BEYOND INNOVATION CONTESTS: A FRAMEWORK OF BARRIERS TO OPEN INNOVATION OF DIGITAL SERVICES

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Abstract

Recently, the interest in the innovation of digital services based on open public information (i.e. open data) has increased dramatically. Innovation contests, such as idea competitions and digital innovation contests, have become popular instruments to accelerate the development of new service ideas and prototypes. However, only a few of the service prototypes developed at innovation contests become viable digital services. In order to strengthen the role of innovation contests as innovation instruments, we propose a framework of innovation barriers to open innovation of digital services. The framework has been designed using a systematic research approach including a literature review of existing barriers, an online survey with participants before an innovation contest, and systematic follow-up interviews with teams participating in the contest. The framework consists of 18 innovation barriers and is intended to be used when organizing innovation contests. It supports the process after the contest when prototypes are transformed into viable digital services. For future research, we suggest the framework to be validated in a longitudinal study involving additional cases. Furthermore, we suggest using the framework as a starting point for constructing guidelines that can help in designing innovation contests.

Keywords: Open Innovation, Innovation Contests, Innovation Barriers, Digital Services, Open Data.

1 Introduction

Novel digital services (e.g. e-services, digital platforms, and mobile apps) can be innovated through closed or open processes. In the latter, organizations may invite developers outside the organization (i.e. open data developers) to pursue innovation driven either by non-profit motives (Kuk and Davies, 2011) or commercial opportunities (Ceccagnoli et al., 2011). In recent years, open development of digital services has been catalysed through the provision of open data. The reason for distributing data in a more open fashion is to stimulate innovators outside the organization in order to design digital services that go beyond what existing ones provide (Boudreau and Lakhani, 2009). However, as organizations adopt such a distributed way of pursuing innovation, they simultaneously risk losing control of the innovation process. To address this issue, Füller et al. (2006), Bullinger and Moeslein (2010), and Hjalmarsson and Rudmark (2012) propose innovation contests as tools to both stimulate

open innovations and retain some control of the innovation process when it is distributed to a larger community of developers.

While innovation contests are becoming ever more popular, experiences indicate that only a limited number of the results developed during these events become *viable* services or products. Becoming viable means that a prototype developed in an innovation contest is transformed into a digital service that reaches the market, receives a critical user base, and fulfils the organizational goals of the contest. Currently, there is little statistics available on the level of success of digital innovation contests. However, Table 1 provides the level of success for three digital innovation contests in Sweden, expressed as viable digital services available one year after the contests as a percentage of the total number of prototypes developed. In total, the contests yielded 42 prototypes based on open governmental and open commercial data. After one year, 24 per cent of the contributions were available as digital services but only four had transformed into viable digital services and attracted a significant user base[1]. This corresponds to a total level of success of approximately ten per cent.

Name of Digital Innovation Contest	No. of prototypes developed	One year after		
		Accessible digital services	No. of viable digital services	Viable Service Percentage
CODEmocracy 2010	12	3	1	8 %
Appening 2011	10	2	0	0 %
WestCoast TravelHack 2011	20	5	3	15 %
Total	42	10	4	9,5%

Table 1. Viable digital services one year after three Swedish innovation contests.

An unresolved question is hence why so few prototypes developed at innovation contests are actually transformed into viable digital services after the contests. One way of addressing this question is through the barrier approach to innovation, which has gained considerable attention (Bond and Houston, 2003; D'Este et al 2012; Hadjimanolis, 2003; Pikhala et al., 2002). However, so far little is known about innovation barriers related to services developed in digital innovation contests. Innovation barriers are defined as constraints or factors that inhibit innovation, e.g. lack of time and funding, resistance to change, lack of key competences, and hindering government regulations. Lee et al. (2010) studied the role of intermediaries to support innovation and they identified a number of factors that restrain innovation. A distinction can be made between actual and perceived barriers, where the latter are the subjective judgments that people make about the presence and severity of a barrier. Most work on innovation barriers has focused on perceived barriers, typically for methodological reasons. While this focus can be seen as a limitation, it should be acknowledged that perceived barriers can be just as inhibiting as actual ones in the sense that they often cause people to refrain from developing and adopting innovations.

While existing work on innovation barriers has provided valuable insights, it has as yet not addressed domains characterized by 1) digital innovation, 2) commercial and non-profit motives as drivers 3) open data, 4) innovation contests. The relevance of the existing theory to explain why so few prototypes from innovation contests are transformed into viable digital services can thus be challenged. Consequently, the research question addressed in this paper is: *what barriers inhibit the development of viable digital services from prototypes generated at digital innovation contests?* The reason to study barriers is to provide the basis to further investigate how open innovation processes can be designed, from contest to viable digital services. This will provide new findings, which not

[1] In this compilation counted in downloads, ranged from 1,000 to 10,000 downloads.

only expand the knowledge base on IT and openness but also provide practical insights into organizing open innovation of digital services.

In chapter two we describe the theoretical framework for innovation barriers and in chapter three we describe the case. In chapter four, we describe the research process designed to empirically investigate the barriers developers perceive when transforming prototypes to viable services. In chapter five, we present the results from the empirical studies: Finally the results are discussed and conclusions are drawn and suggestions for future research are made in chapter six.

2 Theoretical Framework

Traditionally, innovation has been perceived as a linear process of sequential events from research and idea generation to commercialization (Booz, Allen and Hamilton, 1983). The linear process model has been questioned due to its lack of feedback loops and its presumption that research precedes innovation. Kline and Rosenberg (1986) argue that feedback from, for example, sales figures and end-users are necessary in order to evaluate performance and to formulate next steps forward. Furthermore, the central process of innovation is design rather than science and, therefore, most innovation is performed on the basis of the knowledge of the people involved in the innovation process. Thus, a process model of innovation also needs to include feedback loops. The chain-linked innovation process model (Kline, 1985) is a simultaneous model comprised of elements such as research, invention, innovation, and production as well as five different pathways for innovation processes through these elements. A third model of innovation has emerged that includes internal interaction between departments and external interaction between the firm and its customers, partners, and suppliers (Rothwell, 1992). This model was further developed into open innovation (Chesbrough, 2003), where organizations innovate with partners to share risks and rewards. A prime rationale for this model is that firms no longer can rely solely on internal knowledge but need to complement it with external ideas for innovation.

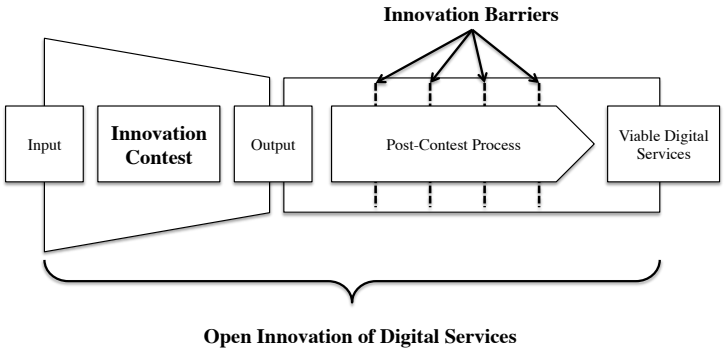

Figure 1. Key components of the theoretical framework

The theoretical framework in our study is based on the third model of innovation currently emerging and its consequences in the development of digital services based on open data. It includes the following key components (see Figure 1): *open innovation of digital services*, *innovation contests*, and *innovation barriers,* as perceived after the contest, when transforming prototypes from a contest to viable digital services.

2.1 Open Innovation of Digital Services

There are two complementary forms of openness in open innovation (Chesbrough 2011). In the *outside-in* form, the initiator of open innovation (e.g. a company) unlocks its organizational borders to make greater use of external ideas and technologies. Openness of this kind means that the open innovator welcomes external contributions (e.g. customer ideas), but thereafter decides which ideas to

pursue by selecting the ones to transform into products. The other form of openness is labelled *inside-out*. This kind of openness refers to situations in which the initiator of open innovation unlocks its own resources so external actors, e.g. developers, can use them. These can then use the resources to develop products and services without adhering to the organizational and/or individual goals of the initiator of open innovation (Chesbrough 2011).

An example of the inside-out openness is organizations that provide open APIs to developers external to the organization. A digital service generated from this form of distributed development could after the contest either become viable outside the organization that provided the open data, or become a part of the digital service repertoire within this organization. Gassman and Enkel (2004) describe the latter scenario as one of three process archetypes for open innovation. Used on the domain of digital service design, this archetype means that the development initiative gradually moves back inside the data provider again, after external knowledge has been used to speed up the innovation process. This means that the organization providing the open data has to either procure or license the use of the digital service from the third-party developer. In the former scenario, the external digital service developer alone exploits the digital service separated from the realm of the data provider. In addition, Gassman and Enkel (2004) provide a third archetype labelled coupled processes. In such processes, the open service developer joins forces with the data provider in a common pursuit and exploitation of making the digital service viable. This means that a coupled outside-in and inside-out process is established to continue the development of the digital services through working in a business alliance.

2.2 Innovation Contest Concepts

There are a number of different concepts to use to actively boost open innovation. Concepts utilizing contest as the driver has evolved from 2000 onwards: e.g. *idea contest* (Piller and Walcher 2006), *community based innovation* (Füller et al 2006; Bullinger et. al. 2010), *online innovation contests* (Bullinger and Moeslein 2010), and *digital innovation contests* (Hjalmarsson and Rudmark 2012).

According to Piller and Walcher (2006), the value with an idea contest is that the contest provides a mechanism by which users can transfer innovative ideas to a firm, which then can transform them into an expanded repertoire of products and services. Compared with the discussion above about the different forms of openness the use of an idea contest therefore resonates with the *outside-in* form of open innovation described in Chesbourgh (2011). This as this form of openness in innovation means that the organizational borders are opened with the purpose to bring in new ideas to the initiator of the open innovation process. One core challenge of organizing an idea contest is consequently to incentivise users to provide innovative ideas (Piller and Walcher 2006). Füller et al (2006) provide, through the concept community based innovation, support for how to identify, access and interact with lead users in online communities in order to stimulate valuable input at different stages during the innovation process (Füller et al 2006). The concept of idea contest is also expanded further in Bullinger and Moeslein (2010) who based on a review of different idea contests distinguish ten key design elements to address in idea contest design (see Table 2).

Design Elements	**Attributes**					
Media	Online		Mixed			Offline
Organizer	Company		Public org.	Non-profit		Individual
Task/topic specificity	Low		Defined			High
Degree of elaboration	Idea	Sketch	Concept	Prototype	Solution	Evolving
Target group	Specified		Unspecified			
Participation as	Individual		Team			Both
Contest period	Very short		Short term	Long term		Very long term
Reward/motivation	Monetary		Non-monetary			Mixed
Community functionality	Given		Not given			
Evaluation	Jury evaluation	Peer review	Self assessment	Mixed		

Table 2. Elements when organizing an idea contest (based on Bullinger & Moeslein 2010)

A *digital innovation contest* is another concept to drive open innovation. It is defined as "an event in which third-party developers compete to design and implement the most firm and satisfying service prototype, for a specific purpose, based on open data" (Hjalmarsson and Rudmark 2012, p.2). In this paper, we use an extended version of this definition to include contests based on any type of digital resource, not just open data but also resources with more restricted access to e.g. technical platforms. We see this extension necessary as many firm-sponsored contests may offer resources that fall outside the scope of open data (c.f. Open Definition (2009)).

The digital innovation contest resonates with the *inside-out* (Chesbrough 2011) or the coupled form of open innovation (Gassmann and Enkel 2004). The reason for this is, as described in section 2.1, that the organizer of the digital innovation contest unlocks its own resources to be used by third party developers to construct new services or products. Events of this kind are based on the nature of an idea contest, however, they also stimulate and encourage third-party involvement in the making of the actual end result by realising resources to the participants; not merely using end users to provide ideas and other input at different stages of the innovation process (Piller and Walcher 2006; Füller et al 2006). Consequently, while idea generation is an important activity in a digital innovation contest, software design, implementation and testing are also crucial activates that have to be performed (Hjalmarsson and Rudmark 2012). In addition to Bullinger & Moeslein (2010), Hjalmarsson and Rudmark (2012) provide complementing guidelines in the design of a digital innovation contest (see Table 3).

Design Elements	**Attributes**		
Needs: resources to stimulate teams to develop prototypes meeting user needs	Resource: provide persona, trend or scenario	Facilitation: support teams in interpreting user needs	
Value: resources to stimulate teams to develop prototypes generating value	Resource: provide business development toolbox	Facilitation: support teams with business value issues	
Data: provision of open data addressing the contest space	Resource: present available open data in an engaging way	Facilitation: support teams with API issues	
Novelty: input stimulating teams to ensure novelty in output	Define rules for intellectual property	Provide baseline for Innovation	Request patent survey

Table 3. Complementary design elements (based on Hjalmarsson & Rudmark 2012)

Open innovation of digital services can be stimulated by different types of contests following the two complementary kinds of openness discussed in the emerging theory of open innovation (Gassman and Enkel 2004; Chesbrough 2011). Innovation contests apply outside-in openness if they merely yield ideas that enable the organizer of the contest to collect input, which it then can transform into solutions within its own business after the contest. Innovation contests apply outside-in openness if they yield prototypes by allowing digital service developers to use the resources of the organizer in their design, and if the organizer lets the crowd decide the winner. An innovation contest applies the coupled form of openness (Gassman and Enkel 2004) if the organizer defines the criteria for the evaluation of the results and lets an expert jury decide the winner of the contest. It is barriers of innovation perceived by teams in the post-contest process in the latter kind of open innovation that we investigate in this study.

2.3 Innovation Barriers

An often-perceived problem is that organizations as well as societies are insufficiently innovative. This includes difficulties in generating innovative ideas, problems in transforming initial innovations into products, and resistance to adopt innovations. One approach to investigating these challenges to innovation is to identify innovation barriers, i.e. constraints or factors that inhibit innovation, as defined by Piatier (1984). There exists a huge literature on innovation barriers as well as the related

notion of success factors for innovation. Barriers and success factors can often be seen as two sides of the same coin, e.g. when the presence of a resource counts as a success factor, while its absence is seen as a barrier.

The literature review was carried out according to a grounded theory approach as suggested by Wolfswinkel et al. (2013). We started by defining the area to be surveyed as barriers for innovation. We then identified five of the major journals in the field of innovation: *International Journal of Entrepreneurship and Innovation Management, Journal of Product Innovation Management, Long Range Planning, Research Policy,* and *Technovation*. We searched these journals using the keywords "innovation barrier(s)" and "innovation success factor(s)", which resulted in 24 papers. The total number of barriers or success factors included in these papers were 179. We carried out an open coding of these reformulating success factors as barriers, which resulted in a set of 29 distinct barriers. Based on these, two of the authors independently carried out axial codings and they then met to consolidate their work. The result of this was a set of ten categories, where each category included one to five barriers. The barriers were consolidated and categorized, see Table 4.

Category	**Barrier**	**References**
Cost	High innovation costs	(D'Este et al, 2012)
	High cost of finance	(D'Este et al, 2012)
Finance	Short-term economic, monetary and financial policies	(Lee et al, 2010; Hadjimanolis, 1999)
	Lack of venture capital	(Greis et al, 1995; Hadjimanolis, 1999; Hall and Bagchi-Sen, 2002)
	Lack of public funds and assistance	(Greis et al, 1995; Hadjimanolis, 1999; Hall and Bagchi-Sen, 2002)
Innovation	Easily imitable innovation	(Lee et al, 2010; Hadjimanolis, 1999)
	High risk-level of innovation	(Becker and Dietz, 2004; Lee et al, 2010; D'Este et al, 2012; Hadjimanolis, 1999; Kaufmann and Tödtling, 2003)
Knowledge	Lack of technical competence and information	(Greis et al, 1995; Becker and Dietz, 2004; Lee et al, 2010; Kaufmann and Tödtling, 2002; Hall and Bagchi-Sen, 2002; Van Riel et al, 2004; Bond and Houston, 2002)
	Lack of marketing competence and market information	(Lee et al, 2010; D'Este et al, 2012; Van Riel et al, 2004; Van der Panne, 2002)
	Lack of management competence	(Greis et al, 1995; Hadjimanolis, 1999; Van Riel et al, 2004)
	Lack of innovation experience	(Hadjimanolis, 1999; Van der Panne, 2002
Market	Uncertain product demand	(Lee et al, 2010; Hadjimanolis, 1999; Atuahene-Gima, 1996; Danneels and Kleinschmidtb, 2001; Bond and Houston, 2002)
	Lack of innovation motivation	(Lee et al, 2010; Kaufmann and Tödtling, 2002)
	Weak value offering	(Bond and Houston, 2002; Atuahene-Gima, 1996; Van der Panne, 2002)
	Multifaceted market conditions	(Becker and Dietz, 2004; Kaufmann and Tödtling, 2002; Atuahene-Gima, 1996; Danneels and Kleinschmidtb, 2001; Van der Panne, 2002; Van de Vrande et al, 2009)
	High market competition and saturation	(Lee et al, 2010; D'Este et al, 2012;Atuahene-Gima, 1996; Bond and Houston, 2002; Van der Panne, 2002)
Organization	Lack of partner co-operation	(Lee et al, 2010; Hadjimanolis, 1999; Hall and Bagchi-Sen, 2002; Van de Vrande et al, 2009)
	Lack of time	(Hadjimanolis, 1999; Kaufmann and Tödtling, 2002)
	Unsupportive organizational culture	(Hadjimanolis, 1999; Van Riel et al, 2004; Bond and Houston, 2002; Van de Vrande et al, 2009; Van der Panne, 2002)
	Weak R&D environment	(Lee et al, 2010; Atuahene-Gima, 1996; Leiponen, 2006; Van de Vrande et al, 2009; Van der Panne, 2002)
	Lack of innovation champion	(Van der Panne, 2002)
Strategy	Weak innovation strategy	(Hadjimanolis, 1999; Bond and Houston, 2002)
	Lack of strategic fit	(Atuahene-Gima, 1996; Danneels and Kleinschmidtb, 2001; Bond and Houston, 2002)

Regulation	Hindering government policies and regulations	(Greis et al, 1995; Becker and Dietz, 2004; Gilsing and Nooteboom, 2006; D'Este et al, 2012; Hadjimanolis, 1999; Hall and Bagchi-Sen, 2002)
	Inefficient intellectual property processes	(Greis et al, 1995; Hadjimanolis, 1999; Hall and Bagchi-Sen, 2002; Van de Vrande et al, 2009)
Society	Lack of public acceptance for innovation	(Greis et al, 1995)
Technology	Unavailable technology	(Kaufmann and Tödtling, 2002)

Table 4. Summary and categorization of barriers found in literature.

3 Case Description

The case selected was Travelhack 2013[2]. The motive for selecting this digital innovation contest were primarily access, this as the researchers by the organizers had received the assignment to provide support in the design and the evaluation of the contest. This enabled the researchers a unique access to the case and the teams participating in the contest. Organizers from the public transportation industry in Sweden spearheaded the design this innovation contest as a catalysing mechanism in their mainly inside-out open innovation process to achieve the twofold purpose: to 1) increase the usage of the open data platform Trafiklab.se, 2) stimulate third-party developers to develop novel digital services that make public transportation more attractive in the Stockholm region. The organizers had no intention to, after the contest, acquire any of the contributions. However, by defining sets of criteria for evaluation and using an expert jury to select winners, they deliberately to some level, ruled the outcome with the aim to point out the services with the highest potential to become viable. The contest was held in the winter and spring of 2013 and spanned three months, divided into three phases (idea, preparation and final).

First, interested parties from December 2012 to mid January 2013 submitted digital service ideas they sought to implement in later phases of the competition targeting one of three contest categories: 1) Digital services that make public transportation trips more fun 2) Digital services that make public transportation more efficient 3) Digital services that make public transportation more accessible to everyone, especially passengers with cognitive disabilities. The ideas were subjected to an evaluation that resulted in that contest organizers, in mid February 2013, invited 25 of the total 58 entries to attend a 24-hour final hackathon[3]. The purpose of the final was to have contestants finalize the prototypes, select a winner, and promote the result to invited venture capital providers attending the hackathon. The shortlist of finalists was based on innovativeness, potential to make impact, technical feasibility, and usefulness. During the second phase, preparation, the teams were provided additional APIs from both the organizations behind the contest (funnelled through Trafiklab.se) and other organizations that had been involved by the organizers with open data resources of relevance to the three contest categories (i.e. Spotify and Microsoft). At the final hackathon, the majority of the organizations providing data supported the teams on-site together with support from business coaches to finalize their pitches to the expert jury as well as venture capital providers invited to the final. During the last phase, the final 24-hour hackathon, 21 teams finalized their services into prototypes and an expert jury selected four winners[4]. The assessment was based on innovativeness, potential to make impact, technical excellence, usefulness and usability. As the ideas at this stage had been

[2] www.travelhack.se/

[3] A hackathon is an event in which mainly programmers (but also participants with other expertise such as graphic design and usability) gather to produce digital services for a constrained time period (e.g. 24 or 48 hours)

[4] One grand prize winner winning a paid trip for the team together with entry tickets to Disrupt SF 2013, San Franscio USA, and three winners of the three contest categories receiving Raspberry Pis.

transformed into prototypes, it was possible for the expert jury to evaluate the technical excellence in the contributions as well as the level of usability in the solution. At the end, 21 prototypes were produced during the innovation contest and 750 new developers registered on trafiklab.se by mid March, pushing the number of registered developers above 1,500.

4 Research Method

This study investigates perceived innovation barriers by digital service developers as their contributions from innovation contests are brought into the market. As shown above, while there are high expectations on service development based on open data, there is simultaneously a dearth of knowledge concerning the innovation barriers that service developers face. To address this knowledge gap, we chose a revelatory, single case study when answering our research question. A single case allows for investigating a phenomenon in depth, especially where research and theory are at their early formative stages (Benbasat et al., 1987; Darke et. al. 1998). Given the nature of the research area, we thus find a single case study an appropriate way of addressing the research question, and we envisage that the results from the study will constitute a platform to perform future comparative research involving additional cases.

The rationale for choosing Travelhack 2013 as case for addressing our research question is that its temporal disposition allowed for an excellent opportunity to access and study the market entry barriers facing service developers after the contest. While successful innovation contests are able to facilitate the development of novel service ideas and rudimentary prototypes, very few of these contest-developed services eventually reach the market. By conducting a case study as developers move from ideas to prototypical and promising services into the marketplace, we were able to reveal the barriers they experienced during this transition. In Table 5, we summarize the research process used.

	Single case study approach						
	Exploratory phase				Confirmatory phase		
Step	Step 1 Review of existing barriers in theories	Step 2 Collect data about anticipated barriers	Step 3 Explore anticipated barriers	Final 24-hour hackathon	Step 4 Design systematic interview guide	Step 5 Collect data about barriers after final	Step 6 Evaluation of barriers, discover additional
When	January 2012 – March 2013	March 2013	March 2013		April 2013	May 2013	May – Sept 2013
Input	24 articles	Output from step 1, 249 interested	Output from step 1 and 2		Output from step 1 to 3	21 team captains	Output from step 5
Activity	Review existing barriers in theory	Collect data about anticipated barriers	Explore anticipated barriers		Design a systematic interview guide	Collect data about barriers after final	Evaluation of barriers, discover additional
Output	179 barriers in the literature consolidated into 29 and grouped in ten categories (c.f. table 4)	39 responses with closed and open answers	15 anticipated barriers prior to final (c.f. table 6)		Guide to collect data about barriers post final	19 responses with closed and open answers	15 barriers evaluated, 3 new barriers (c.f. table 8 and 9)

Table 5. Research method and process

The purpose of the exploratory phase (step 1-3) was twofold. First, while the existing literature offered substantial insight into barriers for innovators' market entry, prior research had not been studying innovations stemming from innovation contests and hence needed empirical confirmation. Second, as digital innovation contests are a new and emerging concept, chances were that new previously

unnoticed barriers would appear. In tandem with the literature survey on innovation barriers (c.f. section 2.3), we asked all individuals who had shown an interest in Travelhack 2013 to participate in an exploratory online survey[5]. It consisted of open- and closed-ended questions regarding a characterization of the team, the anticipated barriers to market diffusion (as the contest had come to an end), and the steps they planned to take to overcome these anticipated barriers

The closed-end questions addressing the innovation barriers were developed based on the results from the literature study and the results from the online survey. The barriers identified in the literature study were, with a few exceptions, used as a basis for the questions in the empirical study. The exceptions were justified by the specific situation of a digital innovation contest where small teams compete against each other and are evaluated by a jury. The barrier Weak value offering (c.f. table 4) was not included since the jury in the contest addressed this one, and only strong innovations could enter the final of the contest. For the same reason, Lack of public acceptance for innovation was not included. The barrier Lack of strategic fit was excluded, as the participants were teams and not organizations. For the same reason, Unsupportive organizational culture was not included. The barrier Lack of innovation champion was not included among the questions asked, as it would have been difficult to elicit honest answers from the teams. The barriers hindering government policies and regulations as well as inefficient intellectual property processes were not included, as they were outside the scope of the investigation. In total 39 attendees answered the exploratory online survey prior to the contest. Of these responses, 6 were left blank, and since some teams perceived more than one barrier, we in total received 37 instances in relation to 15 perceived barriers. We used the list of previously identified barriers to analyse the responses given by the contest participants.

The confirmatory phase (step 4-6) was primarily aimed to evaluate the innovation barriers identified from the first phase based on data collected during the post-contest process. The secondary aim was to identify additional barriers perceived by digital service developers when transforming prototypes to viable services. The data was collected by telephone interviews two months after the contest and made systematic by an interview guide. The guide consisted of close-ended questions to measure the relevance of the anchored innovation barriers from the explanatory phase using a Likert scale 1 to 5 as to what degree they were perceived as a barrier by the team. It also included open-ended questions to collect data to discover complimentary barriers. 19 of the 21 teams participating on the final participated in the interviews, which lasted approximately 45 minutes each. The interviews were recorded and transcribed for further analysis to search for additional barriers, aided by the data analysis software atlas.ti..

5 Results – Barriers to Viable Digital Services

5.1 Results from the Exploratory Phase

The result from this phase included the acknowledgement of the existence of barriers identified in the literature as well as the identification of previously unreported barriers (step 1 and 2). This way we were able to generate new categories while avoiding our possibly biased preconceptions (step 3).

	Barrier	**Instances**
B1	Lack of technical competence and innovation experience	1
B2	Difficulties finding competent team members	1
B3	Lack of time or money	9

[5] The study population consisted at this stage of 249 respondents divided in three groups. A) 132 respondents that had submitted an interest to submit an idea to the contest, but had not when at the idea submission deadline. B) 31 respondents that had been listed in the teams that had submitted an idea to the contest, but not shortlisted to the prototype phase and final. C) 76 respondents that constituted the teams shortlisted to the prototype phase and final.

B4	High market competition and saturation	1
B5	Lack of external funding	2
B6	Multifaceted market conditions and uncertain product demand	3
B7	Lack of marketing competence and market information	6
B8	Inefficient intellectual property processes	2
B9	Difficulties establishing licenses for API:s and other services	3
B10	Lack of partner co-operation for technical development	4
B11	Weak value offering	1
B12	Limitations in existing service-dependent platforms	1
B13	Varieties of smartphones requiring unique service development	1
B14	Difficulties to reach adequate technical quality in the service	1
B15	Lack of partner co-operation for technical test	1
Total		37

Table 6. Anticipated barriers prior to contest attendance

The result of the initial survey, see table 6, shows that the most salient perceived barrier prior to the contest is lack of time and/or money to pursue the development after the contest (B3), followed by marketing issues (B7), and forming necessary alliances with partners (B10). Since the survey entry for barriers was open-ended, we were further able to discover four new barriers for the context of innovation contests (B12, B13, B14, B15).

5.2 Results from the Confirmatory Phase

5.2.1 Evaluation of Barriers to Viable Digital Services

Table 7 provides an overview of 1) the plans that the teams had two months after the contest and 2) the level of development activity at that time.

Post contest plan	No. of teams	Active teams	Type of team			
			corp	s/r	com	mix
Complete the service without collaboration	9	(3)	4(1)	1	3(1)	1(1)
Complete it in collaboration with external organization	6	(4)	2	0	3(3)	1(1)
Complete it by selling the prototype to an external party	1	0			1	
Will not finalise the digital service	3	0		1	2	
Total	19	(7)	6(1)	2	9(4)	2(2)

Table 7. Team plans and development activity two months after the contest.

A majority of the teams answered that they planned to complete the digital service using one of three alternatives (84%). Still at this stage in the post-contest phase, only a minority of the teams actually performed development work (37%). Of these, one team was of corporate type [corp], four of community type [com], and two of mixed type with community and corporate developers working together [mix]. None of the active teams were from the student / research type attending the innovation contest. The evaluation revealed some interesting results about what issues are regarded as barriers to establishing viable digital services after an innovation contest. One overall tendency is the significant difference in the respondents' perception of the different barriers, see table 8. The barrier that scores highest on the Likert scale to complete viable digital service is *B3: lack of time and money* (mean 4.32, st. dv. 0.57) while the barrier *B2: difficulty in finding competent team members* to finalise the service scores lowest (mean 1.32, st. dv. 0.73). B3 stands out when all barriers are compared using mean as base for comparison.

Barriers to viable digital services	Mean	Median	St. Dev.	Max	Min
B3. Lack of time or money	4,32	4	0,57	5	3
B7. Lack of marketing competence and market information	3,26	4	1,25	5	1

B11. Weak value offering	3,21	4	1,44	5	1
B10. Lack of partner co-operation for technical development	3,00	4	1,45	5	1
B6. Multifaceted market conditions and uncertain product demand	2,84	2	1,39	5	1
B13. Varieties of smartphones requiring unique service development	2,42	2	1,39	4	1
B5. Lack of external funding	2,11	1	1,37	5	1
B8. Inefficient intellectual property processes	2,00	1	1,49	5	1
B9. Difficulties establishing licenses for API:s and other services	1,95	1	1,39	5	1
B14. Difficulties to reach adequate technical quality in the service	1,89	2	0,97	4	1
B1. Lack of technical competence and innovation experience	1,84	1	1,09	4	1
B4. High market competition and saturation	1,84	1	1,31	5	1
B15. Lack of partner co-operation for technical test	1,79	2	0,89	4	1
B12. Limitations in existing service-dependent platforms	1,53	1	0,99	4	1
B2. Difficulties finding competent team members	1,32	1	0,73	4	1

Table 8. Perceived barriers in order of importance from highest (score 5) to lowest (score 1).

B3 is followed in relevance by *B7: marketing and lack of market information* when finalising the service, *B11: designing a sustainable business model* for the service and *B10: Lack of partner co-operation for technical development*. The scores that these barriers received are significantly lower than B3, however, they have all a relatively high distribution in terms of answers (B7 = st dv. 1.25, B11 = st. dv. 1.44 and B10 st. dv. 1.45). If the median is used as base for comparison, then the evaluation supports that these four barriers are perceived as the main ones for the transformation of prototypes into viable digital services. One explanation stated in one of the interviews for the relevance of B7 is a lack of information within the team if the intended market is interested in the service being developed. The prototype was developed based on a perceived need in the service and the developer's own interest, rather than accessed marketing information. In several interviews, especially amongst the community teams, B11 is viewed as a non-interest and a non-experience when it comes to developing a business case for a service. As money is needed to finalise the service, a business model becomes a relevant but hard step to take for these teams. Six of the teams want to complete the service together with one or several collaborative partners. One reason stated interviews to motivate B10 as a perceived barrier is that the public transportation authority is viewed as very passive in the post contest phase. A couple of teams see it as a necessity to join forces with external organizations relevant to the services in completing the services, but find it hard to be able to establish such a collaboration. Such an organisation could be an organization providing the data, but could also be an organization promoting the service to users.

B6: difficulties in assessing the market (mean 2.84, st. dv. 1.39) and *B13 varieties and versions of smartphones requiring unique service development* (mean 2.42 st dv 1.39) are according to the evaluation perceived as barriers with lower relevance in developing viable digital services. In regard to B13, this may change if data is collected later in the process closer to launch and when the intended market is more fully understood. The remaining barriers score relatively low in the post questionnaire and are perceived as barriers with less relevance in transforming the prototypes to viable digital services based on open data. However, since some participants perceive these as strong barriers, with a score of four or five, we cannot dismiss them altogether.

5.2.2 Discovery of Additional Barriers

Even though the barriers identified in the existing literature and their testing in the survey from the exploratory phase provided an understanding of the barriers facing service developers as they transform the prototypes into viable services, we purposely inserted an open-ended question for two reasons. First, not all contestants prior to the contest had answered the survey and hence perceived barriers may have gone unnoticed and second, as contestants at this stage were queried about barriers *after* the contest, new and previously unidentified barriers may have emerged. Seven teams brought up in total four barriers as responses to the open-ended question. Of these, one was classified to fall

within the boundaries of an existing barrier (B10, mentioned by two teams) and the remaining three can be found in table 9.

	Barrier	Instances
B16	Lack of partner co-operation for knowledge transfer	1
B17	Viable Product Features Uncertainty	3
B18	Hindering Industry Structures	2

Table 9. Additional barriers discovered after the contest

The first of these three new barriers were *B16: lack of partner co-operation for knowledge transfer* (mentioned by one team) where contestants commented the need to have access to information from within the public transport company: *"[If we knew] what SL was doing internally, and that SL would have liked us to develop [the service] in this or that direction, then SL would consider [the service] as brilliant and probably advertise the solution"* The second barrier was *B17: Viable Product Features Uncertainty* (mentioned by three teams), where contestants described the problem of when a product is sufficiently developed to be attractive in the market (sometimes referred to by contestants as "minimum viable product"): *"[A barrier for us is to] select what features we should focus on, choosing functionality and features in the service. […] Because in our service there is so much you can do with the information that we have available which means that the information can help many different personas"* The final experienced barrier was *B18: Hindering Industry Structures*, (mentioned by two teams) where the viability of the team's services were contingent on finding creative ways of dealing with e.g. music licensing or waiting for changes in industry agreements: *"[W]e have been asked to keep a low profile and not do much until…before the work that this consultant agency does to convince all 27 traffic companies to share their price data."*

6 Discussion

The research question addressed in this paper was *what barriers inhibit the development of viable digital services from prototypes generated at innovation contests?* The question was answered by means of a literature study and a case study of an innovation contest divided into one exploratory and one confirmatory phase, yielding in a total of 18 perceived barriers to viable digital services after an innovation contest. As the domain of the investigation, open innovation of digital services stimulated by innovation contests, was different from those of previous studies on innovation barriers, a number of new barriers were identified. These address in particular technological barriers, such as *B13. Varieties of smartphones requiring unique service development*. When ranking the barriers, *B3: Lack of time or money* was perceived as the most important barrier while *B2. Difficulties finding competent team members* was perceived as the least important barrier by the contest teams, two months after the contest. One could argue that the participants do not perceive barriers with mean score of two or lower as barriers. However, since some participants perceive these as strong barriers, with a score of four or five, we cannot dismiss them altogether. Furthermore, several teams viewed difficulties in finding partners for technical development as a barrier, which indicates a potential for open innovation. A somewhat surprising observation was that technological barriers were not perceived as very important two month beyond the contest.

While this paper has focused on the development of viable services from prototypes created in innovation contests, it should be acknowledged that such contests may have other beneficial effects. In particular, innovation contests can contribute to innovation environments by enhancing experience sharing and fostering networks as well as pooling and distributing knowledge and information resources. Furthermore, innovation contests can help to increase the visibility and awareness of communities and organizations, in particular those arranging the contests. Teams participating in contests can also receive attention for their solutions and competence as well as learn about technology and markets. These effects must also be viewed as design issues when innovation contests

yielding viable services based on open data are organized. The results of the study imply that in the design of innovation contests, further design support is needed to the organizer. The organizer needs to design an open innovation contest that reduces the effects of the barriers identified, several of which are not yet covered by the design elements provided in existing theory (e.g. Bullinger & Moeslein 2010; Hjalmarsson and Rudmark 2012). We conclude that the results of this study provide contribution to practice as they give to the organizer insights of barriers hampering the long-term success of an inside-out open innovation process. Furthermore, the study provides the insight that while existing theory about open innovation processes and innovation contests offers valuable knowledge, it lacks in comprehensive principles and guidelines for organizing innovation processes to create valuable digital services based on open data.

From a methodological point of view, one limitation of the confirmatory phase of the study is that the data collection was carried out at only one point in time, about two months after the contest final. It is possible that after a longer period of time, the teams would change their perceptions of the importance of the barriers. For that reason, we intend to carry out follow-up interviews during the coming years evolving the research approach into a longitudinal and comparative case study. Another limitation is that only one case has been studied, which may compromise the transferability of the findings. One distinctive feature of the case was that the prototypes developed only concerned add-on services to a main service provided by a public sector organization. This may not be typical for innovation in most business domains where third-party access to downstream capabilities to co-create monetary value typically is the rationale for pursuing third-party developer innovation (Ceccagnoli et al., 2011). However, a strength of the case with respect to transferability is that it involved not only idea generation but also prototype development. Furthermore, the case included preparatory phases for developing ideas and prototypes, as well as a final hackathon phase where prototypes were finalized.

In future work, we intend to use the barriers identified as a starting point for constructing guidelines that can help in designing innovation contests. The guidelines should take into account the entire open innovation process, i.e. they should cover not only the design up to the final but also address the ensuing post-contest process. The contest should be so designed as to facilitate the journey from prototypes to viable services. For example, the barrier *B3: lack of marketing competence and market information* could be countered by measures that supply teams with this competence and information. This means that much of future work will take the form of design science research. Another topic for future work is to address not only perceived barriers but also objective ones, which will require complementary methodological approaches including longitudinal studies involving additional cases.

Acknowledgement

This study was partly funded by VINNOVA, Swedens' Government Agency for Innovation Systems.

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