Fostering Techno-Entrepreneurship and Open Innovation Practices in the Innovation Ecosystems – Case Nokia

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Abstract

Organizations have developed Open Innovation practices to promote innovation ecosystems and to leverage their own knowledge and data-based resources. By using case examples on Nokia Open Innovation practices, we describe different perspectives on how a small firm, startup and/or techno-entrepreneur can create and capture value in the context of an innovation ecosystem. Ecosystem members can adopt different forms of collaboration to develop innovations by sharing capabilities, knowledge and data. Virtuous circle of growth and profitability realize in an innovation ecosystem where startups and larger companies complement their capabilities through collaboration. Based on the case examples we examine models of collaboration in an innovation ecosystem. These examples describes how a linkage with a keystone company can help startups and techno-entrepreneurs to overcome typical challenges and accelerate their commercialization process via knowledge creation and data utilization.

Keywords

Entrepreneurship; Open Innovation; Ecosystem; Case study; Nokia

Introduction

Globalisation, technological developments and rapidly changing customer requirements have increased the importance to create and exploit innovation (Rosenbusch et al., 2011). Therefore, it is essential that firms can swiftly take advantage of new emerging opportunities and respond effectively to the changes in customer requirements. Increased competition, shorter product life cycles, changes in regulations and continually changing customer needs all emphasise the importance of agility and resilience, including capability to change planned businesses. Research highlights the role of external knowledge sources in the recognition of strategic opportunities, but is less forthcoming with respect to the role of such sources during the process of exploiting the opportunities. However, realizing strategic opportunities often involves significant interactions with external data and knowledge sources (Foss et al., 2013). Rather than relying only on internal resources, firms are increasingly participating in innovation ecosystems and exploiting both existing internal and external firm-specific resources and capabilities to address rapidly changing business conditions and environments (Zahra and Nambisan, 2012). These various types of inter-organizational collaboration may take many forms, ranging from R&D partnerships to equity-based joint ventures, to collaborative manufacturing and to complex co-marketing arrangements. The most common rationales for collaboration involve combination of mutual learning and capability building, obtaining access to new markets and technologies, and accelerating time to market (Pellikka and Malinen, 2014). In particular, dynamic capabilities may enable firms to re-position themselves to make the right products and target the right markets, allowing them to address consumer needs and opportunities of the future (Teece, 2012). In addition, firms must optimally balance tactical investment in

the existing business as well as the innovation-related activities to drive new business opportunity development (Muller et al. 2005). As previously pointed out, in a changing business environment organization's capability to catalyze the emergence and guide the development of an innovation ecosystem can offer an increasing potential and a powerful source of competitive advantage (e.g. Pellikka & Ali-Vehmas, 2016; Rohrbeck et al., 2009).

From the perspective of an organizational ecology, innovation ecosystem participants co-evolve capabilities around a shared set of technologies while at the same time they can manage the dynamic changes and uncertainty to support new products, satisfy customer needs, and eventually incorporate the next round of innovation (Moore, 1993). Moreover, innovation ecosystems are collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution. Innovation ecosystems allow firms to create value that no single firm could do alone (Adner, 2006). Furthermore, the previous studies have shown that innovation ecosystems have become the new basis of competition. However, the basis for managerial insights and implications remain fragmented, especially from an essential perspective of entrepreneurship, underlining the importance of the studies that elaborates the detailed linkage between production and use sides actors in the ecosystem (see Autio and Thomas, 2014). Although SMEs are considered in general extremely vital in innovation ecosystems, only few studies have addressed practices on how to manage these collaborative settings in small firms (Spithoven et al. 2013).

Objectives and the relevance of the chapter

Previously entrepreneurs, researchers, and policy-makers have made increasing efforts to identify ways to foster new business opportunity development and growth in dynamic business environment as part of the existing and/or emerging innovation ecosystems (Teece, 2010). Due to changing customer needs, extensive competitive pressure, and rapid technology development, firms have become increasingly dependent on external sources of knowledge rather than in-house research (Pellikka et al. 2016). Intensified competition, shorter product life cycles and expanded technological opportunities force firms to innovate more quickly and focus their R&D expenditures, while seeking privileged and rapid access to complementary new knowledge from external sources. Consequently, a new type of industrial research is emerging, less focusing on individual firms but more based on networks and markets, and in some cases, more reliant on innovation systems and knowledge networks (Siikonen et al. 2011). Rather than relying on internal resources, firms are increasingly seeking new approaches to create and capture value via the other partners in the innovation ecosystems. This however means that firms must be able to define a winning strategy (formation and implementation) and to create managerial capabilities, external search practices, and effective ways of working together with business partners that can provide the complementary assets and resources for the further business development and growth (see e.g. Martini et al. 2017). According to Zahra and Nambisan (2012), entrepreneurs, especially in the high technology sectors, fail to capitalize on their connections in and outside the industry, to seek the advice and help they need, to build the scale and scope of operations for success. In other words, techno-entrepreneurs' strategic challenge is how to connect their business into the innovation ecosystem. This process requires understanding the dynamics (see Snowden, 2002) that govern relationships within that ecosystem and the function of entrepreneurial activities in this regard (also Neck et al. 2004). At the same time, large corporations are increasingly seeking new alternatives to enhance their ecosystems, open their commercialization processes and innovation activities, and actively collaborate with the startups to develop their business opportunities further. Moreover, as part of these diverse activities, the relationship and interaction between the organizations also determine the speed of the ecosystem's evolution, which keeps the ecosystem attractive and capable to offer new business opportunities for its members (Virtanen and Pellikka, 2017).

For example, this means that all organizations in the innovation ecosystem (both existing companies and new firms) need to be able to create and jointly execute a well-defined, commonly accepted innovation ecosystem strategy. (Pellikka and Ali-Vehmas, 2016). In this study, we utilize the term 'innovation ecosystem' as '*a network of interconnected organizations, organized around a focal firm or a platform, and incorporating both production and use side participants, and focusing on the development of new value through innovation'* (Autio and Thomas, 2014)

As pointed out, a number of important aspects of innovation ecosystems and entrepreneurship have not yet been subject to thorough empirical analysis, such as issues on the nature of different types of ecosystems and related entrepreneurships or the alternative ways to define and execute an innovation ecosystem strategy in case of a new entrepreneurial firm. Thus, this chapter aims to respond to the following questions:

•To describe how the different types of innovation ecosystems effect on the strategy formation and implementation in a new entrepreneurial firm in high technology industries. As a response to this first question, we provide a case example on the entrepreneurial acceleration activities in Nokia's ICT ecosystem, including empirical evidences on how the other actors of innovation ecosystem are interacting with each other in an open innovation context.

•To provide managerial implications and guidelines for techno-entrepreneurs to realize the benefits of the innovation ecosystems in ICT driven industries. In terms of the second question, we focus on characteristics (e.g. ecosystem dynamics, network structures and proximity) that enhance and promote entrepreneurial activity in different types of innovation ecosystems.

This chapter is constructed as follows. We first discuss definitions of the ecosystem concept by reviewing the previous ecosystem literature especially in the high technology context. Secondly, based on the literature review, we provide case examples from the ICT sector with a further case analysis of the key results and finally we discuss the key managerial implications for both entrepreneurs, policy makers and corporate venturing professionals who are operating particularly in high tech industries. Finally, we provide some avenues for further studies.

Business opportunity development in the innovation ecosystem

External information and knowledge-based resources have become one important source of competitiveness and innovation (e.g. Quintane et al. 2011). Historically, firms attempted to internally create and commercialize innovations relying strongly on their own capabilities and resources to achieve success in the marketplace (e.g. Snow et al., 2011). Rapid market changes, shorter product life cycles and expanded technological opportunities force them to innovate more quickly and optimize their R&D expenditures, while seeking access to complementary new knowledge and data, which both are strategic enterprise resources that enables organizations to gain competitive advantage (English, 1999). Therefore, being competitive in a dynamic business environment depends on firm's ability to discover and exploit opportunities via both internal and external knowledge-based resources (including both market and technological knowledge) to fulfil the business objectives (Wiklund and Shepherd, 2003; Steenkamp and Kashyap, 2010).

Importance of data-based view (DBV) in the innovation ecosystems. Success in business ecosystems that include well-established companies and new ventures requires collaboration and competition, a task that demands strategic thinking to leverage firm's resources and capabilities. Barney (1991) argued that sustained competitive advantage is based on the firm's resources and capabilities that are 'valuable, rare, imperfectly imitable, and not substitutable'. Originally, Penrose (1959) presented the resource-based perspective at the firm level that Wernerfelt (1984) continued by suggesting that the success of a firm depends on its ability to efficiently use different types of resources to grow and maintain business. These studies have had a noticeable influence to the later development of the resource-based view (RBV) that shares a common idea that resources and capabilities can be distributed across organizations and explains why some firms consistently outperform other firms (e.g. Barney, 2001). All these elaborations have highlighted the importance of inter-organizational collaboration in the innovation ecosystem consisting of several parties, such as universities, research institutes, government agencies, suppliers, clients and other firms that can provide essential resources and complementary assets (Brouthers et al. 2015). It is also important to note that the success of a firm require: 1) capabilities to manage knowledge-based assets effectively (both internally and externally), 2) competitive quality of its knowledge-based assets, and 3) successful application of these assets to fulfil organization's strategic objectives (e.g. Teece, 1998; Wiklund and Shepherd, 2003). Therefore, firm's resources should not only be valuable, rare, and inimitable to facilitate superior performance, but the firm

must also have an appropriate strategy, organization and processes in place to take advantage of the knowledge-based resources (see e.g. Pellikka & Ali-Vehmas, 2016; Barney, 1991; Wiklund and Shepherd, 2003). In addition, it has been previously noticed that an increasing role of data and knowledge have become one of the primary wealth-creating assets of a firm (Martín-de Castro, 2015; Siikonen et al. 2011) enabling for example innovation, business opportunity development and commercialization (Virtanen and Pellikka, 2017). For example as pointed out by Pellikka (2014), the small technology firms' capabilities to identify, acquire and effectively use data and more generally knowledge-based resources during the commercialization process plays a highly critical role. It is also necessary to focus on the right activities at the right time during the commercialization process. The previous studies imply that some major challenges encountered during the commercialization are often due to misalignment of activities and knowledge-based resources. In traditional industry sectors, customers, business partners, universities and other organizations may strongly contribute to the business performance (Spithoven et al. 2011). Therefore, in the innovation ecosystems companies are accessing and utilizing purposive data and knowledge flows to accelerate innovation and to expand the markets for external use of innovation with their innovation ecosystem partners. Collaboration within the innovation ecosystem can for example provide the following business benefits:

- *Enhance innovation capability*. Collaboration between the business partners can be an important source of learning capabilities for the firm (Lundvall, 2009). By transferring market and technological knowledge, firms may be able to further expand their competitiveness and competencies (Spithoven et al. 2011). Firms may also collaborate to facilitate the creation of a new standard (Suarez et al. 2015).
- *Shorten time-to-market*. Expanding the data and knowledge on market access reduces innovation time and operational processes in manufacturing via combinatory flexibility (Van de Vrande et al. 2009; Pellikka, 2014). Obtaining some of the required capabilities (for example, for R&D activities) from the business partners via open innovation rather than building them in-house can help a firm to reduce, for example, its financial asset commitment and therefore enhance its flexibility (e.g. Spithoven et al. 2013; Kim et al. 2012).
- *Increase operational performance and productivity*. Inter-organizational collaboration enables a company to obtain effectively necessary resources more quickly than developing them in-house (Spithoven et al. 2013). After market entry, inter-organizational collaboration with the business partners may help to improve business performance via more rapid sales (Lee et al. 2010).

While techno-entrepreneurs in the high-tech industry have strong technical background and experience, many of them ignore the role of internal dimension of the business opportunity development and commercialization (Pellikka, 2015). Internal activities (e.g. resource allocation, business concept design and other key decisions) are crucial and therefore it is important to plan, manage and control these activities effectively during the commercialization process. The external dimension is equally important, i.e. how to manage the external collaboration and innovation ecosystem relationships. It has been noted that techno-entrepreneurs may fail to capitalize on their connections in and outside the industry, to seek the advice and help they need to build the scale and scope of operations for success (e.g. Teece, 2010). Part of this strategic challenge is to connect their ventures to the broader innovation ecosystem, a process that requires understanding the ecosystem strategies (see Pellikka and Ali-Vehmas, 2016), dynamics that govern relationships within the system, and the functions of entrepreneurial activities in this regard. In addition, the companies need a number of skilled workers to assimilate and integrate the externally acquired knowledge (Chesbrough and Crowther, 2006). Previous studies have pointed out the importance to understand better firm-level innovation management practices within the innovation ecosystem context (see e.g. Wang et al. 2011; Pellikka and Ali-Vehmas, 2016). For example, one relatively unknown area in this context is decision-making to define the strategic options and key activities needed before joining into an existing innovation ecosystem. According to Autio and Thomas (2014) these tasks may involve activities such as: 1) ecosystem coordination, 2) optimization of business models to take advantage of innovation ecosystem externalities, and 3) the creation of control strategies to ensure value appropriation with the business partners. These areas will be briefly described in the following section.

Ecosystem coordination. Sourcing of external knowledge for innovation is a critical process of firm's inbound open innovation activities (Dahlander and Gann 2010). However, the complex interdependences among ecosystem

participants raises a practical question of how ecosystems are coordinated and managed. For small companies it is essential to identify the coordinator firm of the ecosystem (if that exist) since the coordinator's role is critical in facilitating and controlling the ecosystem development. This is especially important in platform-based setting where all members of the innovation ecosystem can use ecosystem-enabled assets to grow their business (e.g. Cusumano and Gawer, 2002). In addition, it is important for small firms to be aware of key practices, processes and systems within an ecosystem. This will help managers to coordinate sourcing of external knowledge and integrate the development of innovations in a structured manner (Iansiti and Levien, 2004).

Optimization of the business models. Some challenges in high-technology industries relate to the business objectives and the creation of a business model with the business partners (Pellikka and Malinen, 2014). Various actors involved in the ecosystem must be managed to ensure that their actions are aligned. Small technology firms might be able to enhance their commercialization processes if they can effectively use their agility and flexibility to adapt themselves fast to changes in the market and business environment. Small technology firms may have a potential to gain from collaboration and partnerships due to their ability to use efficiently inter-organizational relationships and networks (e.g. Moensted, 2010). However, many existing business model frameworks fail to explain the dynamics between the components of their models. Westerlund et al. (2014) present a model based on the key value pillars (i.e. value drivers, value nodes, value exchanges and value extracts) that is potentially better suited for designing business models for firms in the ecosystems than the component-oriented approach. The pillars are interconnected and they aim to explain the flows and actions in the business model rather than components of the model (Westerlund et al. 2014).

Creation of control strategies to ensure value appropriation with the business partners. The more dependent an innovation is on other developments in the ecosystem, the less control it has over its own success (see e.g. Adner, 2006). Firms face a choice between taking an active or a passive role in guiding ecosystem development. If an actor assumes the leadership in an ecosystem, it will have a chance to tailor its development to gain own strengths (Iansiti and Levien, 2004). Taking a less ambitious role raises some key questions. Such questions include e.g.: 1) which ecosystem leadership candidates to follow, 2) how to create valuable relationships with the selected candidate, and 3) what is the sufficient level of investment into the ecosystem. The questions still require a clear understanding of the full ecosystem, its structure and dynamics for a successful ecosystem strategy (Adner, 2010; Pellikka and Ali-Vehmas, 2016). Autio et al. (2012) pointed out that the complex nature of innovation ecosystems requires four different strategy categories to enable the value creation. The categories are:

1) *Technological Strategies,* that include technology architectural decisions, standardization strategies, open source strategies, and IPR-related strategies

2) *Economic Strategies* including identification, selection, access and promotion of complementary assets and associated investment strategies

3) *Behavioral Strategies* that cover behavioral tactics in the creation of initial network ties and alliances

4) *Institutional Strategies* to develop and manage interconnectivity within the institutional structures (both formal and informal) necessary to establish an institutional and regulatory framework to ensure smooth coordination and operation of the ecosystem.

It is important to note, that a number of aspects of business opportunity development and commercialization (see Virtanen and Pellikka, 2017) have not yet been subject to thorough empirical analysis. Especially perspectives of small technology firms, including business objectives of ecosystem collaboration and the criteria to design a suitable business model for the dynamic innovation ecosystem setting to enhance growth have not been addressed. The next table (Table 1) provides a summary of some key challenges from the perspective of techno-entrepreneurship and small high technology firms. Furthermore, our aim is to provide recommendations that help to identify opportunities to reduce time to market, lower launch expenses, and open up new business and market opportunities in the innovation ecosystem context.

Category	Description	Recommendations	References
Entering the innovation ecosystem	Fail to capitalize on their connections in and outside the industry, to seek the advice and help to build the scale and scope of operations for success Fail to integrate inflows of knowledge from the most relevant ecosystem partners with internal innovation activities to direct innovation actions SMEs struggle with the liability of smallness, facing resource constraints and scale limitations and having fewer technological assets to bargain with Corporate ventures face the dual challenge of building credibility with their parents and establishing market legitimacy	Co-creation with innovation ecosystem partners to bring in market-based knowledge and applied technology that small firms can exploit more easily for commercialization efforts in the dynamic business environment Concentrate on the particular nature and the distinct mix of interactions with external innovation partners in a firm's ecosystem strategy Continuously align the inbound knowledge flows with the firm's in-house innovation activities as part of business opportunity development via pre-determined practices with the strategic ecosystem partners (e.g. large companies and universities) Create and continuously improve boundary resources (e.g. APIs, SDKs) of a platform to enable data and knowledge usage	Zahra and Nambisan (2012) Dahlander and Gann (2010) Spithoven et al. (2013) Dougherty and Dunne, 2011 Dahlander and Gann (2010) Brunswicker and Vanhaverbeke (2015) Brusoni et al. (2001) Weiblen and Chesbrough (2015) Eaton et al. 2015
Innovation ecosystem dynamics	Fail to attract the skilled workers to integrate the externally acquired know-how into the commercialization Small firms and startups may face more risks associated with open innovation than large companies, such as becoming heavily dependent on the external business partners Lack of the ability to change a direction and/or abandon a business, product or solution concept due to the changing needs during commercialization Fail to materialize ecosystem benefits because the capabilities, skills, and knowledge cannot be smoothly transferred and integrated into the firm's own processes and activities	Techno-entrepreneurs need to consider ways they may effectively grow the organization and manage its evolution as part of an selected ecosystem Entrepreneurs should develop their ability to foresee emerging market changes and the adjustments that need to be made as part of the ecosystem Entrepreneurs can use resources such as external innovation support services as channels to bring complementary assets into the firm to support the critical phases of the commercialization process or to expand the knowledge base related to critical activities. In addition, the startup and acceleration program-based approach helps limit the risk of dependency Small companies need to create a routine and/or a process for assessing ecosystem risks holistically and systematically Managers need to learn to establish expectations that are more realistic, develop a more refined set of environmental contingencies, and arrive at a more robust innovation strategy.	Zahra and Nambisan (2012) Chesbrough and Crowther (2006) Pellikka (2014) Adner and Levinthal (2004) Martini et al. 2017 Adner (2006) Puranam et al. (2009) Dougherty and Dunne, 2011
Building trust	A lack of trust between the parties, difficulties in relinquishing control, the complexity of a joint project, and differential ability to learn new skills are all barriers to effective collaboration Fail to reduce the behavioral uncertainty regarding whether and when ecosystem partners suppliers will behave opportunistically to renegotiate agreements and reset terms in their own favor	Co-creation e.g. via startup and acceleration programs that involves the joint creation of value by the firm and its innovation ecosystem partners Utilization of a structured routines, programs or standardized process for identifying and develop co-creation opportunities Further develop and manage external knowledge search practices and the practices to effectively use knowledge internally Systematically develop key enablers of trust building within ecosystem environments including e.g. complementarity of obligations over the product lifecycle, differing perceptions of obligation fulfillment, and balance between value creation and community values	Frow et al. (2015) Reypens et al. (2016) Martini et al. 2017 Autio and Thomas (2014) Adner and Kapoor (2010) Weiblen and Chesbrough (2015)
Disconnection in the innovation ecosystem	A disconnection in the innovation ecosystem between the development of knowledge and innovation ecosystems. Policy makers have primarily supported the creation of knowledge ecosystems assuming that these ecosystems will automatically trigger the development of business ecosystems. The unstructured ecosystems mean that it is too early to tell who the participants will be and which roles they will have in the evolving ecosystems.	Innovation policies to enhance new business development and commercialization should take into account the each type of ecosystems An integrated, holistic approach should be taken in attempts to enhance the commercialisation process and to focus more on the content of the services they provide and orientate the delivery of their services more towards meeting the real challenges that the small technology firms confront during commercialisation in their ecosystems Managers need to create a business model design tool that takes into account the characteristics of an individual ecosystem The use of innovation brokers, intermediaries and other private or public organizations that can help small companies to conduct business partner search and technology scouting	Clarysse et al. (2014) Pellikka (2014) Westerlund et al. (2014) Pellikka and Virtanen (2009) Appio et al. 2017

Table 1. The key managerial challenges among small and medium-size technology firms in the innovation ecosystems context

Fostering innovation ecosystems via open innovation collaboration between startups and large companies - Case examples

Neither using the input of outsiders, nor searching for outside commercialization opportunities to improve internal innovation and processes is new. Over the years, many companies in different industries have implemented these ideas (see e.g. Dahlander and Gann, 2010). For example, Nokia continuously identify opportunities and systematically scans emerging trends and changes from the perspectives of technology, business and changing user preferences (see Vanhaverbeke et al. 2008). Knowledge gained from these multiple activities helps identifying potential indicators of change in the market, including potential disruptions. By early identification of these indicators, companies can take steps to address change or disruption sooner. This can help companies especially in the technology industry to prepare and develop their own response to otherwise unforeseen changes. In Nokia, the key activities to foster the innovation ecosystem can be divided into the following categories: 1) innovation ecosystem events and campaigns, 2) innovation support services, and 3) funding and commercialization-related activities (see e.g. MacCormack et al. 2013; Weiblen and Chesbrough, 2015). In the next section, all of these are briefly described.

Innovation ecosystem events, campaigns and competitions. Companies are continuously searching for better ways to identify and exploit novel solutions. Increasingly, they discover that many of the promising business, product and service concepts are found from the external sources, e.g. via innovation ecosystem partners outside *of* their organizations, in an ecosystem of innovators who possess wide-ranging skills and knowledge. Creation of new technology-based businesses inherently involves a high level of uncertainty due to market and technology risks especially in the early phases of commercialization process and in business opportunity development (Pellikka & Virtanen, 2009). One typical way for firms to cope with the technological and market uncertainty associated with new business opportunity and commercialization is systematic elaboration and co-development in the selected domain. During the early phase when technological and market uncertainty is high, firms are better off creating options through small investments that are regarded as real options (see e.g. McGrath, 1997). After making an initial investment, management can turn its attention to other matters and wait for a signal whether or not it is appropriate to harvest or cultivate the initial investment as the level of uncertainty has decreased (Adner and Levinthal, 2004). Practical examples in this area are grants to universities that allow them to explore inventions or emerging technologies further. Joining a research consortium or establishing research agreement with partners are other possibilities to explore technologies or business opportunities in the early phase and to provide strategic flexibility (also Vanhaverbeke et al. 2008).

Nokia Open Innovation Challenge. Nokia Open Innovation Challenge, in partnership with venture firm Nokia Growth Partners, is a call for ideas, technologies, and new business models in IoT. Nokia is shaping a new revolution in business by creating technologies that connect the world and by co-innovating within multiple ecosystems to invent disruptive technologies. Co-innovation is an essential part of Nokia's ambition to bring in people with creative ideas and innovative solutions. “Nokia Open Innovation Challenge” -initiatives have been arranged annually since 2013. Nokia Open Innovation Challenge is a typical example of outside-in startup programs (e.g. Weiblen and Chesbrough, 2015). In this model, the focus is on making interesting startup products or technologies available to the sponsoring organization by enabling multiple startups to elaborate and deliver their ideas. The sponsoring organization gets a head start compared to its competitors and can extend its existing business into new focus areas. The format allows the corporation to pursue multiple interesting approaches in parallel via many startup companies it incubates. This leads to faster mutual learning and a more thorough exploration for the sponsoring corporation than it could hope to do if it relied only on its own resources (https://www.nokia.com/en_int/about-us/news-events/open-innovation-challenge). For startups, collaboration with a large corporation is much easier in the situations where a solid startup collaboration and acceleration program is in place (also Weiblen and Chesbrough, 2014.

During the pre-incubation phase in Nokia Open Innovation Challenge, the top 10 innovator teams with their assigned Nokia mentors and selected Nokia customers will attend a two-day Concept Development Workshop to brainstorm and co-create the steps towards joint business and ecosystem collaboration. The scope and objectives of the Nokia Open Innovation challenge are changing annually to target the most relevant areas of programmable world and to

accelerate the development of new concepts and businesses with other players in the innovation ecosystem (also Weiblen and Chesbrough, 2015). In 2017, Nokia Open Innovation Challenge focuses on the product concepts and technologies on transportation, smart cities, safety and security, and in general on connected industries. Especially it is a call for startups and innovators who are working on the next big ideas in IoT aiming to improve people's lives and who are able to demonstrate a working prototype for their idea that:

- Improves cities by solving urban challenges
- Improves health and safety with digital technology
- Improves the ways to interact and experience with virtual reality and machine interactions
- Enables the next industrial revolution with 5G (and LTE), robotics and sensors

The benefits for the participants and especially for the finalists include acceleration of commercialization process within the Nokia innovation accelerator program, access to the internal and global market through Nokia and investment opportunities from Nokia Growth Partners and other venture capital firms. The concept of Nokia Open Innovation Challenge can be summarized as follows (Figure 1):

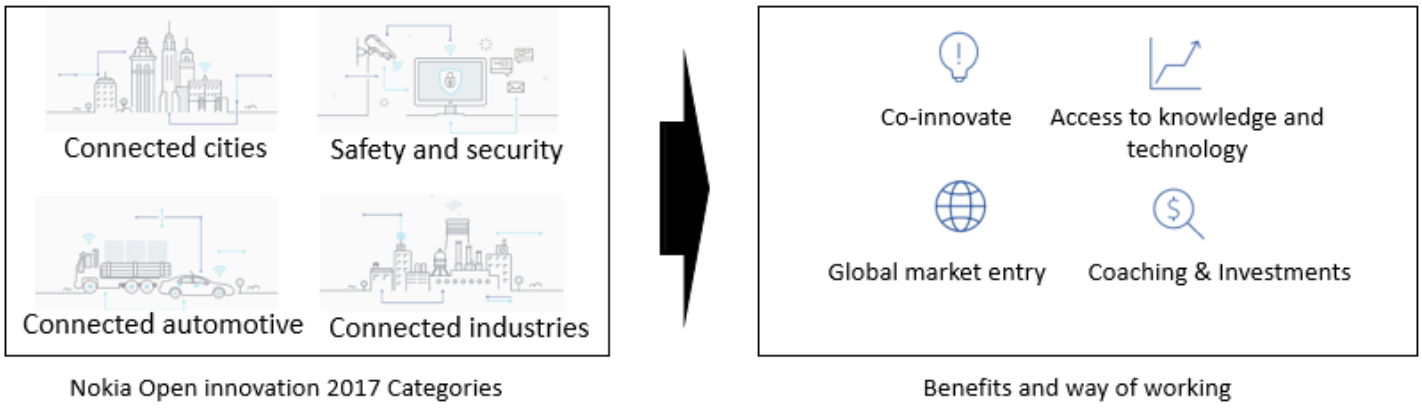

Figure 1. Nokia Open Innovation Challenge

Another example to accelerate ecosystem-wide co-creation and open innovation activities via open network and modern IT tools is Open Ecosystem Network (https://open-ecosystem.org/). The network is an open, cloud based, social & mobile co-creation environment for entrepreneurs, developers, business incubators, universities etc. to share ideas and find the other organizations and people who would like to co-develop something new.

Nokia Innovation Platform. Nokia Innovation Platform is a live development and trial environment for start-ups, industry and other partners to accelerate innovation of Internet of Things (IoT) solutions through an open, collaborative model (https://platform.innovation.nokia.com/index.php). Nokia Innovation Platform gives access to all the technologies that Nokia and ecosystem partners develop. This environment enables digital transformation through the innovation projects for Nokia's customers in different vertical segments. The rapid development tools provided by the platform enable Nokia's customers to quickly assemble the necessary enablers for new business applications and experiment with them. Nokia Innovation Platform is able to provide secure communication across multiple wireless access standards and to connect the sensors and devices to the platform utilizing technologies such as 4G-to-5G and LTE-M / Narrow Band-IoT. This platform solution includes central cloud services and network core services, which are available for the ecosystem partners all around the world. For applications requiring ultra-low latency and high throughput, cloud services run in a local mobile edge computing system, closer to the radio network. In addition, IoT-related services offer device management capabilities designed for rapid, remote deployment of any device, sensor, meter, or module compatible to almost all current IoT device management standards.

The platform provides data collection layers that facilitate data acquisition as well as fault and power monitoring, provisioning, configuration and remote diagnostics. For example, ecosystem partners and developers can build upon this Platform as a Service (PaaS) solution to develop or customize their applications. Developers are able to control the software deployment with minimal configuration complexities, and the Nokia Innovation PaaS provides the networks, servers, storage, OS, database and other services to support the applications. Services and applications built on top of open source technologies or provided by Nokia and its partners will enrich the service catalog of innovative solutions for vertical IoT markets. Nokia Innovation Platform is available as a service to innovators in verticals. There is no need for upfront capital expenditure in servers and wireless infrastructure as Nokia provides all the required equipment for the innovation projects. The key benefits for small high technology ecosystem partners can be described as follows (see also Appio et al. 2017; Weiblen and Chesbrough, 2015):

- Good reference to accelerate the development of business opportunity and ramp-up of new business. With Nokia, the ecosystem partners can join innovative IoT projects around the world, and deploy their technology in real life pilots. Startups can get access to the world, learn and validate opportunities and create great references that entrepreneurs can use later on. In addition, as one of the Nokia's innovation partners, the companies will benefit from Nokia's global reach, which will enable business opportunities worldwide, and can accelerate their international development.
- Global visibility among the potential customers. Nokia's registered innovation partners, startups and other companies will benefit from additional visibility: Starting with the web portal where the firm's brand will be visible, leveraging solutions featured on the portfolio, gaining visibility through various communication initiatives around projects that ecosystem builds together.
- Gaining access to complementary assets, lowering risks and gaining investments as well as achieving rapid implementation. Innovating in partnership with Nokia and other ecosystem members gives all the parties a very important advantage: Each party can focus its resources on where it will make a difference, and rely on other partners to bring in the other needed pieces.

Innovation support services (ISS). Previous studies have clearly underlined that small firms are dependent on the external partners' resources to create and exploit innovations (e.g. Spithoven et al. 2011). Many of these resources are gathered through wide variety of external search mechanisms and for example via innovation support services (e.g. Appio et al. 2017; Pellikka, 2008) such as innovation intermediaries. The objective of ISS is to accelerate commercialization and improve the innovative performance of firms via providing timely support, knowledge and capabilities to the each phase of the commercialization process. For example, startup incubators, co-working spaces, and government-funded support schemes have been increasingly ramped up to enhance innovation efforts within innovation ecosystems and especially between large companies and startups (Weiblen and Chesbrough, 2015). One example of this type of innovation support mechanism is Nokia Quja Startup Space (http://www.nokia.com/en_int/quja-startup-space), which is dedicated to build an open ecosystem at Nokia's headquarter campus in Espoo (Finland) and to create a community of techno-entrepreneurs. Quja concept is an open layout co-working space where startups can accelerate their growth efforts in an exciting environment with other entrepreneurs. Startup space facilities have been designed to enable continuous dialogue with other startups, as well as with other companies at the Nokia campus. Proximity of Nokia's R&D teams working on the same campus enable easy access to capabilities (such as Nokia Innovation Platform described above), Nokia campus events and local technology infrastructure (e.g. End-to-End demo and trial environment) that can accelerate commercialization efforts.

Invent with Nokia. Companies can actively leverage external sources as new alternatives to generate intellectual property through collecting ideas from individuals or external professionals and selecting ideas that create synergies with the existing technologies and patents. In May 2011, Nokia launched 'Invent with Nokia' (https://inventwithnokia.nokia.com/home), which is an Intellectual Property (IP) open innovation platform designed to facilitate inventive activity of inventors outside Nokia. One main purpose is to promote inventions that may be of use to develop new mobility-enabling technologies and solutions for consumers. These inventions may or may not

be covered by a patent application, a granted patent or a registered design. This concept is running on an online platform where the innovative ideas can be submitted for the evaluation in the following categories: 1) Cellular standards, 2) Wireless technologies, 3) IP and Optical, 4) Fixed networks, 5) Application and analytics, 6) Digital Health, 7) Digital Media and 8) Emerging technologies. Based on the evaluation, Nokia selects the promising ideas, supports the acquisition and management of the intellectual property rights, and then pays for the idea to the contributor. Internal experts are involved in the refining of the original ideas and the company offers financial, legal, and R&D resources to develop the selected ideas further which is a great help for the inventor to commercialize the developed asset.

***Corporate venture capital*.** A growing number of startups have considered corporate venture capital (CVC) in recent years (Park and Steensma, 2012). CVC refers to the practice of established firms taking a minority equity stake in privately held entrepreneurial ventures. For a startup, corporate venture capital helps to increase credibility on the market or to provide access to experts and specialized equipment of the corporation, such as testing facilities. It is hence not surprising that corporate venture capital funding has been shown to have a positive effect on startups, which require specialized complementary assets and/or operate in particularly uncertain environments. Consequently, some corporate venture funds position themselves as being fully independent from their parent (e.g. SAP Ventures or Google Ventures), whereas others, such as GE Ventures, stress their corporate ties and highlight the collaboration potential in common areas of interest (see Weiblen and Chesbrough, 2015). The latter approach in considered to provide more agility, effective decision-making and freedom for the decision-makers required to perform in the fast-moving venture capital market. Nokia Growth Partners (NGP) is an independent venture capital firm with one sole corporate sponsor (http://www.nokiagrowthpartners.com/). NGP actively invests in China, India, Europe and the US and focus on growth-stage investments. NGP backs entrepreneurs with companies that contribute to the increasingly connected world targeting the Connected Enterprise, Connected Car and Digital Health. The financial independence from Nokia ensures high quality investments both from a strategic and financial point of view and let NGP to actively support its portfolio companies. NGP can provide the companies it invests in access to global market through partnerships and through own networks in the US, Europe and Asia as well as directly through Nokia. The mix of operational, strategic, consulting and financial experiences offer a broad suite of support for the portfolio companies. NGP can also help in relationships with co-investors and potential acquirers as well as financial advisors. The independent set-up with Nokia is unique and extensive financial rigor is applied to every deal. NGP often assumes a board seat or board observer seat as part of the investment. NGP has done 63 investments in growth-stage companies since 2005 and 41 follow-on financings in total.

Implications and recommendations for techno-entrepreneurs and startups

The main objective of this chapter is to describe different perspectives on how a small firm, startup and/or techno-entrepreneur can create and capture value in the context of an innovation ecosystem. We have presented that innovation ecosystem members have several forms to collaborate to develop innovations by sharing capabilities, technologies, knowledge and data e.g. via platforms. Virtuous circle of growth and profitability may emerge in an innovation ecosystem where the startups and larger companies build collaboration together. Innovation ecosystem becomes a platform for fast growth for the smaller firms while the agility of the startup community can provide rapid means for larger companies for renewal (Weiblen and Chesbrough, 2015). In addition, previous studies have shown that platforms can accelerate the value recognition function of absorptive capacity and, therefore, can accelerate further diffusion of knowledge, data and knowledge acquisition and co-development among the innovation ecosystem partners (see Kokshagina et al . 2017; Clarysse et al. 2014). These activities can also enable startups and small companies to deepen their specialization while further developing their business opportunities via business concepting, business modeling, market launching and business planning (Virtanen and Pellikka, 2017). The final vital element in the ecosystem is the need for an industry leader company or a 'keystone' company. Their role is to ensure the continuous improvement of ecosystem and engage new innovative start-ups to join the ecosystem and create offerings that are compatible with the expectations of other ecosystem stakeholders, including end-users. We have provided some selected examples from the large company context on ecosystem activities with the techno-entrepreneurs and startups. These concrete examples show a wide variety of alternatives on how startups can collaborate with large companies in the context where data and knowledge-based resources play a continuously

increasing role. In addition, these examples describe how a linkage with a keystone company (often also a platform leader) can help startups and techno-entrepreneurs to overcome typical challenges during the commercialization process such as a lack of distribution channels, limited resources and other liabilities arising from their newness and inexperience (also Zahra and Nambisan, 2011). The next section will highlight the key findings and recommendation based on our analysis and the concrete examples from ICT sector.

Importance to choose the right ecosystem and the leading company. For both startups and large companies, it is important that they predetermine what they want to achieve during the ecosystem collaboration. The potential list of the targeted objectives can include for example first reference customer, proof-of-concept, real-life technology testing, joint-pilot, co-creation, funding, innovation support services, new distribution channels, etc. All of these influence the potential way of working and models for ecosystem collaboration. It is hence not surprising that corporate venture capital funding has been shown to have a positive effect on those startups, which require specialized complementary assets and/or operate in particularly uncertain environments. Table 1 lists the four key categories that can act as a framework to help techno-entrepreneurs to plan their further activities on the innovation ecosystem participation. It is important to identify all the strengths and potential limitations both internal and external (i.e. ecosystem-related) and based on that evaluation, decide the most rational and systemic approach to the existing and/or emerging ecosystems to create and capture value. In addition, entrepreneurs and managers should balance their efforts towards both external search and internal integration of knowledge to accelerate business opportunity development (see Martini et al. 2017). These findings supports recent calls in the literature that argue for the importance of understanding the dynamics in an ecosystem of value creation and capturing (see Adner and Kapoor, 2010). The ecosystem dynamics are dependent on the multiple factors. The structure of the ecosystem, role of the different stakeholders and especially the role of the leading platform company all influence the level of complexity, value creation and sharing in the ecosystem. As Autio and Thomas (2014) underlined, it is crucial to be aware of the different types of ecosystem architectures that determine for example the platform design principles of shared technological resources. Ecosystem dynamics depend on both who will be able to connect to the innovation ecosystem (i.e. activity architecture), in which roles and what the resulting value sharing will be (i.e. value architecture). Specific cases include ecosystems with multisided platform, where the platform leader can adjust the profits and losses between the ecosystem participants (Evans, 2003). To compensate the power of the platform leader, both end-users and startups can seek different strategies, (Parker et al., 2016), like multi-homing, i.e. engaging with multiple ecosystems at the same time. Multi-homing is not an easy choice for a small company due to high costs of incompatibility between the ecosystems, especially when the total market size is small (Tukiainen et al., 2014).

Capturing value via data-based view (DBV). Digitalization of the society is a key opportunity for techno-entrepreneurs and startups to successfully commercializing innovations. Therefore, accessing and effectively utilizing complementary data and knowledge-related assets in the ecosystem is a critical success factor. As pointed out earlier, many industry sectors and domains (e.g. IoT and digital healthcare) and new business opportunities are generated by an ecology of private, public and nonprofit organizations in where data and knowledge play an essential role to drive value creation, which is dispersed across ecologies (e.g. Dougherty and Dunne, 2011). In order to stay relevant in the business all ecosystem stakeholders (e.g. other startups, large companies and universities and end-users) must plan and continuously align both the inbound and outbound data and knowledge flows via pre-determined practices. In particular, the essential role of platform boundary resources has been highlighted (Eaton et al. 2015) i.e. an interface between the platform owner and innovation ecosystem partners must be well-designed to enable a seamless data flow and usage for the platform users. In practice, the platform owner can for example provide Application Programming Interfaces (APIs) and Software Development Kits (SDKs) for the startups, developers and other ecosystem partners that enable utilization of generated data for multiple value capturing purposes (also Iansiti and Levien, 2004). This is why startup and accelerator programs may be very beneficial for the techno-entrepreneurs when they create an opportunity for them to build this alignment and at the same time to co-capture value together with the ecosystem leader. The access to data and knowledge is not the only concern. All information includes also multiple direct and indirect liabilities, related to e.g. security, privacy and integrity. Data and knowledge ownership is currently rather open issue, which for a startups and small companies may turn out to be critical for a long-term sustainability. Data ownership is broader concept than access to data including also

liabilities and obligations related to the data. Data based value creation affects the related liabilities where the total added value may become also negative.

Contributing trust building in the innovation ecosystems. An industry platform requires more than technical efforts and astute decisions about design and architecture to facilitate complementary innovations. Platform leaders must establish a set of business relationships that are mutually beneficial for ecosystem participants and be able to articulate a set of mutually enhancing business models (Gawer and Cusumano, 2014). Key enablers of trust building within ecosystem environments include complementarity of obligations over the product lifecycle, differing perceptions of obligation fulfillment, and balance between value creation and community values. On top of the co-creation activities, programs, etc. startups have to maintain and improve their professional way of working that enhance their brand as a reliable and respected ecosystem member. One effective way to enable this is to utilize structured routines and standardized process for identifying and systematically developing relationships with the other ecosystem members. Due to the assumed cultural differences, the different ways of working and the dynamic market changes mean that the capability to be able to react to sudden changes and emerging requirements is an important element also for trust building among the ecosystem partners. The platform leader has a specific role in building trust within the ecosystem. They monitor the health of key capabilities among the startups and stimulate large firms and incumbents to continue investments in technologies and commercial infrastructures which these start-ups can leverage (e.g. Clarysse et al. 2014). Ecosystems may choose to operate with different, or sometimes even with multiple trust models. In general, open innovation activities in the innovation ecosystem call for specific sensitivity to the relationships between the stakeholders (Ali-Vehmas, 2016). Central in this respect is the increasing importance of the business model alignment for innovation within firms, since it finally determines which external data and knowledge can be utilized and which internal knowledge will not be usable to accelerate business opportunity development and commercialization. Trust is an excellent proxy to study this alignment in practice. Through trust alignment, other rather practical matters such as active management of external research and external paths to market as well as an active management of intellectual property can be organized in profitable and sustainable way for all stakeholders in open innovation (see also Van de Vrande et al. 2010). Hence, realizing the potential benefits via ecosystem, platform-based and/or open innovation requires a specific mindset and needs an expanded set of capabilities within startups as well as in other organizations.

Although our study provides the latest insights on how techno-entrepreneurs can formulate their innovation ecosystem strategy, several very interesting and essential elements of this research area are still waiting for the future research efforts. From this perspective, we propose that future research on the innovation ecosystem studies and especially when related to techno-entrepreneurs and startups should focus on the concrete benefits to firms participating in a specific ecosystem setting, as well as the data-based view and knowledge flows between the ecosystem members (see also West and Bogers, 2014) for value creation. It is essential to elaborate the detailed value creation dynamics (Autio and Thomas, 2015) and to understand how the ecosystem creates and delivers value, how the value is increasing sequentially and how it is distributed along the value chains and networks. Therefore, we also recommend that the forthcoming studies could examine the role of interfaces, structure and architecture of the ecosystems, and how platform design might focus the attention of innovators onto specific trajectories of technological change (also Snowden, 2002).

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