This paper was presented at The ISPIM Innovation Conference – Innovating in Times of Crisis,
7-10 June 2020.
Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-466-1

The city as an experimental environment: the identification, selection and activation of distributed knowledge in regional innovation ecosystems

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Abstract: During the past decade, Open Innovation (OI) literature has extended its scope from an economical context to the context of societal value creation. This also entailed the notion of (local) distributed knowledge as a driver for innovation, and the importance of multi-stakeholder collaborations in NPD-processes to develop new urban ICT systems for complex urban issues. Hence, several studies have discussed stakeholder ecosystem architectures for such collaborations. However, little is known on how to identify and select stakeholders for collaborative environments embedded in the urban context. Based upon the development and implementation of an open-ended collaboration ecosystem for urban innovation, this paper studies the contextualized interactions between knowledge actors in the ecosystem and processes of attraction, identification, selection and activation. These insights converge in the development of a '*stakeholder acupuncture framework*', which structures mechanisms and practises within dynamic collaboration ecosystems and defines key boundary conditions for such open-ended ecosystems.

Keywords: Open Innovation; Quadruple Helix; Distributed Knowledge; Innovation Systems; Urban Innovation; Smart Cities; Living Labs; urban acupuncture

1 Introduction

Henry Chesbrough (2003) introduced the Open Innovation (OI) concept as a new model for organizing technological innovation, and argued that firms should make use of external and internal ideas, as well as internal and external paths to market, in order to advance their technologies. Further studies pointed out that participation in such cooperations or Open Innovation Networks has multiple beneficial returns on a firm's innovative performance, e.g. new product development processes, increasing patent rates and the improvement of existing products (Laursen and Salter, 2006; Chiang and Hung, 2010; Zeng et al., 2010; Pateli and Lioukas 2017). However, the last decade this concept has expanded its application from a strictly economical and business context to also include the context of societal value creation. As researchers, practitioners and

Event Proceedings: LUT Scientific and Expertise Publications: ISBN 978-952-335-466-1

policymakers became convinced that OI might be a proper method to tackle 'wicked' societal challenges which can only be tackled through (intense) collaboration between diverse actors and domains (Gassmann and Enkel, 2004; Chesbrough et al., 2006; Mo Ahn et al., 2019). Especially *cities*, all over the world, face complex challenges regarding population growth, aging, climate change, public transport,… Hence, the pressure on urban areas as a driver for societal change and accelerated innovation is systematically growing (Grimm et al., 2008).

Consequently, this paper looks at OI within the regional ecosystem of a city, and approaches such ecosystems in accordance with the '*quadruple innovation framework'* (Carayannis et al., 2018, p.149), which envisions regions as "*eco-systemic agglomerations of organizational and institutional entities or stakeholders with socio-technical , socio-economic, and socio-political conflicting as well as converging (co-opetitive) goals, priorities, expectations, and behaviors that they pursue via entrepreneurial development, exploration, exploitation, and deployment actions, and interactions*". In addition, these stakeholders possess different kinds of assets distributed among the entities present within the regional space (Lakhani and Panetta, 2007). These assets, particularly knowledge assets, constitute the main driver of regional innovation development (Lönqvist, 2013). Hence, identifying, selecting and activating such assets is an important aspect in the sustainable development of innovative urban ICT of complex societal challenges.

During the past decade, research was conducted concerning the application of OI within the regional context. For example, different frameworks were developed in order to apply OI (Schuurman, 2015) on the level of the ecosystem e.g. the quadruple helix innovation framework (Carayannis et al., 2018), process e.g. urban living lab literature (Steen and van Bueren, 2017) and user innovation e.g. user innovation (Baldwin and Von Hippel, 2011). However, processes and practices to attract and activate the right stakeholders within multi-stakeholder open innovation collaborations, have not been thoroughly studied. To elucidate, this challenge arises due to the specific context of regions and the stakeholders present in a region's ecosystem. Here, studies point out, that the value of partnerships in smart city projects depends on the city council since cities have different institutional contexts (Healey, 1997; Carvalho, 2014). This paper extrapolates these findings, in line with Carayannis and colleagues, and argues that regional ecosystems have their own context of stakeholders who possess their own set of assets useful for regional ICT development (Lönqvist et al., 2013). In addition, OI collaboration ecosystems also have a wide variety in topic-specific challenges. Consequently, the participating stakeholders in regional NPD-processes are assumed to have a good match with OI-projects in order to gain access to the right assets present within the regional innovation ecosystem. This has already encouraged researchers to develop frameworks that help in identifying and activating the right stakeholders for new urban media development (E.g. Juurjärvi and Pesso, 2013; Sanduli et al. 2017). However, these frameworks don't discuss all of the issues of the specific context of a regional innovation ecosystem, nor the project-oriented nature of such ecosystems.

In addition, literature regarding the involvement of stakeholders in OI-projects mainly focusses on the assessment of the collaborative match between stakeholders, or on typologies of stakeholder roles in collaborative projects. E.g. in alliance management literature the variables complementarity, commitment and compatibility are widely used

as qualitative parameters in order to assess potential stakeholders (Kale and Singh, 2009; Sandulli, 2017). As another example, Leminen and Westerlund (2012) developed a typology regarding the stakeholder roles in a living labs. However, these frameworks do not address dynamic processes of finding, attracting and activating these stakeholders (within the context of a regional ecosystem).

Consequently, this paper aims to explore processes of identification (finding), attraction and activation of collaborative actors in regional OI ecosystems. Hence, the added value of this work is twofold. Firstly, a '*stakeholder acupuncture framework*' is developed, which structures the identification and attraction of stakeholders in OI-projects within a specific of a regional innovation ecosystem, complementary to the existing frameworks discussed. Secondly, this framework can be applied by local policy makers and practitioners when instigating OI-projects.

2 Research Framework

2.1 Urban living labs as open innovation networks

In addition to Chesbrough (2003), further research describes open innovation as an intense co-development with users and other stakeholders which results in innovations that batter fit the needs and expectations of customers (Pascu and van Lieshout, 2009). This concept has been broadened from an economic and commercial perspective to the perspective of creating societal value (Gassmann and Enkel, 2004; Chesbrough et al., 2006; Mo Ahn et al., 2019) and an increased focus on regional innovation networks (Levén, Holmström and Mathiassen, 2014). Regional innovation networks can be defined as inter-organisational networks formed from heterogeneous actors that originate from the same geographical area and collaborate in NPD-processes (Park, 2016; Stuck, Broekel and Revilla Diez, 2016). In line with Carayannis and colleagues (2018), we interpret the local ecosystem, in accordance with the *quadruple innovation framework*, as regional networks of stakeholders who can be divided in four helices: governmental actors, economical actors, knowledge actors and civilian actors. The characteristics of these networks are described as fractal, multi-level, multi-modal, multimodal and multilateral configurations of dynamic tangible and intangible assets such as skills of individuals, relationships between key regional stakeholders and formal mechanisms for supporting knowledge creation within a region (Lerro and Shiuma, 2011; Carayannis et al. 2018). In addition, Lönqvist and colleagues (2013) argue that these assets are distributed among the network and form the driver for regional innovation. When looking at the regional innovation ecosystem, we consider this as a network which is in a constant state of flux with present stakeholders, who possess assets and mutually interact within this network. In addition, we also apply the network of networks theory in the conceptualisation of the regional ecosystem, which describes the ecosystem as a network of serval heterogeneous networks, among which interdependencies exist between the present stakeholders (Jian and Tao, 2015). These theories can be visually conceptualized as the '*regional innovation network'* (figure 1).

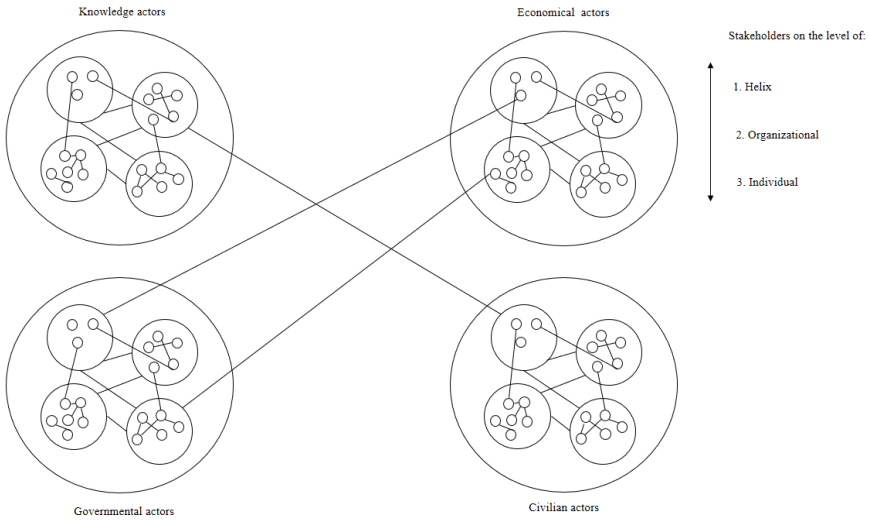

Figure 1: The regional innovation network. Stakeholders within the ecosystem exist on three levels, helix, organisational and individual level. The present stakeholders in the network interact with each other on these three different levels.

In the OI-discourse, these actors should be connected in order to share their assets for new product development. During the past decade, urban living labs are widely studied as an operationalization to do so (Baccarne et al. 2014). An urban living lab can be described as a project-based and geographical defined domain that is being used as an experimental laboratory which forms a structural approach towards distributed innovation processes (Steen & van Bueren, 2017), which consists out of three layers (Schuurman 2015). The highest layer focusses on the ecosystem, where the aim is to exchange knowledge and stimulate collaboration. In the middle layer, the focus is on user involvement and real-life experience in function of innovation development being facilitated by living lab projects. Lastly, the lowest layer focusses on user innovation by applying research and development methods in order to involve different stakeholders. Hence, Schuurman conceptualizes the ULL as an intervention in the OI-network, defined in space and time, that bridges the gap between a regional innovation network and the stakeholders within this network.

2.2 Stakeholder roles in an urban living lab

The interpretation and application of an ULL can be incongruent. Steen and van Bueren (2017) showed that a ULL has it's defining characteristics which differ according to the project. First, the overall aim of an ULL is to learn and experiment in order to discover solutions for existing problems. These existing problems take form in different topical interests, e.g. innovation in healthcare, innovation in climate neutral investments, etc. As mentioned in the introduction, we argue that a different thematic focus of an ULL will need different types of knowledge assets. Consequently, this implicates a need for stakeholders who possess these theme specific assets. Second, according to their assets, stakeholders take in different roles during the ULL project. Moreover, Juujärvi and Pesso (2013) found that the roles of citizen stakeholders are variable from being an informant to tester as well as a contributor and co-creator in the development process (Veeckman and

van der Graaf 2015). On the level of organisations, stakeholders vary in role as well. Juujärvi and Pesso (2013) applied the typology of stakeholder roles within the context of an ULL. More specifically, city representatives are conceptualized as enablers who create vision and allocate resources; firms and local service providers as utilizers who produce place-based knowledge; educational institutions as providers of R&D methods and the systematic augmentation of knowledge; and civilians of the ULL as users. However, these roles may differ according to the ULL, e.g. educational institutes can act as enablers who create vision and promote networking as well. Here, we argue that this may suggests multi-role actor relationships, which is not thoroughly studied. Here, an enabling role, between utilizers and providers creates a brokering position that allows the enablers to manage these stakeholders (Schuurman 2014). We argue that this enabling function can be executed between the other stakeholder roles as well, which makes it possible for one stakeholder to take in the brokering position between all participating stakeholders in an ULL. In addition, Piazza and colleagues (2019) argue that network relationships can improve the innovation capability of an actor when being embedded in a network of relationships. Consequently, the actor is able to monitor the innovative changes in the region, exploit network synergies, leveraging on complementary knowledge and develop new innovative processes.

2.3 Stakeholder match

OI-collaborations, alliance management research and PPP (public-private-partnerships) literature have defined three main aspects as important actor attributes to improve the success of the collaboration: (1) actor complementarity, (2) actor commitment and (3) actor compatibility (Sandulli et al. 2017). For example, strong complementarity between partners may improve inter-actor knowledge transfers (Geels, 2004). A stronger commitment and compatibility may improve institutional matches in favour of R&D processes (Sandulli et al. 2017). Consequently, this literature contributes in assessing stakeholders whether they form a a good match in a partner-alliance, in the case of this study an collaboration within an ULL. We will briefly elaborate on these aspects according to Sandulli and collegues (2017):

- Actor complementarity

Actor complementarity is being described as a the additional contribution of actors in three dimensions; (a) Technological knowledge base, the amount of overlap in technological knowledge in order to facilitate knowledge transfers. (b) Knowledge spill over, complementarity of topical knowledge. (c) Relational resources, addition of new relational resources by the new actor.

- Actor commitment

Actor commitment can be described on different levels. First there is political commitment, which creates a fundament for a partnerships and may lead to long term investments that may lead to a momentum. However because of a misalignment in political plans, differents implementation plans and organisational values between governments, organisations and individuals within the (governmental) organisations, the contribution of partners may be jeopardized. Thus, we argue that the commitment should be strong on the level of government, organisations and individuals.

- Actor compatibility

This is the conformity of goals and cultures of the participating stakeholders. Here, an alignment of goals contributes in the collaboration between the participating partners.

2.4 Conclusion: intervention in the regional innovation ecosystem

We can conclude that a regional innovation ecosystem consists of stakeholders who possess different kinds of assets which are seen as the driver of regional development. In order to find solutions for complex societal problems, these assets need to be identified, attracted and activated for NPD-development. An urban living lab can be used in order to operationalize these stakeholders and their assets. By applying an ULL as an intervention within a regional ecosystem, we aim to gather insights in how this affects the identification and attraction of stakeholders within the regional innovation ecosystem. Next, the aspects of a stakeholder match, which indicate whether an actor has a contribution in a collaboration or not, will be assessed in order to study the impact of the intervention format on these aspects.

3 Methods

The methodology section of this paper is divided in three parts. First, we briefly describe the design of the central intervention on which our case study is based. Next, we briefly describe the specific context and application of this intervention ('*City of People: challenges in healthcare*'). Finally, we provide an overview of the research methods used to analyse this intervention in relation to the regional innovation ecosystem.

3.1 Intervention design

Building upon the theoretical insights we discussed before, a collaboration format was developed which was applied as an intervention in the ecosystem of the city of Ghent. In order to describe this format, we will divide the format in three different levels (in line with Schuurman (2015).

Macro-level

The *quadruple helix* innovation framework was applied in order create a basic constellation of stakeholders within the project. Table 1 provides an overview of the participating stakeholders in the intervention, complemented with the *actor role* they fulfil within the quadruple helix framework and their role within the project.

Table 1 Participating stakeholders within the '*City of People: challenges in healthcare-project'*

Actor	*Helix*	*Role*	*Role description*
Ghent University	Knowledge actor	Broker, enabler, utilizer	Broker: coordinating role between participating stakeholders Enabler: facility of physical space Utilizer: development of innovative technologies and process-based insights

imec	Knowledge actor	Enabler, utilizer, provider	Enabler: facility of supportive technology, physical space and user involvement methodology Utilizer: development of new products Provider: knowledge network provider
City of Ghent	Governmental actor	Enabler, provider	Enabler: facility of physical space Provider: ecosystem network provider
City inhabitants	Civilian actors	User	User: potential end-users of the new product developed.

Source: Quadruple Helix innovation framework (Carayannis et al.,2018), actor roles in Urban livinglabs (Juujärvi & Pesso, 2013; Leminen & Westerlund, 2012, Veeckman & van der Graaf 2015).

Meso-and micro-level

At the Meso-level, the intervention was operationalized as an Urban Living Lab (Steen & van Bueren, 2017). Within the format of this urban living lab, we created three boundary conditions by which we aimed to stimulate the attraction and activation of the participating stakeholders. In Table 2 an overview is given.

Table 2 Boundary conditions created for stimulating attraction and activation of stakeholders.

Boundary condition	*Aim of the condition*
Specific and narrow topical focus (*immobile and lonely elderly citizens)*	Create a specific topic in order to validate the relevance and contribution of joining stakeholders based on this topic.
Core stakeholder constellation + open-ended network	Create an open-ended network in order to make stakeholders, aside from the core constellation to join and leave the project.
Temporal experimental environment with a design thinking methodology	Create an experimental environment, defined in space and time, where stakeholders could share and contribute without obligation. Design thinking methodology was applied in order to bridge practical and communicational barriers between the participating stakeholders (Fisher, 2015)

Source: Fisher (2015)

3.2. Context and application of the intervention

These principles were applied in a project '*City of People: Challenges in healthcare*'. This project was set up as a collaboration between the City of Ghent (local municipality), Ghent University (local university) and R&D company imec (regional technology center) and ran for 12 months in 2018. The project addressed the complex challenge of immobile elderly people who risk social isolation. In order to find a solution for this challenge, the project conducted an R&D process which systematically involved a wide variety of civil

stakeholders (e.g. senior citizens and volunteers), researchers (from the different knowledge institutes in the city), entrepreneurs and local social caretakers originating from the Ghent neighborhood '*Muide-Meulestede*'. This intervention was implemented in a hyperlocal context. In collaboration with these stakeholders, a senior-proof smart speaker was developed which detects social isolation and makes it possible for senior citizens to ask for social contact with a volunteer.

3.3 Research methodology

The analysis of this study was executed through participatory action research (Bradbury and Reason, 2015). The authors had an active coordinating, executive and participating role within the project and took in the position of a broker in the innovation network. A first role comprised that of project coordinator, which allowed the researchers to be gatekeeper of the in-and-outflow of stakeholders within the project, and define the open-ended nature of the collaboration. A second role, in collaboration with researchers from imec.livinglabs, was the execution of the different research steps in the R&D process. By participating in such a direct manner, we were able to use different sources of evidence in our analysis, such as the results of conducted R&D steps, as well as our own experiences (ethnographic observations) and lessons learned as soft-data gathering. As hard data sources, we were able to gather different sources of evidence such as e-mail communications, meeting reports of steering committees, initial project proposals, project reports and project deliverables.

The hard and soft data were analyzed to explore processes of identification, attraction and activation of collaborative actors in regional OI ecosystems. This analysis is executed in two separated phases. In the first phase, a framework is developed, which describes the triggered mechanisms as a result of applying the intervention, and the specific boundary conditions. This was achieved using an inductive methodology. In the second phase, processes of stakeholder value creation are assessed within the dynamic collaboration ecosystem with fluctuating actor commitment and involvement. More specifically, the relationship is studied between the intervention and actor levels of complementarity, commitment and compatibility.

4 Findings

4.1 The Urban Acupuncture Framework (UAF)

First, we describe the mechanisms that got triggered within the ecosystem because of the implementation of the intervention. These findings are conceptualized in the *'Urban Acupuncture framework*' (figure 3).

The effect of urban acupuncture

The boundary conditions, as described in the methodology section, resonated with the ecosystem where the intervention took place. By establishing an experimental window within the ecosystem, the intervention generated a *centripetal force* on urban actors originating from all four helices. We conceptualize and appoint this mechanism in relation to the concept of *urban acupuncture* (de Sola-Morales, 2008; Hooghduyn, 2015). This implies that the experimental nature of the intervention, combined with the

hyperlocal application generated high levels of visibility, which was in turn amplified through (re)medion an (re)presentation through networks of networks and traditional media broadcasts. As such, the intervention served as an 'acupuncture needle' within the regional ecosystem which pulls the nerves of the ecosystem in order to find and attract the relevant stakeholders.

Identifying stakeholders

The intervention attracted and formalized both interests and engagements at the individual level as well as at the organisational level. However, organisational network ties, in all cases, derived from the interest and initiative of an individual actor within this organisation. For example, the project involved a local higher education institute (*Artevelde Hogeschool*) in order to deploy students as volunteers to visit elderly citizens and to contribute in developing the senior-proof smart speaker. The tie with the organisational level actor got activated because of the interest of an individual teacher working on the institute. The teacher could be considered a latent tie of the core consortium, which was identified and activated through the experimental nature of the intervention. The hands-on an practical nature of the urban experiment (mediated through news media) triggered contact initiation and the potential transformation from a latent to a strong tie in the collaboration. The open-ended and time-boxed nature, combined with the actor compatibility (cfr. infra). allowed the formal involvement at the organisational level, hence allowing the activation of the assets of this urban actor.

Picture 1: Elderly citizens test the senior-proof smart speaker together with the Student volunteers.
Picture 2: A researcher from Ghent University gives a lecture regarding the project outcomes.

Furthermore, the dissemination of the intervention through remediation processes within the regional innovation network is of high importance. This happens though a series of communication practices covering different networks of networks. The oscillating process of urban acupuncture facilitates a more dynamic understanding of collaboration ecosystems as actors come and go over time. This also implies that ecosystem collaborations should not be consider fixed, but should rather be studied from an ecosystem lifecycle perspective. The intervention we studied combined active (content generation and addressing existing ties) and passive modes (non-controlled content remediation and addressing latent or non-existing ties) of dissemination and

communication. These modes evolved over time. In the beginning of the intervention, during the instigation phase, (pro-)active identification and communication towards actors in the regional innovation system was required. This implies scanning the environment (activating existing networks) for valuable urban actors and actively approaching these stakeholders. In a second stage, these stakeholders co-shaped the collaborative network, though autonomous, non-solicited, communication practices within organisational bodies, (professional) issue networks, and personal weak and strong ties. For example, a local social caretaker was approached through the organisational actor (City of Ghent) and was immediately convinced of the added value of the project at a personal level. Next, she helped in finding elderly citizens to involve in the research steps in order to gain their knowledge. These actors could not have been identified, reached and activated without the remediated experiment-oriented communication practices that took place within the network of this local social caretaker. As the intervention progressed, the active mode of communication was gradually replaced by a passive mode of communication, as this mode increasingly gained momentum. As the experimental window and the research activities proceeded, and first insights and stories were being generated, making the acupuncture even sharper (the experiment becoming increasingly tangible), this allowed all involved actors to give lectures and talks regarding the project, to network on events, etc. On top of that, the experimental nature generated stories that media actors value, which stimulated an increase in traditional mass media communication and triggered new cycles of communication and distribution. For example, following a field trial with a prototype of the senior-proof smart speaker, newspapers, radio shows and the local television started to write articles and produce a television report about the project and feature several of the actors involved (researchers, politicians, civic servants, senior citizens, students, …). This attracted actors which were not identified by (and unknown to) the actors within the ecosystem, originating from all helices (also outside the defined geographical boundaries), expressing interest to explore the possibilities of collaboration in the network. Hence, the process of urban acupuncture can be considered a mechanism to *identify* distributed knowledge in the (local) environment.

Community of interest

However, actor identification does not imply *activation* and *selection*. When conceptualizing innovation ecosystems as dynamic entities, this could be considered the absorptive capacity (Cohen & Levinthal, 1990) of the ecosystem, the capacity of the ecosystem to actively manage and absorb the potential value of new ecosystem actors and the assets they represent. The open-ended nature of the studies intervention implied the construction of an ‘outer layer’, designed to absorb incoming ties. This can be considered an ‘issue based network’ around the project which we see similar to a ‘community of practice’ (Wenger, 2011). However, as the stakeholders were attracted because of their interest towards the project, we appointed this network as a ‘community of interest’. In this community, member actors were systematically updated with the latest research results and activities. However, depending on the phase of development and shifts in the orientation, the interest and relevancy of certain stakeholders varied over time. Therefore, when a stakeholder showed interest, the intervention allowed dynamic shifts in involvement and commitment. Similar to the attraction process, this entails an active mode (the project seeks resources) and a passive mode (actor initiative). This was achieved through a layered ‘onion-like’ organisational structure with flexible layer

memberships, representing different levels of involvement and formalized communication practices within this layer (inflow & outflow). Such model contributes to the absorptive capacity of the innovation ecosystem.

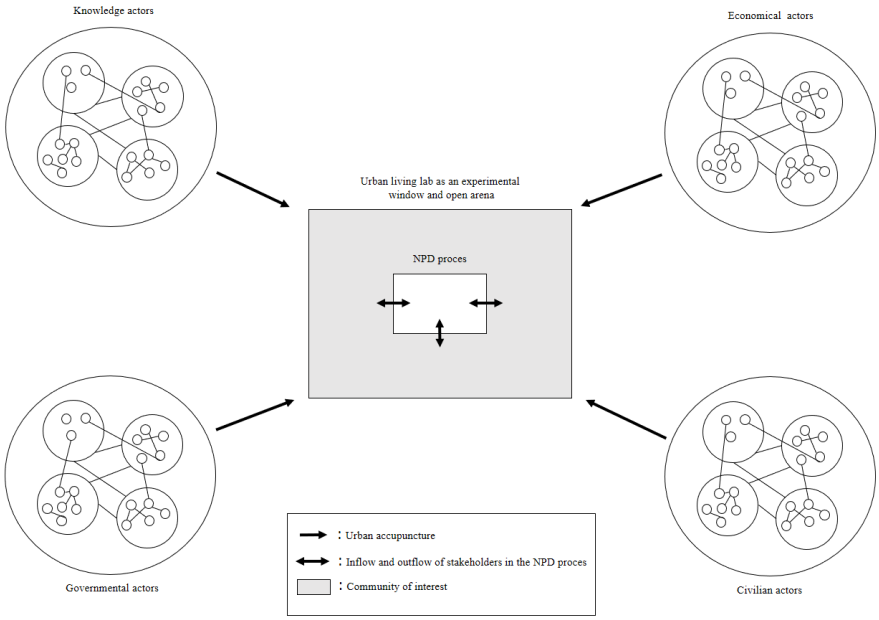

Figure 2: Visual representation of the Urban Acupuncture Framework (UAF).

4.2 Assessment of the stakeholder match

This paragraph elaborates on the insights we gathered by studying how the intervention was related to value-generating stakeholder matching. As was discussed earlier, this is an important dimension to assess the quality of collaboration ecosystems (Sandulli et al. 2017). This analysis is structured by relating the implemented intervention boundary conditions to the different dimensions of stakeholder match assessments (1) complementarity, (2) commitment and (3) compatibility. Table 2 provides an overview of this analysis.

Table 3 Boundary conditions versus stakeholder matching.

Boundary condition	*Affected aspect of a stakeholder match*	*Relationship between boundary condition and stakeholder match.*
specific and narrow topical focus (*immobile and lonely elderly citizens)*	complementarity, commitment and compatibility	**Complementarity:** Attraction of stakeholders within the regional environment who have complementary knowledge and relational resources. Easier to asses due to the specificity. **Commitment:** Actors at the individual level joined because of intrinsic motivation with a clear topical delineation (as opposed to broad interest groups). **Compatibility:** Intrinsic motivation also implied a match in goals at the individual level.
core stakeholder constellation + open-ended network	complementarity, commitment and compatibility	**Complementarity:** Inflow and outflow processes of stakeholders without obligation enabled new and relevant stakeholders to join the project, and ensured maximum compatibility. This unlocked access to new knowledge and relational resources. **Commitment**: The core stakeholder constellation created a fundament of political commitment, which facilitated ownership and safeguarded minimal commitments. Individual and committed stakeholder were able to join (and leave) the project on free will. **Compatibility:** The core stakeholder constellation created a flexible reputational label for the project. This was beneficial for communication with stakeholders and granting access to networks and their resources.
temporal experimental environment with a design thinking methodology	complementarity and compatibility	**Complementarity:** A common design language was created through the design thinking methodology. Lowering communication and cultural barriers between different domains. **Compatibility:** by creating a common design language through design thinking methodology, a translation between the participating stakeholders was realized. Here cultural barriers were eased down between the stakeholders.

Source: Sandulli et al. (2017)

4.2.1 Boundary condition: specific and narrow topical focus

'Social isolation amongst less mobile elderly citizens' provided a clear focus which facilitated the identification and matching of stakeholders to contribute within the project. This was beneficial for the complementarity of these stakeholders in terms of knowledge and relational resources. Initially, this focus allowed to actively search for relevant stakeholders within in the ULL area in the beginning of the project. For example, as mentioned before, we approached a social caretaker who was working with elderly citizens on a daily basis in the ULL area. Later on in the project, the clear focus and more tangible research results made us able to draw the interest and therefore attract stakeholders in a passive manner. Here, we were approached by social caretakers and

researchers who showed an intrinsic motivation to collaborate. E.g. after a lecture in the city library, a researcher with expertise in loneliness with elderly citizens took initiative to approach us. In the following steps, this stakeholder helped in the definition of the next research steps. Hence, access to a new source of knowledge was provided. The attraction of such stakeholders also allowed to connect with other relevant stakeholders. Considering these processes, the intrinsic motivation of the joining stakeholders benefitted the commitment and compatibility of these joining parties. Moreover, this intrinsic motivation implied a complementarity in goals of these individuals.

4.2.2 Boundary condition: open-ended network

The intervention started with a core constellation of stakeholders which is described in table 1. The importance of this basic constellation surfaced in two different manners. First, it created a political commitment which resulted in a momentum at organisational level. This commitment from above was perceived by individuals as an extrinsic incentive to contribute within the project. Second, the basic constellation also allowed to set up a '*flexible reputational label'*, which can be considered as a fifth actor within the innovation ecosystem. More specifically, due to the decentralize multi-actor collaboration nature of the basic constellation, researchers could, for example, instrumentally switch between communicating actors. The associated diplomatic relationships and attitudes toward these communicating actors facilitated access to networks that would otherwise be harder to reach. E.g. the 'reputational label' of the municipality facilitated the activation of local social caretakers because their organisation is structurally embedded in the broader municipal bureaucracy. In other cases, private medical caretakers were more sceptical towards the municipality. Here, the 'reputational labels' of the university and imec provided easier access. On other words, during the intervention, the 'ownership' of the collaboration could instrumentally shift, hence utilizing these reputational labels in a flexible manner, and improving the political and individual commitment as well as the compatibility of the participating stakeholders.

In addition, the open-ended nature of the innovation network and the non-obligatory in-and-outflow of stakeholders, which was discussed earlier, added to the complementarity of these stakeholders with the project. This multi-layered flexible model of commitments and engagement allows to manage and activate these stakeholders when needed in the project, ensuring optimal compatibility in the ecosystem. E.g. After a phase of exploring the needs of elderly citizens, a phase of prototype development was conducted. Here, the citizens had no relevant input for the project. However, when the prototype needed to be tested, the elderly citizens could be activated again in order to share their knowledge and provide feedback on the prototype in development.

4.2.3 Boundary condition: temporal experimental environment

As discussed, a temporal experimental environment was set up, were different stakeholders could contribute their knowledge, focused on experimentation and limited in space and time. By applying design thinking methodologies a common design language gradually grew between the participating stakeholders. This was beneficial for the complementarity as well as the compatibility of the participating stakeholders. First, the knowledge spillovers between the stakeholders were improved. E.g. due to the low levels

of digital literacy among elderly citizens, co-creating a new digital prototype with them was difficult. However, by conducting stakeholder interviews in combination with contextual inquiries, we were able to gain insight in the needs of the elderly. Next, we analyzed these needs and translated them to a conceptual prototype which the engineers of imec could use to start building a real prototype that we further validated with the elderly citizens. Here, implicit knowledge spillovers tool place. Because we lowered this communicational barrier, practical complications and cultural differences were eased out as well. The experiment-oriented activities in such a neutral collaborative space allowed all stakeholders to grow closer together (both in culture and design language) and learn in a collaborative manner, though series of iterative prototyping and experimentation.

5 Conclusion and discussion

This study aimed to gather insights in how processes of identification (finding), attraction and activation of collaborative actors in regional OI ecosystems takes place. In order to do this, we firstly conceptualized the regional ecosystem as fractal, multi-level, multi-modal, and multilateral configurations of dynamic tangible and intangible assets within a narrow geographically bound environment" (Carayanis et al. 2018; Lönqvist et al. 2013) and as a network of networks (Jian &Tao, 2015). This is a context of distributed knowledge (Lakhani & Panetta, 2007), which requires interactions that formulate ties and activate resources. However, such interactions are underexplored in current literature. This research is based on an intervention with three boundary conditions to attract and activate relevant stakeholders within the ecosystem (a specific and narrow topical focus, an open-ended network and a temporal experimental environment).

An analysis of the practices and interactions that occurred revealed a process of *urban acupuncture*, through which the intervention generated a centripetal force that attracts relevant stakeholders. Hence, this process can be considered a mechanism to *identify* distributed knowledge in the (local) environment. On top of that, a *dynamic open-ended multi-layered* collaboration architecture contributes to the absorptive capacity of the collaboration, hence optimizing *selection* and *activation* of stakeholders. Furthermore, establishing a *temporal experimental window* (defined in time and space), optimizes *stakeholder matching*. More specifically, the dimensions of *complementarity*, *commitment* and *compatibility* (Sanduli et al. 2017).

These insights contribute on two levels. Firstly, earlier studies have widely discussed general frameworks and typologies to assess stakeholder matches in collaborations. However, little research has been conducted to understand processes of identification and attraction of matching stakeholders. This study provides explorative insights in the processes underlying multi-actor involvement over time in experiment-oriented collaborations within a regional innovation ecosystem. This is formalized as the '*Urban Acupuncture Framework*' (UAF). Secondly, these insights may fuel strategies of (local) policy makers and practitioners to shape future OI-collaborations that aim to tackle complex societal challenges.

Since this research has an explorative nature, and is limited due to its single case study design, several research opportunities remain. The first opportunity arises in studying the

attraction mechanisms in other OI-projects in other contexts. Studying similar formats, with a mixed application of boundary conditions, could validate the insights gathered in this study. A second opportunity would be to further validate the impact of the intervention within the regional innovation ecosystem at the level of *network ties*. These would be interesting to study focused on a single intervention, as well as over a series of interventions, to better understand evolving social capital and network structures within a regional innovation ecosystem, and their relation to urban acupuncture strategies (e.g. though the application of longitudinal social network analysis).

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