Managing Actors, Resources, and Activities in Innovation Ecosystems – A Design Science Approach

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Abstract. Through a design science approach, the paper explores how actors in a network create and sustain competitive advantage independently and through participation in a system of actors (i.e., a collaborative network) who are not hierarchically managed but, rather, act toward their own goals within the innovation ecosystem. In accordance with design studies, the relevance of research and its quality are evaluated against practice. The two cases discussed in the paper highlight that, in practice, innovation ecosystem actors must manage activities and relationships at the level of both individual and organisation. This finding has interesting research implications, as innovation ecosystems have been studied mostly at either macro or interpersonal (micro) level while the organisation (meso) level is seldom discussed. Furthermore, the findings should help managers to strive for and utilise innovation ecosystems better and to evaluate their ability and potential to survive via internal and external collaboration aimed at innovation.

Keywords: Innovation ecosystems, collaborative networks, innovation management, design science, ARA (actors, resources, and activities) model.

1 Introduction

Innovation is increasingly perceived as collaboration beyond organisational boundaries rather than intra-organisation action. Nonetheless, only around a third of innovating companies drew on external development or knowledge sources from 2010 to 2012 [1]. Therefore, huge potential remains in innovation ecosystems that are able to integrate diverse actors for collaborative innovation [2] in today's business environment, wherein knowledge is highly dispersed and complexity is growing all the time. Therefore, we wish to draw attention to the dynamic, hyperconnected, and networked but often loosely bound *ecosystems* that enable collaborative innovation.

The ecosystem view offers a systems approach to innovation management by focusing on how actors in a network create and sustain competitive advantage independently and as participants in a system of actors who, rather than being hierarchically managed, each act in pursuit of their own goals [3, 4]. In other words, the concept of ecosystems emphasises that the relationships constantly co-evolve through the actions and interactions of the actors involved. These collaborative systems of innovation, wherein the actors co-produce the outcome of innovation follow dynamic and multifaceted models. Thus, the multiplicity of participant types, roles, and inter-dependencies implies that ecosystem management is a challenging task and that possibilities for ecosystem management are not equally distributed among participants. Hence*, innovation ecosystem management* is simultaneously an engrossing academic research question and a practical challenge for all actors involved in collaborative innovation systems. *Design science* was, therefore, a natural choice for the research approach for our study of two emerging innovation ecosystems, in Finland and Italy.

2 A Design Science Approach to Innovation Ecosystem Management

2.1 Current Understanding of Innovation Ecosystems

The ecosystem approach represents a departure from existing literature on innovation and network management. The ecosystem should be understood as a context wherein there is ongoing interplay among actors taking a variety of roles – for instance, as keystones, dominators, or niche players [5]. The logic of action differs by ecosystem type, with business ecosystems focusing on co-creation of value for customers, co-generation of new knowledge constituting the main activity in a knowledge ecosystem, and innovation ecosystems positioned between the two [4]. In other words, as pointed out by Autio and Thomas [6], 'the defining element of innovation ecosystems is not a given product, but rather a coherent set of inter-related technologies and associated organizational competencies that glue a variety of participants together to co-produce a set of offerings for different user groups and uses' (p. 208). Clarysse et al. (2014) have stated that knowledge ecosystems are formed around a university or public research organisation (PRO) whereas large companies are the leaders of business ecosystems [7]. It also has been shown that national and city governments are becoming increasingly important in influencing innovation, and they can support the knowledge flows between large corporations and start-ups to speed up innovation [8]. The multiplicity of participant types, roles, and interdependencies implies that the possibilities and the challenges ecosystem management entails are not equally distributed across participants [9].

The concept of ecosystems emphasises that the relationships are constantly co-evolving through actions and interactions of the actor taking part [4, 6]. Interaction within and beyond (organisational) boundaries is essential to innovation ecosystems [10]. The results of the collaborative innovation arise from the dynamics of strategic manoeuvring amongst actors, and, therefore, the key factor for success is their ability to manage dynamic strategic interactions related to innovation [11]. Instead of aiming to avoid uncertainty, all actors must be flexible and prepared to make adjustments; the connection with each other implies that a decision or action taken by one influences all the others – but not in any uniform manner [4].

Still, most research on business systems (including innovation perspectives) has stressed gaining of individual-level benefits over system-level value creation and innovation. That is, the focus has been on company strategies in innovation ecosystems instead of system innovations. The study described here, in contrast, calls attention to the ways in which total value creation can be increased through joint activities by the key actors and, furthermore, distributed fairly among them.

2.2 The Logic of Collaborative Networks

The study approached innovation ecosystems from the meso (organisational) level. When the ecosystem approach is applied in discussion of collaborative networks, it becomes clear that each network member has its own reasons to collaborate. In the ecosystem approach, collaborative networks are defined as autonomous, geographically distributed, and heterogeneous [12]. Thus, the concept of collaborative network organisations (CNOs) highlights that there is an organisation overarching the participants' activities, roles, and shared governance rules. While CNOs are dynamic and often temporary in nature, innovation ecosystems are even more loosely structured, and participants' individual interests bring constant changes. On the other hand, the concept of virtual organisation breeding environment (VBE) represents the more loosely coupled co-operation setting found with a puddle of organisations and their related supportive institutions and hence is better suited to addressing innovation ecosystems. However, long-term co-operation agreements and interoperable infrastructure are mentioned as a 'base' also for breeding environments [12]. Therefore, we prefer to use the idea of the *innovation ecosystems* to capture a dynamic, temporary, continuously changing, hyperconnected, and networked assemblage that enables collaborative innovation.

2.3 The Design Science Approach

Design-focused professionals, such as architects, engineers, lawyers, and managers, face growing pressure to find new ways to solve nested problems – i.e., to act and decide on the basis of a systematic body of evidence [13]. In management and business studies, design science holds a steady but minor position on the sidelines of mainstream descriptive studies. There are some examples of problem-solving and of bridging between theory and practice through design science, in the operations management [14] and information systems fields [15]. Design science can be linked to several other qualitative approaches too, such as action research, participatory case studies, academia–industry partnership, and constructive approaches. With the lens of design science, the common goal in these exploratory approaches should be the researcher developing a 'means to an end', an artefact to solve a practical problem [14]. In our study, the practical managerial challenge and the research question were both 'How are the innovation ecosystems created and managed – and by whom?' The result of this study is a conceptual artefact [16], i.e. a collaborative model for innovation ecosystems evaluated in two case studies. The type of knowledge contribution can be described as exaptation, meaning known solutions extended to new problems [15], as the solution is based on the ARA model. The design science research process utilised in this study is illustrated at the Figure 1. The process is based on the DSRM Process presented by Peffers et al. 2012 [16]. Hence, the demonstration and evaluation phases are integrated as the conceptual artefact's use and test occur through the case studies. The first two phases (problem identification and setting the objectives of a solution) were carried through during the program preparations.

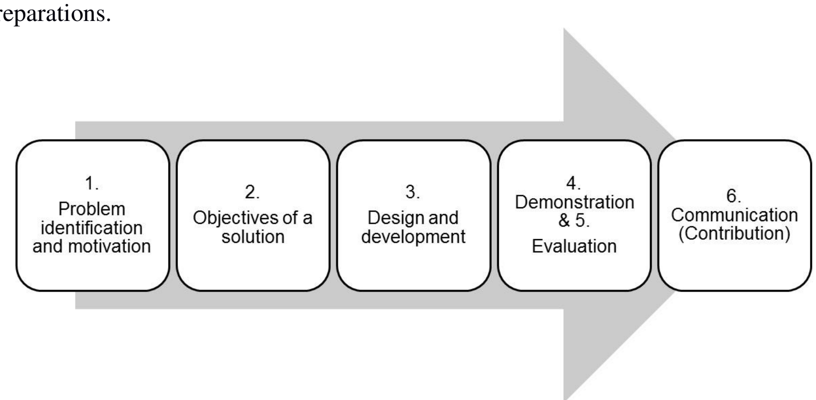

Fig. 1. Design Science Research Process in this Study.

In other words, through the case studies, the practitioners and researchers strove to jointly build and evaluate a design science research artefact, a collaborative model for innovation ecosystems (Figure 2). This kind of approach also suggests that research is not just about understanding and explaining issues and phenomena but also about changing them [17] and affecting creation of new ideas and innovation. Therefore, a joint project (or process) of researchers and practitioners – companies or other organisations – and close co-operation throughout the problem-solving are necessary in such a research setting.

2.4 A Preliminary Artefact for the Joint Solution – a Collaborative Model for Innovation Ecosystems

In our study, the above-mentioned practical managerial challenge and research question were addressed via a systemic approach to innovation management. Together we worked to build a conceptual artefact, the collaborative model for how a network of actors creates and sustains competitive advantage independently and as participants in a system of actors who, rather than being hierarchically managed, pursue their own goals [3, 4]. In other words, the objectives of the solution were qualitative, i.e., describe how this new artefact is expected to support solutions to problems related to collaboration in innovation ecosystems. The main research question, 'How are the innovation ecosystems created and managed – and by whom?', was broken down into three sub-questions:

- Who are the *main actors* in an innovation ecosystem?
- What kinds of *resources* are needed to integrate key actors in an innovation ecosystem?

- What are the *key activities* of the various actors within the innovation ecosystems?

This division into sub-questions was theoretically grounded in the well-known actors, resources, and activities (ARA) model, introduced by Håkansson and Johanson [18]. This particular theoretical model was chosen for several reasons. Firstly, the ARA model describes the in-built dynamics of a network, its actors, and its resources, which makes it a suitable concept for use in a study approaching innovation ecosystems at organisation level. Furthermore, it is in line with the practical managerial questions raised by all actors involved in the research process. In addition, the ARA model's way of approaching networks is closely related to the concept of interaction and knowledge as a dynamic resource, which formed an important practical and theoretical starting point for our study. Finally, the ARA model highlights the ever-evolving and emergent nature of the networks so is a good fit for studies of systemic innovation activities. A challenge becomes clear at this juncture: the latter aspect of the networks makes it hard to address our study's managerial perspective, with the question of whether an innovation ecosystem is manageable or not.

3 The Research Design for Demonstration and Evaluation

Design science was a natural choice for the research approach in our study of two emerging innovation ecosystems, from Finland and Italy: *innovation ecosystem management* is both a fascinating question for academic research and a practical challenge for the many actors involved in collaborative innovation systems. Since creation of innovation ecosystems and their management is a newly developing phenomenon and area of research, we consider qualitative methods to be appropriate.

Both interviews and focus groups were utilised for describing actors and their roles, relationships, and activities in the two emerging innovation ecosystems examined. Table 1 presents a summary of the data sources used for evaluation as well as building the artefact (see the Design Science Research Process at Figure 1). The informants (interviewees or focus-group members and workshop participants) held senior corporate management, R&D, business unit, or innovation management positions. The workshops focused especially in building and demonstrating the artefact, i.e. the collaborative model for innovation ecosystems.

The empirical material was collected and analysed by four researchers, the authors of this paper. The cases selected were chosen because through the joint development programmes the researchers and practitioners shared the challenge of innovation ecosystem creation and management. Furthermore, the two cases chosen enable exploration that involves comparison between two national systems of innovation. The multiple-case-study approach is well suited to new research areas when new perspectives are sought and when there is little knowledge available about the complex phenomenon being studied [19].

Table 1. Summary of the data sources.

Case	Interviews	Focus groups	Workshops
Finland	In all, 17 interviews, at 11 companies, five research institutes, and one facilitator organisation	Problem-solving-based group discussions of four subprojects	Two workshops on innovation ecosystem building
Italy	In all, 20 interviews, at 18 companies, one research institute, and one regional competence centre	Problem-solving-based group discussions of two subprojects	Two workshops on actor dynamics and resources' integration

Most of the organisations involved were established, globally operating Finnish and Italian companies and public organisations – i.e., public research institutes, universities, and regional development agencies. The ecosystems represented various fields of industry and organisation sizes, bringing diversity to the problem-solving and increasing the learning and variety. Our data analyses for joint problem-solving were based on the above-mentioned ARA model [15], which helped researchers and practitioners alike to gain a holistic, general view of the two innovation ecosystems and their characteristics. The focus-group meetings and workshops were organised as a means of joint problem-solving and to assist in the data analysis and test the preliminary findings from the interview data.

4 Findings from Evaluation

There were both similarities and differences between the two innovation ecosystems and between their respective actors, resources, and activities.

Actors. The main difference was in the ecosystems' size, the number of actors involved. The Italian ecosystem, DATABENC, consists of 48 actors whereas the Finnish programme (REBUS) has 31 actors formally involved. The DATABENC ecosystem featured a large number of SMEs (77% of the actors), while there were mainly larger companies in the REBUS ecosystem. In both ecosystems, the informants agreed that several other actors should be more fully involved. Specifically, the participants recognised that in the ecosystem composition phase, it is important to confirm the involvement of a broad spectrum of actors, while membership dynamics (i.e., entry and exit of actors) were emphasised in the orchestration phase. For instance, funding institutions were not actively involved in either ecosystem, although they could be important in the commercialisation of innovations created by actors in the ecosystem.

Resources and roles. In the Italian ecosystem, two universities, a national research centre, and a regional competence centre have a pivotal role in bringing together all the actors, while a local institution (in the Campania region) acts as a facilitator. Similarly, the six universities, the research institute, and the national open innovation company (FIMECC) in the REBUS ecosystem have a significant role in integrating the actors' efforts and facilitating collaboration among the various organisations involved. Both cases show that public organisations can have the role of a keystone in innovation ecosystems. Furthermore, more than one actor may act in this kind of role. Accordingly, technological competition and similarities in resources were identified also as motivation for exiting the DATABENC ecosystem.

Activities. For both ecosystems, the participants suggested that having various kinds of joint activities – such as joint discussions and operations – and shared resources was critical. In this connection, face-to-face discussions were considered to be important. Also, the need for networking via development forums (in relation to Open Source initiatives and innovation platforms) was highlighted as a means to ensure collaboration for innovation by increasing commitment. Developing clear joint rules was seen as an especially strong way to increase trust in a situation wherein the relationship does not necessarily have a long history. Furthermore, the presence of SMEs active in the cultural heritage sector in the DATABENC ecosystem showed their important role as the 'glue' between education and knowledge through monitoring and fruition activities.

Structure. The ecosystem structure differed between the two cases. The four sub-projects of REBUS form quite independently operating sub-ecosystems that have their own goals while at the same time collaborating with other stakeholders, who were not directly involved. There were four sub-projects also in the DATABENC ecosystem, but they were closely linked to one another. They sought to reach complementary goals that merge in the strategic purposes of the entire ecosystem – namely, the implementation of an integrated system of knowledge, the development of diagnostic monitoring, and advancing of technologies for a sustainable future.

Joint configuration of the artefact – a collaborative model for innovation ecosystem management. The ARA model supported joint problem-solving between the practitioners and researchers, along with developing the collaborative model for an innovation ecosystem (see Figure 2). Firstly, the work identified the *main actors* in the innovation ecosystem and also the changes in actors as a baseline for management. The findings highlighted that management needs and governance possibilities in innovation ecosystems differ from those in direct business relationships, such as dyadic supplier–purchaser relationships. In innovation ecosystems, the relationships are not typically governed with contracts, and this renders the role of relational governance mechanisms important. Secondly, recognising the *resources* of actors was a starting point for a negotiation process aimed at balancing out the self-interest of the actors involved. Accordingly, the practitioners pointed out that, in addition to their resources, it is important to understand the *roles of actors*. The role, which is closely linked to the relevant actor's business model, affects what resources that actor is ready to bring and on what kind of terms. Finally, portraying the *key activities* of the various actors within the innovation ecosystems proved to be the most case-specific element and depended on the goals of the development programme.

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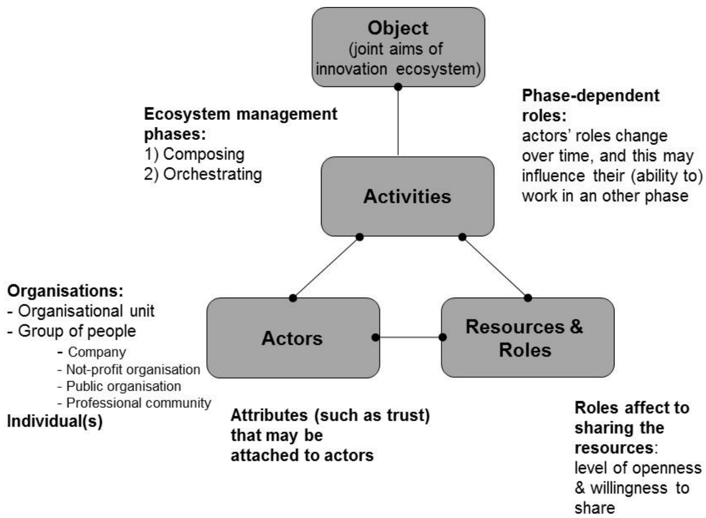

Fig. 2. Collaborative model for innovation ecosystems (built on the basis of the ARA model).

The key activities related to management of the innovation ecosystem were similar between the two cases and consistent with the view of interactions implied by the ecosystem concept; i.e., relationships between actors proved to be the primary mechanism for managing the actors in the ecosystem. Finding a balance between the interests of the individual actors involved is critical, and, therefore, motivating the actors to put effort into the joint activities and the whole ecosystem is vital.

5 Conclusions

Our work makes two main contributions to innovation management literature and practice: firstly, we have proposed an initial, explorative taxonomy of actors and pointed to a need to understand the respective roles, and, secondly, we have identified key activities for developing and managing actors through their relationships within innovation ecosystems. Furthermore, the work underscores that actors need to manage activities and relationships at both individual and organisation level. This has interesting research implications, as innovation ecosystems have been studied mostly at either the macro or the interpersonal (micro) level, while little attention is devoted to organisation level. It is vital for actor organisations to understand and manage the inter-organisational and the interpersonal level at the same time.

How the design science approach works. By adopting problem-solving as the main *modus operandi* for the development programmes and the research work, we attempted to achieve simultaneous attainment of efficiency and innovation. Although conducting such explorative research to address ill-structured managerial problems involves many methodological challenges, we found three benefits arising from that choice.

Firstly, a common well-defined problem served effective co-ordination of knowledge originating from various disciplines and communities of practice. Secondly, innovativeness cannot be programmed beforehand. That is, a waterfall-type planned programme would hardly have created innovative and feasible solutions. In contrast, an iterative and incremental problem-solving process allowing learning and redefinition offered greater possibilities for doing so. Thirdly, when one runs large programmes that involve several parties and highlight research–practice co-operation, there is a danger of project execution getting bogged down in the realities faced in the participant organisations' day-to-day practice, so we needed to avoid this. To that end, we paid particular attention to project-execution flow, which was defined as the speed of the problem-solving process. We arrived at a feasible goal of achieving 3–6-month process cycles in task-specific problem-solving processes, with the timing dependent on ambition level, the iterations needed, and case-specific scheduling.

Thus, the study highlighted how identifying the problems and objectives is itself a challenge. The joint process before creation of the actual artefact (i.e., the innovation ecosystem) forms a key stage in which the translation of knowledge between research and practice occurs. However, it is not at all certain that the new kinds of artefacts required by the design science research approach can be innovated and discovered. The discussion above should help managers in their search for better innovation ecosystems and their utilisation of these, while simultaneously assisting them in evaluating the ecosystems' ability and potential to survive by means of internal and boundary-spanning collaboration for innovation. In summary, it should help them better understand how to collaborate for innovation, with whom, and why.

There is significant room for fruitful research, though it is clear that no 'one size fits all' solution exists for the management of innovation ecosystems. These ecosystems and their models of operation differ from each other in the forms of joint processing, their rules of participation, and the ownership of results. Thus, the conceptual artefact, the collaborative model for innovation ecosystems, build and evaluated in this study opens several avenues for further research. Although, the evaluation was done in two innovation ecosystems the co-evolution within these ecosystems is still on-going and the study can provide only a snap-shot to this process. Therefore, one obvious need for further research would be follow-up of these ecosystems. Another important dimension for future research would be a quantitative approach in order to test the net types and differences and their impacts on a larger scale. Furthermore, innovation ecosystems influence in the creation of innovative start-ups or spin-offs should also be explored as the current studies focus more on roles of well-established companies and research institutes in the two emerging innovation ecosystems.

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