Innovation Processes in Business Ecosystems: Creating a Common Understanding by Requirements

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***Abstract*--In established supply chains, companies use specific requirement standards to coordinate product development activities. In recent years, companies like Apple and Google have focused on creating and controlling business ecosystems that integrate actors also from other industries in their innovation processes. These ecosystems are characterized by a different way of communicating requirements necessary to achieve successful collaboration in a joined innovation process. In this paper, we endeavor to identify those factors which emerge as important in how requirements are communicated in the ecosystem setting to provide stable and predictable operations. To this end, we explore four ecosystems displaying different product innovation traits and seek the variables that determine the manner in which requirements are communicated in business ecosystems. Our explorative work leads to central propositions, which we offer as the focus of future extensions of our work.**

I. INTRODUCTION

Organizations that make the transition from the supply chain context to a business ecosystem need to review how product requirements are defined in this new setting. It is essential for the ecosystem leader to understand what possibilities exist to guide other actors to achieve the expected product or product idea. Recent years have been marked by the emergence of a number of new business ecosystems, because of the potential to deliver greater value to the customer through the collaboration of a host of actors. The value enhancement of traditional products such as cellular phones through app development in the Apple or Google Android ecosystems is testament to this strategy. The overarching question we would like to answer is how these keystone firms organize their respective business ecosystems in relation to requirements that are communicated to ecosystem actors, to assist their product development efforts.

Our objective is therefore to understand the interaction between the keystone company and the host of actors that form the ecosystem in relation to product requirements. In an explorative approach we decided to select two cases of well-known companies from the ICT industry, namely Apple and Google, and two cases from other consumer product industries, namely Local Motors and Lego. The case studies describe, first of all, the ecosystem leader itself, and second how the business ecosystem has been established. However, our focus is on the product requirements that are communicated by the keystone organization to other actors in the business ecosystem, which we explore in our case studies. By comparing these diverse set of cases, we establish the common elements that characterize these ecosystems and in turn determine seminal differentiating factors. We highlight the latter as having some level of explanatory power of how product requirements are communicated in different business ecosystem settings, and subsequently offer two preliminary propositions that we believe can guide future research.

The structure of the paper is as follows. First of all, we give a theoretical background to business ecosystems, describing how they develop, and listing success factors that may exist, such as the ability to create niches and opportunities for new firms [20]. Second, we take a closer look at the theoretical background of product requirements. After providing our theoretical framework, we describe the research method, and then elaborate on the cases. The paper closes with a discussion of the commonalities and differences in the business ecosystem cases, leading to our propositions and ideas for further research.

II. THEORETICAL BACKGROUND

A. Business ecosystems

Business ecosystems are economic communities that include customers, lead producers, competitors, and other stakeholders supported by a foundation of interacting organizations and individuals [28]. These ecosystems come together in partly an intentional, highly self-organizing way, and partly an accidental manner [29]. Because of their ability to adapt, business ecosystems develop through the processes of emergence and coevolution [34]. Examples of business ecosystems include the semiconductor lithography ecosystem [4] [5] [22], the PC (personal computer) ecosystem [14] [17], and the Firefox browser ecosystem [40].

Ecosystems might consist of a wide array of firms, which can be classified under some generic types of members. The most essential member of an ecosystem is the 'keystone', which is a vital species in the case of biological ecosystems and also a central member in the case of innovation ecosystems [20]. The keystone, also referred to as platform leader [14] or ecosystem leader [28], plays the role of regulating the overall function of the ecosystem, defines the rules and as a consequence its actions influence the success of all other members. Even though keystones exert substantial power within a given ecosystem and command a greater share of the overall profits [30], they represent only a small biomass or population of organizations of that ecosystem [20]. Firms such as Wal-Mart, Microsoft, Apple, and Mozilla have been crucial keystones to their respective ecosystems, ensuring the continued development of the ecosystem [20] [14] [40] [30]. The key to the success of these firms has been

their ability to provide platforms (e.g. tools, technologies, manufacturing processes, and services), which other members of the ecosystem could utilize in developing their own offerings. For instance, Microsoft's operating system platform has enabled a large number of software developers to create programs for Windows [20], while Mozilla and Apple have similarly built vast ecosystems around the Firefox browser software and iPhone operating system (iOS), respectively, resulting in thousands of add-on extensions and apps [40]. The keystone strategy involves the creation of value, and in turn, the sharing of the created value with other member of the ecosystem. By creating and sharing value, the keystone firm is able to subscribe and retain other firms within the ecosystem, which is vital for continued ecosystem development [30]. Moreover, the objective of keystones is to provide stable and predictable operation within the ecosystem. To ensure a well-functioning ecosystem, Wal-Mart, for example, has implemented a procurement system that enables suppliers to access information concerning demand quantity and variety [20].

The keystone is supported by 'niche players', which form the great majority of the ecosystem and generate the largest portion of innovations as well as the created value. Whether in biological or business ecosystems, niche players have specialized functions which contribute toward the holistic function of the ecosystem. Their specialization also helps them differentiate from other members of the ecosystem. The role of niche players in the ecosystem often means that they are also 'complementors' who help the keystone expand the realms of its application. For example, Intel and Microsoft are platform leaders in the PC ecosystem because they assume great authority in the architectural design of the PC system and subsequently govern a plethora of complementors (i.e. firms offering complementary technologies), which produce platform-specific hardware and software products [14].

Although different theoretical perspectives have been taken to describe the network of organizations [37] [13] [15] [39] [27] [12], the business ecosystem framework offers a different analytical lens. The ecosystem firstly represents the environment of the firm, which crosses over different industries. For example, Apple is the member of an ecosystem that crosses over the PC, consumer electronics, and information and communication industries [30]. The ecosystem framework therefore provides a view of the firm's dynamic business environment formed by technological innovation linkages rather than through membership to a specific industry. Secondly, business ecosystem keystones install not only cooperations with other companies but also create whole business models for other actors in the business ecosystem. Innovation ecosystems also emphasize objective orientation and the life cycle of the network of firms, coevolution among its members, and the role of different actors that comprise this network. Unlike alternative scientific approaches which see the network as a static entity, the business ecosystem model emphasizes the change dynamics (from the analogy of biological ecosystems) that exists in the network, and in turn, the strategic implications that such dynamics can have on member organizations [30] [20] [14]. An important issue that arises in this development is the way to integrate new actors (individuals or organizations) into the innovation process of a business ecosystem.

Iansiti and Levien defined three critical success factors for a business ecosystem. First, the productivity as the success factor for any business, second, the robustness to survive inside and outside shocks and third the ability to create niches and new opportunities for new firms [20]. Moore believes that keystones are an important success factor for business ecosystem. "The key to a business ecosystem are leadership companies, 'the keystone species', who have a strong influence over the co-evolutionary process" [28]. This means that keystones have to be proactive to give the community a common direction, which is valued by the community. In our paper we focus on business ecosystems with such a keystone defining the rules of the ecosystem. One instrument to give a community a common direction is to establish requirements.

B. Requirements

A requirement is a statement of the characteristics and performance of a product, a part of a product, a process or the person involved in the process [38]. In this sense, requirements are the "preconditions, a person or a system need, to solve a problem or to reach a target" [4]. Especially in collaborative innovation processes for the development of complex products or systems, requirements help to create a common understanding [6]. The quality of requirement definitions, especially at the beginning of a project, influences significantly the success of a project [7].

Even though most of them are technical, in requirements not only technical issues are covered. The brand-owning company of the final product e.g. is interested to influence the several attributes of the product developed in the innovation process as early as possible. A company in the premium segment can sell its top branded products with a price premium compared to normal products [3]. Brand equity itself consists of four dimensions: the brand loyalty, brand awareness, perceived quality of brand and brand associations [1] [2] [23]. The dimension being regulated by requirements is the perceived quality as the "consumer's judgment about a product's overall excellence or superiority" [44]. Therefore, the brand-owning company has to make sure by requirements that the partners in the business ecosystems share their brand understanding of design, functionality, ergonomics, reliability, quality and performance.

Quite often leading companies in ecosystems possess industry product platforms to ensure their business case. Apple, for example, provides as product platforms a hardware platform (iphone) and a software platform (iOS) as well as a development platforms for app developers. An App cannot be developed and used without these platforms.

Product platforms are defined as a "collection of modules or parts that are common to a number of products, and this commonality is developed intentionally to attain certain effects" [19]. Based on a product platform, the development of new products can be simplified which might increase the development time and might decrease the development costs. Both allow a greater product variety [31] [32]. As product platforms become a part of the final product (e.g. iphone + iOS + App) companies providing these platforms have to put some effort in defining the requirements of the interfaces between the product platform modules and the variant parts.

Development platforms offer "tools and rules to facilitate development, a collection of technical standards" [10]. Like at toolkits [35], development environments can be seen as economical tools for open innovation – most of the tools are internet based attracting a big amount of potential actors [36]. The idea is to move the trial and error process from the company to the actor [16] [41] [42]. The keystone offers necessary solution information to the actors, like programming language or tools. Therefore, the toolkit / development environment enables the actor to participate actively in the innovation process of the keystone [35].

III. RESEARCH METHOD

We aim to understand how business ecosystems create value through collective effort, under the guidance of a keystone organization. More specifically, our objective is to identify common proceedings as well as differences in the management of business ecosystems by looking at the requirements given by the keystone organization to other actors within the ecosystem. For this explorative approach, we felt it most appropriate to undertake a qualitative study by examining a number of cases, as we aimed to understand contemporary events, where we have no control over the actors [43], and to understand in detail how the leading companies manage their business ecosystems.

We selected two well-known companies in the context of ICT and two other companies in the context of consumer product development, which have years of experience as keystones of their respective business ecosystems. All four cases highlight the participation of numerous actors in the innovation process and the role of these actors as "idea contributors".

In this paper, we analyzed the role of requirements in the coordination of keystones and other actors. Therefore, we gathered data from the Internet pages of the selected companies. First of all by entering the business ecosystem specific web side of the keystone (e.g. Apple developer web side) afterwards to sign up as an actor of the business ecosystem to retrieve all given information's [43], especially guidelines like: acceptance criteria, accepted topics, human interface, shape; Requirements: technical, language, platform; House rules. Furthermore, papers and studies about the leading companies were analyzed by comparing the companies' background, the differences of the business ecosystems and their information and requirements given to the actors to come up with comparable data for the case studies. The development of these companies were reviewed with respect to aspects like financial performance indicators and company acquisition activities to get a broader overview of the company itself and the information being offered to the actors in the business ecosystem. With this collected information, we identify with the help of a cross case data analysis patterns of the way how keystones use product requirements to guide other actors within the ecosystem.

IV. CASE STUDIES

We describe each case in three sections. First of all a short company description is given, second the business ecosystem of the company in relation to its main actors is analyzed, and third the requirements given to the actors in the business ecosystem is described.

A. Apple (iOS)

Apple originally came out of the computer and software industry, gaining its major revenues from software and hardware devices. Nevertheless, Apple revolutionized the sector of mobile device, popularizing today's Smartphone business, not by enhancing the quality of telephone communication but by adding new functionality to the telephony experience through the availability of a plethora of additional application software (i.e. apps). In 2013, Apple acquired $10 billion revenue from its Apple App Store that enables users to purchase and upload software onto their Apple smartphones [8].

To create a greater variety of software products Apple created a new business ecosystem integrating actors in the development process. The emergent ecosystem is characterized by a large number of actors that are software developers (i.e. a software company or an enthusiast), which are part of the whole innovation process from the idea to realization. Apple nonetheless does the product launch. The intellectual property stays with the actors. The revenue within the business ecosystem is shared at a ratio of 70% to actors (e.g. software developers), and 30% for the keystone organization [9], Apple.

What is important from Apple's perspective is that the app looks and feels like Apple. Clearly defined requirements are subsequently an important instrument in the overall innovation process. What this means is that Apple establishes the developer's environment, providing toolsets and databases with software and human interface modules – in line with the anticipated role of the keystone. Before starting development, the software company receives from Apple a detailed description of this process from the start to the commercialization of the app. The goal of the app is clearly defined as an added value to the costumer. The technical requirements are given from the beginning with respect to the operating system (i.e. the platform) with detailed guidelines. The actor chooses one of Apple's devices for which the app

is to be designed and developed. Furthermore, Apple provides specific descriptions of human interface requirements to ensure that the look and feel of the Apple experience is preserved. Ergonomic requirements such as size of buttons are illustrative of human interface elements. Requirements for functionality are also given in a user experience guideline, which is intended to support the development of the app. And finally, guidelines concerning quality and the acceptability (For instance, undesired topics like war or religion are not accepted by Apple) of apps are provided. To ensure that Apple's philosophy, Apple decides whether an App is accepted and can be sold in the Apple App Store or not.

B. Google (Android)

Google is a global player having its origin as a service provider in the internet industry. A major percentage of their revenues is generated by advertisement. In 2005, Google bought Android, and in 2007 the open Handset Alliance under the lead of Google, together with 33 companies was founded to develop a mobile device operating system named Android. Today the alliance has 77 partners [33]. The goal is to have Android spread as wide as possible. About 80% of today's mobile devices work with Android [21].

The goal of the Android business ecosystem is similar to that of Apple's iOS, which is to enable the end-user's access to a vast number of apps for all devices working with Android. The scope of delivery is therefore software that is developed and ready to be sold to the user. The Android ecosystem constitutes actors that capable of developing software. These actors are part of the whole innovation process from idea generation until the realization of the idea in the form of an app, but unlike the actors in the Apple ecosystem, they are able to make decisions concerning the launch of their apps independent from Google. It is not necessary for software developers to use Google Play Store to launch their apps. The intellectual property is also retained by the actors and not owned by Google. The transaction fee, which has to be paid for apps being sold by Google play is 30% for Google. The transaction fee might differ depending on the apps stores used to sell the app.

In Google's keystone strategy, the idea of platform development is even stronger than in the Apple ecosystem as the software platform Android is offered to different hardware platform producers (HTC, Sony, Samsung, LG etc.). The software developer gets a good development environment with toolsets, a development platform, as well as modules to be used to support the development of the apps. The requirements given to the actor also differ strongly between Apple and Google. The initial situation and the goals to be achieved are clearly defined as seeking unique features for the end-user. The technical requirements are also given in detail. Decisions concerning the device or display size with which the app should function belong to the actor, and moreover, the app may be used in different devices when developed by different companies. Requirements concerning shape, design, and the human interface are not described in detail however, with examples given in the absence of company specific needs. Functionality is described as added value with no concretization and ergonomic aspects are mentioned in some examples. Finally, there are no requirements concerning the acceptance of an app, meaning that Google does not specify conceptual topics that should not be addressed in the app and the functionality of the app is not tested.

C. Local Motors

Local Motors is part of the automotive industry with one big difference to the other OEM (original equipment manufacturers i.e. automotive companies) - only about 59 people are employed in the company. Nevertheless, the aim of Local Motors is to design, construct, and build cars for the end-user. To achieve this goal the company employs a new way of automobile development, namely, working in collaboration with actors that form a business ecosystem. The goal of this business ecosystem is based on the idea of open source, of information exchange, and the permanent evaluation process by the community of members. The scope of delivery is a developed part of the car ready to be built. More than 100 products have been developed, but only one product per purpose. Local Motors describes the actors in the ecosystem as designers, engineers, fabricators, and experts [26]. The actors contribute their knowledge to the innovation process depending on their expertise [11]. Designers design the exterior, then the engineers develop different parts of the car, and so on. The launch of the product is done by Local Motors. The earnings of the ecosystem actors depend on whether they was able to find the best solution for the product or not; the first three winners receive approximately $1000.

To support the actors during development, data from interface components are offered, as well as a hardware platform and interface information. Additionally, tools for easier construction is ready for use as well as a platform to exchange data. The starting point of each round of the development process is clearly described, for example, defining it as a design task or development task. Subsystems necessary for the development effort have clearly defined interfaces and requirements of the system. Data from interface components are also given. In the different challenges the framework concerning shape, design, and the human interface are given by Local Motors, but mostly decided upon by the community of actors. The requirements concerning functionality were clearly described as well as the ergonomic aspects. The quality is ensured by the open source community, although decisions centering on solution selection belongs to the company and not the open source community.

D. Lego Cuusoo

Lego is a leading company in the toy industry, gaining its major revenues from its famous products of small, plastic bricks with which cars, cities, and fantasy worlds can be

built. Lego Cuusoo is an online platform (a website) [25] where people from all over the world can make their ideas of what to build with Lego's famous bricks. As a result, an ecosystem of actors converge upon Lego's platform.

The goal of this business ecosystem is simply described as finding new ideas. Ecosystem actors (i.e. enthusiasts) create product concepts, which are then shared with the people on the website. However, the actor is only involved at the beginning part of the innovation process that includes the idea phase and the evaluation of the product idea which determines whether the concept will be liked or not. The rest of the innovation process is done by Lego. Interestingly, ecosystem actors receive only a revenue of 1% of the total net sales of the product.

A detailed description to start the project is not necessary and anybody can start a project when they have a great idea. There are neither development tools nor platform requirements offered to the developer. Platform requirements do inherently exist, however, because only ideas built on existing Lego bricks will be accepted. So, color and shape of the bricks are set. Concerning functionality, actors are required not to build already existing theme-based products. Hence, the idea should be standalone [24]. There appears to be a large emphasis on quality, which are firstly addressed by not accepting controversial topics, such as those related to drugs and politics. The quality of the product is also ensured by the definition that only Lego bricks are allowed for the ideas. Further, the first acceptance decision is not done by Lego, it is done by the uses of the internet page Lego Cuusoo. Only ideas with at least 10.000 user votes a project is taken in consideration by Lego for further evaluation.

V. DISCUSSION AND CONCLUSIONS

Our case selection allowed us to compare the product development intricacies in different ecosystem settings. The four cases differed with respect to a number of variables, such as the type of product that is developed by actors in the ecosystem (e.g. software and hardware), the size of the ecosystem with respect to the number of actors, the industry of the keystone organization, production characteristics (e.g. high or low volume of output), and the sharing of revenue among the keystone and other ecosystem actors. Through the exploration of these cases, our intention has been to divulge some of the differentiating variables that may determine the mode of product requirements in business ecosystems, where the focal, keystone organization collaborates with multiple actors in the network that do not lie on the direct path of value creation.

From the analyzed cases, we identified several types of requirements communicated by the keystone organization to other members of the ecosystem. For the reader's convenience, we classified them into three generic categories of requirements (s. Fig 1): strategic, brand, and platform requirements. The keystone's strategic requirements include setting goals for the partners that align with a central vision, or technical requirements that ensure particular function that essential to the systemic product the customer will acquire. For brand requirements, we identified several methods through which the keystone (e.g. Apple) is able to sustain its brand image. Quality of the product, ergonomic design, and also certain acceptance criteria – all exemplified in Apple's ecosystem leadership – that play a role in preserving brand reputation. And in the third category of platform requirements, the figure lists keystone activities such as providing databases, tools and toolkits to complementors that ease the design and development of products. By communicating these requirements to the ecosystem actors, the keystone organization, in collaboration with other actors, is able to innovate products.

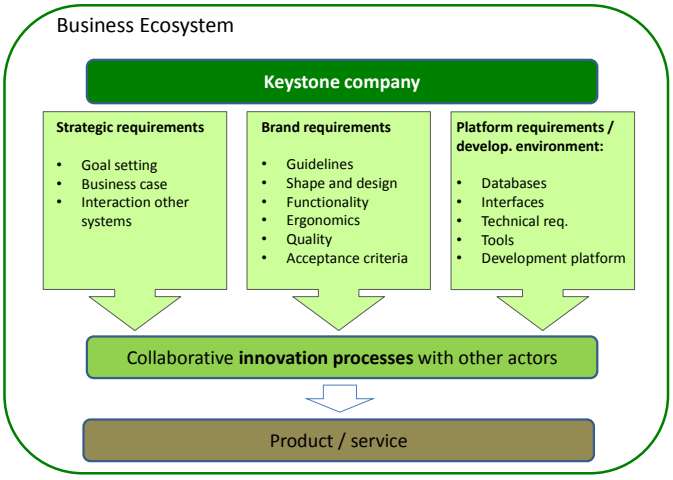

Figure 1: Requirements influencing the innovation process in business Ecosystems (Adapted from [18].)

When comparing the results of our case studies some repeating elements emerged. Namely, these are the platform requirements, referring to the provision of a platform and the tools (or toolkits) by the keystone organization to their collaborators. This appears to be a minimum requirement in the keystone's strategy to manage the innovation process in the ecosystem, as also echoed by ecosystem scholars in the literature. By providing a technical platform (e.g. and operating system, website, or product architecture), the keystone ensures that the complementary products developed by other actors in the ecosystem can work in conjunction with the keystone's own product. It is only through this collective function that the customer can gain greater value from the usage of the systemic product. At the same time, the platform, together with toolkits, assist complementors design and manufacture their products. In some way, we observe the platform and supporting toolkits to provide implicit product requirements to the ecosystem actors.

Secondly, we observe a couple of interesting factors that differ with respect to the nature of the ecosystems, which we believe will have an influence on the manner in which product requirements are managed. One of the emergent

factors from our case studies is the degree of involvement of the ecosystem actors in the holistic innovation process. When we compare the case of the Apple and Google cases, we witness that the involvement of software developers in the innovation effort is slightly shorter in the former with respect to the latter. Product launch and ownership of intellectual property is governed by the keystone, Apple. By contrast, Google affords greater ownership to its ecosystem collaborators. This factor is more pronounced in the case of Lego Cuusoo, whereby complementors are involved at the very outset of the innovation process, after which the keystone takes responsibility of developing and launching the innovation. We anticipate that the greater involvement of complementors in the holistic innovation process will necessitate the communication of more explicit requirements by the keystone. This is because complementors essentially own a greater portion of the innovation effort and subsequently work more autonomously in producing complementary products. To avoid the lack of functionality with the technical platform, the keystone is compelled to provide elaborate requirements at the outset. By contrast, in ecosystems where the contribution of ecosystem actors is for a brief period (e.g. Lego Cuusoo), the keystone is less likely to demand strict requirements as the latter owns a substantial portion of the innovation process and has greater internal control over the final stages of product development. This issues underlines the centrality of the innovation process to how requirements are managed in ecosystems. For instance, with respect to the phases of innovation, keystone organizations that design the ecosystem to integrate complementors only for the ideation process are, we believe, more likely to allow these actors freedom in their contributions. We subsequently make the following preliminary proposition:

Proposition 1: The more phases of the innovation process a complementor is involved in, the greater is the control over the management of requirements by the keystone.

While we promote future studies to investigate this proposition, our explorative work provides some tentative support for our anticipation. For example, the interest of Lego in the idea generation phase means that there is essentially no technical platform upon which other actors should develop their products (or ideas), and nor is there any restrictions imposed by the keystone. Any requirements of the complementors' product lie predominantly on quality. When reviewing the Apple ecosystem, however, we observe that there is greater elaboration of product requirements for actors that are engaged from the beginning until the launch phase of the innovation process. They receive, for instance, a detailed set of guidelines concerning Apple's operating system platform, which acts as a set of technical requirements, thereby limiting design and development efforts. This is further illustrated in the case of Local Motors, which shows that clear technical and interface requirements provided to developing actors can lead to finished products [24].

A second variable that emerged from our exploration as likely to have an impact on requirements management is the volume (or variety) of products that are innovated by the ecosystem. For example, the number of products (i.e. apps) developed in the Apple and Google ecosystems is very large, while the case is quite the opposite for the ecosystems of Local Motors and Lego Cuusoo, which produce much smaller numbers of products. Our anticipation, following the logic prescribed by operations management literature, is that as the number of innovations developed by the ecosystem decreases (i.e. a transition towards low volume, high variety production), there should be a burgeoning focus on the quality of the innovations, which is demanded by customers. On the contrary, for ecosystems that are characterized by higher number of products developed by the host of complementors, we would anticipate a focus on other requirements features, such as technical requirements of platform provision. We therefore offer the following proposition:

Proposition 2: The lower the number of innovations produced by the ecosystem, the more likely that quality will be emphasized by the keystone in its product requirements management.

Our examined cases lend some support for this preliminary proposition, although we advocate more in-depth analyses of a sufficient number of business ecosystems to add further verification in future studies. The Apple and Google cases illustrate that the respective keystone organizations emphasize functionality and technical aspects of the apps that are developed by ecosystem actors. The quality of the apps, while no doubt important, do not receive a high level of significance as the focus of the ecosystem is on delivering a vast range of value adding products for the customer. On the contrary, Local Motors and Lego Cuusoo ecosystems are marked by a much lower number of innovations, and as stipulated in the case descriptions, quality of the products emerges as a central theme. In fact, in both cases we observe the engagement of the ecosystem members in deciding on the worthiness of the created innovations, together with the keystone organization.

The objective of this paper has been to bring to light the key elements of business ecosystems that are likely to influence the nature of requirements management. To this end we have employed an explorative approach by studying four cases. In this methodological approach our empirical work has been limited by the number of cases that can enhance our understanding of the issues at hand. Nevertheless, the results of our work allow us to derive two propositions that are intended to form the focus of continuing research, which should concurrently address the limitations of the present study.

We believe that our work has strong implications for organizations that make the transition from the traditional supply chain context to a business ecosystem, and need to review how product requirements are to be defined in this

setting. Our preliminary work suggests that these organizations need to take into account the significance of platforms and toolkits in enhancing the innovation effort of collaborators, and ensuring the functionality of holistic products delivered to the customer. Furthermore, we propose that organizations need to consider the degree of involvement of complementors in the overall innovation process as well as the scope of products developed by the ecosystem in devising requirement management strategies.

Remark: This is partly based on a previous paper presented on ICE Conference Munich, 2012 [18].

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