need for tailored approaches to satisfy different segment of SMEs that participate in virtual accelerators.

5. Discussion and conclusions

Water is critical for the wellbeing of mankind and serves as key resource in the development of economic sectors such as energy, food and health. However, the current state of the water and sanitation sector calls for the development of new technologies and innovative solutions for targeted segments of customers and end-users. In this respect, finding effective ways to support the development and market uptake of water related innovations via organized networks remains an important challenge for researchers and practitioners. Following this challenge, we have in this study explored the concept of networked acceleration as a way to enable and orchestrate water-related innovative solutions. Within this domain, we have analysed the Water Innovation Accelerator with respect to its purpose to aid the development and market uptake of water related innovative solutions by connecting different players via its entrepreneurial network.

5.1. Main findings

Overall, the findings of this research confirm the value of virtual accelerators where private and public actors with different assets and competencies may come together in inter-organizational networks as a way to open up opportunities for water innovation. The virtual accelerator concept in which WIN is embedded has in this respect proven to be very successful with respect to its overall purpose. In less than two years it has helped several SMEs to grow by giving them access to risk capital, test beds and a better understanding of what kind of solutions the municipal or multinational companies require to develop their business. It has also continually expanded the number of SMEs and partner organizations that participate in the WIN network.

The analyses of the design elements of the WIN network confirm its overall effectiveness as a potential policy instrument to support the development and market uptake of water innovations. The regular partner meetings seem to work well for building trust and commitment among network members, which typically require familiarity and mutual exchange in the network relationship (Anderson et al., 2007). Presentations and networking during meetings serve as a mean to connect different players, which further support their ability to spot and seize water related businesses opportunities. Extant literature also suggests that a balance of strong and weak ties needs to be created in the network of SMEs to keep the innovation process under control (Gretzinger et al., 2011) and the analysis suggest that the WIN network, with its multiple layers, seems to be an efficient means of supporting such balance.

The majority of SMEs participating in the WIN network value several value adding aspects for developing their businesses. However, the overall patterns suggest that the acceleration process offered by WIN may work better in SMEs who are at the commercialization stage, rather than those who operate in earlier stages of innovation when resource acquisition and technology development often become more prevalent. This is evident by the relatively higher ratings for the value of WIN in contributing to business opportunities and the development speed and market aspects of the business. The respondents also regard the possibility to receive operational advice and help in developing the business model as valuable aspects. In addition, several SMEs relatively high rates for intangible services, such as credibility, participation in a good development environment, and learning from other companies, which further corroborate the potential effectiveness of virtual accelerators as an instrument to support the development and market uptake of water innovations.

We acknowledge that our study is embedded in a number of potential shortcomings. A major issue is our focused empirical setting, which on the one hand enabled us to collect rich and relevant data, but which may provide constraints on the possibility to generalize our findings to network-centred incubators that operate in other institutional settings. For example, we cannot tell if other business cultures with less willingness to participate in open innovation networks would undermine our findings. Moreover, we have in the present study not considered the dynamics of interactions that occur within and between SMEs and the partner organizations that participate in the entrepreneurial network. Further research on the characteristics and interactions of network members would thus be a valuable addition to our research. In this respect, we welcome empirical studies that can corroborate and extend our theoretical approach and findings across contexts.

The present study provides implications for researchers, incubator managers and policy makers. For researchers, we provide theory and empirical data that explain how a network-centred approach to incubation embedded in the open innovation paradigm can be relevant in areas characterized by systemic complexity, such as the development of water related innovative solutions (e.g., Partzsch, 2009; Krozer et al., 2010; Levidow et al., 2015). In this respect, we have reviewed the current state of the art in research on open innovation, incubation models, and entrepreneurial networks and applied this framework to depict and analyse the design, working and performance of the virtual accelerator under study. To this end, the study has generated an ana-

lytical framework and empirical findings that can be developed and refined in future scholarly studies.

For incubator managers, our study provides insights into the design, working and performance of virtual incubation models to accelerate water innovation. In this respect, our framework and analysis show how virtual incubators may effectively facilitate the acceleration process by connecting private and public actors with different assets and competencies via its entrepreneurial network. The findings emphasize the critical role of the incubator team for identifying and encouraging the exploitation of network-embedded innovation opportunities. In addition, the findings suggest that the perceived effectiveness of the acceleration process for SMEs seems to be largely contingent on the extent to which they are positioned in later stages of the innovation process as well as their geographical proximity to the incubator network. These insights can thus be used to organize and manage virtual incubators as to increase their effectiveness.

For policy makers, we have provided a theoretical rationale for policy interventions in the form of virtual accelerators as a means to reduce the water intensity of production processes and improving water recycling and water reuse. Our findings suggest that virtual accelerators may serve as an effective policy tool as innovation intermediaries to support the commercialization of knowledge that has an economic value to society. However, given the systemic complexity and international intertwinement of markets and technologies surrounding the global water and sanitation sectors, our study also imply that such initiatives require concerted policy efforts that go beyond local and regional policy levels. In this respect, funding and support of virtual accelerators aimed at developing water innovation may require increased coordination via national and supra national public bodies.

5.2. Conclusions

Water-related innovations are high on the global policy agenda. In this study we provide theoretical and empirical insights that inform scholars, policy makers and incubator managers of how to enable and orchestrate innovative solutions by connecting different players via organized networks. In this respect, we outline the theoretical basis for designing effective organized networks and we analyse and identify elements that support such efforts. To this end, the study recognize virtual incubators as an effective mean of creating cooperation and knowledge exchange in constellations of public and private actors that, if managed well, can support the development of water related innovative solutions for the joint benefit of industry and larger society.

Acknowledgements

This study has been conducted within the research project Entrepreneurial Systems – A Condition for Growth, financed by the Swedish Research Council. The authors are grateful for the valuable comments and feedback provided by the editors and reviewers in the course of developing this work.

Appendix. Swedish Standard Industrial Classification (SNI)

SNI-Code	Description
02.102	Silviculture
20.150	Manufacture of fertilisers and nitrogen compounds
27.110	Manufacture of electric motors, generators and transformers
27.510	Manufacture of electric domestic appliances
28.250	Manufacture of non-domestic cooling and ventilation equipment
28.290	Manufacture of other general-purpose machinery n.e.c.
28.990	Manufacture of other special-purpose machinery n.e.c.
37.000	Sewerage
46.699	Wholesale of other machinery and equipment n.e.c.
46.710	Wholesale of solid, liquid and gaseous fuels and related products
46.742	Wholesale of plumbing and heating equipment
58.290	Other software publishing
62.010	Computer programming activities
62.020	Computer consultancy activities
70.220	Business and other management consultancy activities
71.122	Industrial engineering activities and related technical consultancy
71.124	Engineering activities and related technical consultancy in energy, environment, plumbing, heat and air-conditioning
71.200	Technical testing and analysis
72.110	Research and experimental development on biotechnology
72.190	Other research and experimental development on natural sciences and engineering
74.900	Other professional, scientific and technical activities n.e.c.
85.594	Staff training
85.600	Educational support activities

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