Contests as innovation intermediaries in open data markets

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Abstract. Innovation contests are becoming popular instruments for stimulating development of digital services using open data. However, experience indicates that only a limited number of the results developed during these events become viable digital services attracting a significant user base. To further deepen our understanding of the role, design and function of innovation contests in open data markets, we conducted a survey of the websites of 33 digital innovation contests. The results of the survey show that organizers design digital innovation contests to function as intermediaries for open data innovation. By analyzing the activities performed by organizers we found several examples of how innovation contests support the participants in designing, implementing and providing services after the contests are concluded. We contribute with a key design element and attributes for the post-contest process of digital innovation contests, which adds to existing key design elements. For future research we suggest to further study open data markets and the intermediary role of digital innovation contests. Moreover we propose to develop guidelines and tools for organizers of digital innovation contests to design contests that better meet the needs of a particular open data market.

Keywords: Innovation contest, open innovation, open data, open data market, innovation system

1. Introduction

The interest in open service innovation increases constantly. For example, the European Commission estimates that the expected outcome of the proper manipulation and management of open data is expected to enhance the EU economy with at least €40 billion each year [1].

Contests, such as idea competitions and digital innovation contests, have become popular ways to stimulate the development of new service ideas and prototypes. However, only a fraction of the results from innovation contests become viable digital services. Less than 10% of the prototypes developed during innovation contests are finalized and attract a significant user base [2].

Innovation contests are normally conducted during a limited period of time when participants develop service ideas and prototypes. These ideas and prototypes are then evaluated, e.g. by an expert jury, and winners are selected. Bullinger and Moeslein [3] and Hjalmarsson and Rudmark [4] describe how innovation contests can be organized using 14 different key design elements.

Despite their popularity, the role and functions of innovation contests in open data markets [8] and how they affect the innovation system including the digital service innovation process and the actors involved in this process is still unclear. Typically the contests are concluded as winners are selected but

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in order to bring a service idea or prototype into a market there are further development steps to conduct, including design, execution and monitoring [5]. Moreover, organizers and sponsors of innovation contests may also take part in this post-contest process, e.g. by taking over the ownership of the service prototype and provide it to end-users. But so far it is unclear as to what extent organizers and sponsors of innovation contests are providing (or should provide) support for the post-contest process, e.g. the innovation contest key design elements presented by Bullinger and Moeslein [3] and Hjalmarsson and Rudmark [4] do not include design elements for the post-contest process.

Therefore our aim in this paper is to investigate the role and functions of digital innovation contests and explore how organizers of digital innovation contests support the post-contest process. Hereby we support the understanding for how organizers of digital innovation contests can take further steps in supporting developers in making viable digital services and their intermediary role in open data markets. Our research questions are formulated accordingly:

What are the functions of digital innovation contests in open data markets?
How are digital innovation contests designed in order to support the post-contest process?

We conduct a survey on information available through the Internet supplemented by interviews of one case of digital innovation contests in order to answer the research question. The main contributions are knowledge about the functions of digital innovation contests as innovation intermediaries and a new key design element for innovation contests labeled "Post-contest support" to be added to the design elements defined by [3,4]. Moreover, attributes for the key design element is defined based on a categorization of the activities organizers use to support participants in the post-contest process identified in the survey. In addition the survey results provide a reference for digital innovation contest design.

The paper is organized in seven sections. Following the introduction in the first section we present a theoretical frame of reference in the second section and the method used in the third section. In chapter four we present a case of digital innovation contests and in the fifth the result and analysis. In the sixth section we discuss the results and conclude and suggest areas for future research in the final and seventh section. In the appendix we provide a list of the innovation contests included in the survey.

2. Theoretical frame of reference

Open data is believed to become a major source of future innovation [1] and provide a basis for new markets to emerge. By open data we refer to data and information that "...anyone can freely access, use, modify, and share for any purpose (subject, at most, to requirements that preserve provenance and openness)" [6]. Several governments promote the availability and use of open data to improve democracy and to support service innovation, for example the European Commission has issued the Public Sector Information (PSI) directive on the re-use of public sector information [7]. Public administrations in Europe control large volumes of information collected by numerous public authorities and services and the outcome of the proper transformation and management of this information is expected to enhance the EU economy with at least €40 billion each year [1]. Open data is made valuable through *open data services* [8]. Open data services take raw data and make it available to users or manipulate it in ways that make it useful as information [8]. However, the understanding of open data services is still low, in particular the creation of sustainable open data markets and how actors are established in the market [8].

2.1. Systems of innovation

Systems of innovation is an approach for studying how actors interrelate to innovate and populate a market. By systems of innovation we refer to networks of public and private actors that act and interact to

adopt and diffuse new technologies [10,11]. Innovation systems are determinants to innovation as they include "all important economic, social, political, organizational, and other factors that influence the development, diffusion, and use of innovations" [20, p. 14]. According to [12] this means that innovation systems focus on the determinants rather than the effects of innovation, such as growth and employment.

An innovation system includes components and relations between these components. The components could be either organizations or institutions [12], where the latter are "...sets of common habits, routines, established practices, rules, or laws that regulate the relations and interactions between individuals, groups and organisations" [13, p. 46]. For example the PSI-directive is an institution aimed at regulating the access to and use of open data in member states of the European Union. The relations of an innovation system, between the components, are often complex and reciprocal [12]. Relations between organizations could be business transactions, selling and buying services or goods, but also learning processes where knowledge is exchanged between organizations not necessarily managed as business transactions. Institutions can have strong effects on organizations' behavior and may also emerge from organizational practices. There are also relationships between institutions where for example laws can have a large impact on informal rules for how organizations exchange information. Another important aspect of innovation systems is the boundaries where national, regional and sectoral are most commonly discussed [12].

The organizations involved in innovation systems of open data services can be defined as open data suppliers, developers and end users [14–16]. In Deloitte's proposed innovation system for open data [14] the developers are app developers and business, whereas in Tammisto's and Lindman's view [15] the intermediaries are open data consultants, linked data developers and applications developers. The end users play a key role in the innovation system not only in using but also in the co-production of data and services [17,42]. For example, citizens co-produce through crowd sourcing, self-organization of government functions and by preparing monitoring reports [5]. Open data brokers [43] have been suggested as a complementary role in the open data market. The function of an open data broker is to intermediate innovation and to arrange links between open data and third-party developers. The different actors are linked to each other through raw and enriched data as well as services, feedback and payment [14]. According to Janssen and Zuiderwijk there are several business models for intermediating the relationship between consumers and suppliers of open data [9]. These *infomediary business models* range from single purpose apps that present real-time information to the user about for example weather to service platforms that provide features for finding, importing, cleaning, manipulating, and presenting information. So far the role of digital innovation contests in open service markets is unclear although Hjalmarsson et al. claims that organizers of digital innovation contests can take on the intermediary role of open data broker [43].

2.2. Innovation intermediaries

The systems perspective on innovation emphasizes co-operation between different actors as key to successful innovation [44]. Due to gaps that hinder effective co-operation, there is a need for intermediary organizations to fulfill bridging and brokerage roles in innovation systems. An innovation intermediary is an "...organization or body that acts as an agent or broker in any aspect of the innovation process between two or more parties. Such intermediary activities include: helping to provide information about potential collaborators; brokering a transaction between two or more parties; acting as a mediator, or go-between, bodies or organizations that are already collaborating; and helping find advice, funding and support for the innovation outcomes of such collaborations" [19, p. 720]. Howells [19] presents a typology of ten different functions that innovation intermediaries perform, see Table 1. An intermediary performs these functions, or a subset of them, to overcome constraints in an innovation system.

Table 1
Functions of innovation intermediaries [based on 19 p. 720]

Innovation intermediation functions
1. Foresight and diagnostics
2. Scanning and information processing
3. Knowledge processing, generation and combination
4. Gatekeeping and brokering
5. Testing, validation and training
6. Accreditation and standards
7. Regulation and arbitration
8. Intellectual property: protecting the results
9. Commercialization: exploiting the outcomes
10. Assessment and evaluation

By organizing digital innovation contests actors try to motivate other actors to participate in open service innovation and to transfer information between actors about available open data and available technical solutions. Hence, organizers of digital innovation contests take on the role of innovation intermediaries, stimulating the development of new open services. However it is unclear how digital innovation contests are designed in order to perform the functions of innovation intermediaries.

2.3. Digital innovation contests

In the current situation where open data receives much attention from governments but the market is still in its infancy, digital innovation contests have become one important method to propel service innovation based on open data [4]. So far, the competitive market has failed to mediate the relationship between the actors of the open data service innovation system and to generate revenues for the developers [18]. It is estimated that less than 0.01% of all developers can expect a return on their investments by 2018, even for mobile services related to games and entertainment. Users have high expectations for what should be paid for, and today digital services are rather used by companies to build brand recognition and product awareness than for making profit. A digital innovation contest is an event to drive open service innovation where third-party developers compete to design and implement service prototypes, for a specific purpose, primarily based on open data but also using more restricted means as technical platforms [4]. Contests are often used during early stages of open service innovation to stimulate the generation of ideas and service prototypes [17] but also to influence development efforts to ensure that the results are aligned with organizational goals [4].

Different types of contests have been discussed in order to control and organize innovation: idea competition [40], community based innovation [3,41], online innovation contests [3], and digital innovation contests [4]. The value with an idea competition is that the contest provides a mechanism by which users can transfer innovative ideas to firms and organizations [40]. Consequently, a core challenge of organizing an idea competition is to motivate users to provide innovative ideas, which the initiator of the contest then can transform into new services and products. Füller et al. provides, 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 [41]. The concept of innovation contests is extended in Bullinger and Moeslein [3] when presenting the concept of online innovation contests.

Bullinger and Moeslein [3] and Hjalmarsson and Rudmark [4] have defined key design elements for designing innovation contests, see Table 2. The design elements include for example media, target group and data. For each design element there are attributes, e.g. the design element *target group* could be either

Table 2
Key design elements when organizing an innovation contest [based on 3 and 4]

Key design elements	Attributes
Media	Online – Mixed – Offline
Organizer	Company – Public organization – Non-profit – Individual
Task/topic specificity	Low – Defined – High
Degree of elaboration	Idea – Prototype – Idea or Prototype
Target group	Specified – Unspecified
Participation as	Individual – Team – Both
Contest period	Very short term – 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
Needs	Resource – Facilitation
Value	Resource – Facilitation
Data	Resource – Facilitation
Novelty	Rules for intellectual property – Baseline for innovation – Patent survey

specified or unspecified. The design elements in Table 2 do not cover the process after the innovation contest is concluded. In this paper we are interested in increasing the understanding of how organizers of innovation contests support this process.

Organizers design different types of digital innovation contests by varying the attributes of the key design elements. The key design elements refer primarily to functions during the contest period and do not take into account the post-contest process when an idea or prototype is implemented, commercialized and made available to end-users at an open data market. However in their role as innovation intermediaries there is an opportunity for digital innovation contests to further support the participants in finalizing and disseminating their services.

2.4. Innovation barriers

Constraints or factors that inhibit innovation are called *innovation barriers* [21]. The barrier approach to innovation aims at identifying and eliminating barriers at various stages of innovation [36]. From a static view, barriers are determinants of innovation but [36] argues that the nature of barriers are dynamic, evolutionary and complementary. Barriers act at different levels, for example nation, region and firm and the impact of a barrier is determined at which stage or phase of innovation it acts and the mechanism of action [36]. There exists a huge literature on innovation barriers as well as the related notion of success factors for innovation [22–35]. 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 largest barriers perceived by participants closely following a digital innovation contest are lack of time or money, lack of marketing competence and market information, weak value offering, lack of partner co-operation for technical development and multifaceted market conditions and uncertain product demand [2], refer to Table 3.

Through innovation contests, organizers aim at removing some of these innovation barriers by performing different functions, refer to Table 2. However the understanding of the actions performed through digital innovation contests to support service innovation based open platforms and the creation of sustainable open data markets is so far unclear.

3. Method

In order to answer the research questions, we conducted a survey [37] on current innovation contests

Table 3

Perceived barriers by participants in digital innovation contests in order of importance from highest (score 5) to lowest (score 1) [2, p. 10]

Barriers to viable digital services	Mean
B3. Lack of time or money	4.32
B7. Lack of marketing competence and market information	3.26
B11. Weak value offering	3.21
B10. Lack of partner co-operation for technical development	3.00
B6. Multifaceted market conditions and uncertain product demand	2.84
B13. Varieties of smartphones requiring unique service development	2.42
B5. Lack of external funding	2.11
B8. Inefficient intellectual property processes	2.00
B9. Difficulties establishing licenses for API:s and other services	1.95
B14. Difficulties to reach adequate technical quality in the service	1.89
B1. Lack of technical competence and innovation experience	1.84
B4. High market competition and saturation	1.84
B15. Lack of partner co-operation for technical test	1.79
B12. Limitations in existing service-dependent platforms	1.53
B2. Difficulties finding competent team members	1.32

that met to the following criteria:

- The contests should be organized to stimulate development of digital services
- The services should be based on open data

Innovation contests were identified using two Internet search strategies: keywords and relation to open data sources. While searching the Internet we used variants of the following keywords: *innovation, competition, contest, open data, hackathon, app.* We also searched the open data sources listed in www. datacatalogues.org in order to find out if there were innovation contests arranged or associated with specific open data sources. In addition, the list of digital innovation contests was complemented with contests known by researchers familiar with the area. All in all 33 digital innovation contests were identified that met the above criteria, see Appendix 1.

The survey was designed based on the key design elements defined by Bullinger and Moeslein [3] as well as Hjalmarsson and Rudmark [4] and complemented with one question:

- How do the organizers of digital innovation contests support the participants during the post-contest process?

Since Bullinger and Moslein [3] do not specify the attributes for the design element "Contest period" we decided to specify the attributes accordingly: very short term < 1 month, short term 1–2 months, long term 3–5 months and very long term > 5 months.

Data was collected from contest websites for two main reasons. First we wanted to base our analysis on the information available to the participants when they decided to enter the contest and not on the perceptions of representatives of the organizers. Second we wanted to study a large number of contests in order to get an overview of the phenomenon and the time available to us was simply not enough to conduct the amount of interviews necessary. However, by only using information published at web sites we would risk missing important contextual information. Therefore we complemented the analysis with a description of one of the included contests, Travelhack 2013. The case description is based on interviews with organizer representatives, jury members and participants.

The results were then analyzed using content analysis [38]. Thematic analysis was used to categorize the types of support provided by the contest organizations. Braun and Clarke [39, p. 6] define thematic analysis as "a method for identifying, analyzing, and reporting patterns (themes) within data". In order

to validate data quality, two researchers performed the analysis independent from each other. Differences in interpretation were then discussed in order to reach a consensus on the interpretation.

4. Travelhack 2013

The digital innovation contest Travelhack 2013 was organized by SL, the public transportation organization of Stockholm, Samtrafiken, a service provider owned by transportation organizations in Sweden, and the research institute Viktoria Swedish ICT. The main objective for organizing the contest was to provide a platform for the best developers in Sweden to design and develop novel digital service prototypes that support travellers using public transportation, and by this increase the attractiveness of public transportation. The reasons for selecting the case was that the goals of the innovation contest resemble the overall goals of open government data, and that the organizers provided a catalogue of open traffic data[1] as well as promoted use of open data from other areas, for the participants to develop on.[2] The contest was held in the winter and spring of 2013 and spanned three months, divided into three phases: idea, preparation and final. Proposals on ideas were divided into three categories:

- Digital services that make public transportation trips more fun;
- Digital services that make public transportation more efficient;
- Digital services that make public transportation more accessible to everyone, especially passengers with cognitive disabilities.

A jury then evaluated the ideas based on four criteria: innovativeness, potential to make impact, technical feasibility, and usefulness. Out of a total of 58 proposals, 25 teams were invited to the final and 21 participated. The purpose of the final was to have contestants finalize the prototypes, select winners, and promote the result to invited venture capital providers. The final was organized as a 24-hour hackathon, i.e. an event, typically lasting several days, in which a large number of people meet to engage in collaborative computer programming (http://www.oxforddictionaries.com). During the final, the organizers and data providers supported the teams on-site together with business coaches to finalize their pitches to the expert jury.

The organizers had no intention to acquire any of the participant's services after the contest, and instead venture capital providers were invited to the final. However, no teams have so far managed to attract funding from the invited venture capitalists, however through other means of finance the development, one year after the contest, is ongoing in at least six of the 21 teams participating in the final.

5. Results and analysis

In this chapter we present and analyze the results from the survey. We found that public organizations organized most of the studied digital innovation contests and they used mixed formats including both online and offline elements. The contest period was in most cases 3–5 months where both individuals and teams could participate to win monetary prizes or a mix of monetary and non-monetary prizes. The non-monetary prizes were for example trips and nominations to other contests. An interesting observation was that support during the post-contest process was used as a mean of reward in only one instance. For an overview of the design elements, please refer to Fig. 1.

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[1] Trafiklab.se.
[2] For example: Spotify, Oxify, Skype, Bing Maps, Windows 8, Windows Phone och Rebtel.

Media	21 % Online	67 % Mixed		12 % Offline
Organizer	15 % Company	63 % Public Organization	9.5 % Non-pro / 3% Ind.	9.5 % Co. P.O.
Task specifity	6 % Low	54 % Defined	39 % High	
Degree of elaboration	3% Idea	60 % Prototype	12 % Mixed	25 % Unspecified
Target group	45 % Specified	55 % Unspecified		
Participation as	9 % Individ.	24 % Team	55 % Both	12 % Unspec.
Contest period	22 % Very short	15 % Short	45 % Long	18 % Very long
Reward	45 % Monetary	22 % Non-monetary	33 % Mixed	
Communication	39 % Support provided	61 % Not provided		
Evaluation	66 % Jury	31 % Mixed	3% N/A	
Needs	37 % Support provided	63 % Not provided		
Value	43 % Support provided	57 % Not provided		
Data	57 % API:s with data provided	22 % referred to API:s	21 % Not provided	
Novelty	52 % Support provided	48 % Not provided		

Fig. 1. Summary of survey results.

5.1. Relation to the functions of an innovation intermediary

Below we will present the design of the competitions in more detail and relate to the functions of innovation intermediaries as described by [19] and presented in Table 1. A few of the design elements are omitted from this presentation since there is no clear connection to the intermediary functions.

Task/topic specificity also called problem specification is the solution space for the innovation contest. This can either be low (open task), defined or high (very specific task). A majority of the contests were defined and highly defined. Most organizers seem to demand a special function from the services that are developed during the competition, but leaves much room for individual interpretation by the participants. By specifying the task and topic for the participants the contests articulate needs and requirements that are part of the function *1. Foresight and diagnostics*. However, they do not provide technological roadmaps supporting foresight. Instead the technology seems to be quite given and contests rely on participants own understanding of technologies related with open data and services.

Degree of elaboration is the required level of detail for submission to the contest, and can either be an idea or a prototype. Most of the competitions required a prototype or the combination of idea and prototype. This is related to parts of the function of *5. Testing, validation and training* where innovation intermediaries provide support for technical evaluations.

Target group is the type of people meant to participate in the competition, for example that all participants must live in a special area or that all participants' needs to be of a certain age. A little less than half of the studied contests specified requirements for participation. By specifying the target group for participation the contests scope and filter partners for future collaboration, which is part of the function *2. Scanning and information processing*.

Participation as measures the number of persons forming an entity of participation, as an individual, a team or both. Most contests accepted participation as both individual and as team. The related intermediary function is similar to target group above and by specifying the form of participation the contests scopes and filters partners for future collaboration, which is related to the function *2. Scanning and information processing*.

Community functionality are means for interaction within and between participants, often an online forum or similar, and can either be given or not given. Most contests do not provide this functionality although a significant number do. By providing such functionality digital innovation contests support both identification of potential partners for collaboration and matchmaking to establish teams and collaboration between teams. Hence, activities that support the functions *2. Scanning and information processing* and *4. Gatekeeping and brokering*.

Evaluation is the method to determine ranking of submissions to the innovation contest and can either be a jury evaluation, peer review or mixed. A majority of contests use jury evaluations and some combine this with peer reviews. Through the evaluation process, which can be carried out in several steps, scoping and filtering is performed together with prototype evaluation, activities that support the functions *2. Scanning and information processing* and *5. Testing, validation and training*.

Needs are means either as resources provided to stimulate contenders to develop contest contributions that meets end users requests of digital services (through e.g. a persona, scenario, trend, case, brief), or facilitation during the contest to understand end users' needs connected to the contest purpose. A significant number of contests provided this support with the majority providing this in the form of a resource (case description or problem brief). This support is associated with articulating needs and requirements and the function *1. Foresight and diagnostics*.

Value are means either as resources provided to stimulate contenders to develop contest contributions that possess the potential to become a viable service and a business (through e.g. a toolbox to develop a business model, connection to venture capital), or facilitation during the contest to create a valuable offer in relation to the contribution or a business model. A significant portion of the contests provided this support with the majority offering this in the form of workshops or meet-ups where contenders were matched or introduced to business coaches or representatives for venture capital or networks. This means that digital innovation contests support business planning and commercialization, which belong to the function of *9. Commercialization: exploiting the outcomes*. Moreover, contests use this in order for participants to discover and include business needs and requirements in their solutions, which is associated with the function *1. Foresight and diagnostics*.

Data is the developers' raw material in open data challenges. A majority of the contests provided own APIs with data. Of the organizers that not provided own data, a large number guided the participants where to find appropriate data for the contest's purpose. A majority of the contests that provided open data also allowed and promoted other data sources to be used in the contest. By providing data and information about other data sources and standards for accessing data in the form of APIs innovation contests help participants to combine knowledge and resources from different partners as well as providing standards for building services hence supporting the functions *3. Knowledge processing, generation and combination* and *6. Accreditation and standards*.

Novelty is a design element that strives to promote that the outcome from the contest has a higher level of innovation than current services on the market. In order to promote this the organizer could have defined rules and criteria for intellectual property and evaluation, which includes novelty. The organizer could also provide an innovation baseline in terms of a review of existing services on a market that creates the baseline for innovation. The organizer could require a patent survey from the participant together

Table 4
Summary of innovation intermediary functions associated with how digital innovation contests are designed

| Design elements	Related to function
Media	–
Organizer	–
Task/topic specificity	1. Foresight and diagnostics
Degree of elaboration	5. Testing, validation and training
Target group	2. Scanning and information processing
Participation as	2. Scanning and information processing
Contest period	–
Reward/motivation	–
Community functionality	2. Scanning and information processing
	4. Gatekeeping and brokering
Evaluation	2. Scanning and information processing
	5. Testing, validation and training
Needs	1. Foresight and diagnostics
Value	9. Commercialization: exploiting the outcomes
	1. Foresight and diagnostics
Data	3. Knowledge processing, generation and combination
	6. Accreditation and standards
Novelty	8. Intellectual property: protecting the results
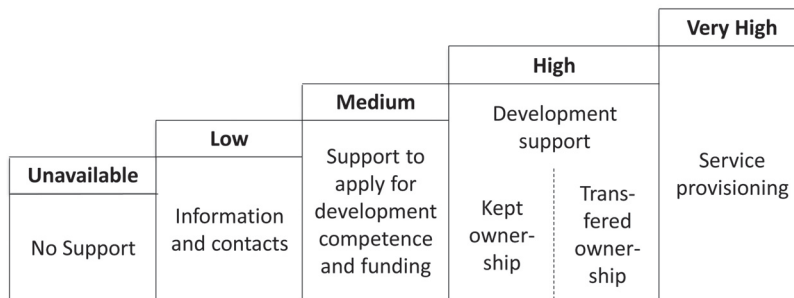
Fig. 2. Classification of the level of support provided by the contests for the innovation process after competition is completed.

with the submission of the contribution providing evidence for novelty. A majority of contests provide support to ensure novelty in the contest contribution. Of these the majority of contests present rules and criteria that include novelty. By doing so contests support participants in assessing their ideas for protection of intellectual property that is associated with the function *8. Intellectual property: protecting the results*.

To summarize, a digital innovation contest is designed to provide support associated with several of the functions performed by innovation intermediaries, see Table 4. In our study, some contests have designed their contests to provide more thorough support than other contests.

5.2. *Support for the post-contest process*

In this section we present how the organizers and sponsors of the innovation contests support the participants after the contests have been concluded. The results show that organizers of innovation contests provide varying levels of support for the post-contest process. We have categorized the levels of support using thematic analysis of the activities described at the surveyed websites. We name these levels: unavailable, low, medium, high and very high, see Fig. 2.

We claim that organizing this type of support requires a design element of its own and we label it "Post-contest support". Hence, the levels of this support become attributes of the design element "Post-content support" and the naming adheres well to the naming convention of attributes used by [3].

Unavailable – In half of the contests, the organizers choose not to give the winner further support with funding or competence development. This is often phrased as a wish for the winning developer to continue working on the project alone. Another example is where the organizers do not mention any continuance of development after a winner of the competition has been selected.

Low – Low level of support is where the winner is offered information and contacts. These can be presented to the winner in several forms. A few examples are participation in events organized for possible sponsors or a nomination to another contest. In 31% of the contests the support for the post-contest process is low. This type of support relates to an innovation intermediary's function to filter out promising participants and ideas or prototypes to other contests or to be presented to contacts that can help the participant to develop the solution to a viable open service, *2. Scanning and information processing*. It also relates to the function of sharing information and combining knowledge of several partners, *3. Knowledge processing, generation and combination*.

Medium – The winner is offered support to apply for development competence and funding, often from the appropriate authority but also from other sources such as bigger corporations or sponsors. 3% of the contests offered this level of support. This type of support also relates to the support discussed above but the innovation contest takes greater responsibility for establishing the relationships moving towards brokering of contracts, *4. Gatekeeping and brokering*. Moreover the support is of a more commercial nature resembling the functions of finding potential capital funding and organizing applications to retrieve funds, *9. Commercialization: exploiting the outcomes*.

High – The organizer of the Innovation contest offers the winner developer support. At this level, the rights to the winning mobile application or computer system can either stay with the original developer, or be transferred to the organization hosting the contest. If the winner of the contest keeps the rights of ownership to the winning submission the development support often consist of enrollment in a mentorship program or help with refining the product. On the other hand, if the ownership of the submission is transferred over to the organizer of the contest, the organization in question in most cases choose to further develop the product without the involvement of the original contestant. 13% of the contests offered this level of support. At this level the organizers of the innovation contest share a greater deal of the development risks and perform the functions associated with the previous levels but also with *5. Testing, validation and training* and with *8. Intellectual property: protecting the results*.

Very high – Only 3% of the competitions offered a very high level of support. At this level the organizer of the contest and the winner work together to refine the product and later see that the results are funded and published by an appropriate authority. This most likely results in a used service available on the market. Here the innovation contest offers comprehensive support related to marketing and sales and public offerings associated with *9. Commercialization: exploiting the outcomes*.

To summarize, digital innovation contests by providing this support performs additional functions as well as functions at a greater scale associated with innovation intermediaries. It is primarily functions related to filtering and sharing of contacts as well as supporting funding and commercialization.

6. Discussion

Digital innovation contests play an important role in stimulating open service innovation. So far the market for open data services is limited but the interest from government is vast and digital innovation

contests promote open data sources and provide means for citizens, third-party developers and firms to meet and collaborate to develop new open data services and hence support the establishment of sustainable open data markets. Organizers of digital innovation contests can by increasing their understanding of their role as innovation intermediaries design their contests so that they support innovation in the most favorable ways. Our survey shows that organizers are often public organizations that act in local innovation systems, maybe as suppliers of open data. Given the local context in terms of for example user needs, available competencies and actors they can choose the most important functions of the innovation contest and design it accordingly. By integrating the contest with the local innovation system increases the chances of innovation to occur since innovation systems are determinants to innovation [20]. It also becomes clear that a digital innovation contest is a specific actor in an open data innovation system that other actors, such as open data suppliers, applications developers and end users must relate to and can benefit from collaborating with. By studying open data through the lens of systems of innovation we gain a better understanding of open data, its associated actors and how sustainable open data markets [8] are established.

Organizers of digital innovation contests can choose to provide more or less support to the participants in the process after the contest. We defined a key design element with five attributes that can be used by organizers of innovation contests to design and describe the level of support they provide to their participants. By providing low to medium support in the post-contest process organizers can help participants overcome the greatest innovation barriers *Lack of time and money* and *Lack of marketing competence and market information* (see Table 3). The higher levels of post-contest support may support participants to overcome barriers related to technical development and commercialization. But we do not claim that the organizers always should strive for providing a high level of support. If you provide a higher level of support you will also share a higher portion of the risks associated with development and commercialization. On the contrary, if you want to stimulate developers to take own responsibility for their services then you want to provide for example a low or medium level of support. But if you want to ensure that the services become used by a large number of end users then you as an organizer may consider to provide a higher level of post-contest support.

It might be tempting for public organizations to provide very high post contest support especially when the public needs are great and the market forces are weak. However it might be in conflict with public procurement laws. Designing the digital innovation contest as an event for innovation procurement might be a possible way to fulfill public procurement laws.

We found that the web information provided by innovation contests covered much of the design elements defined by [3]. However it was difficult to evaluate topic specificity due to a continuum scale (low – defined – high). It was also hard to differentiate between types of awards since they are mostly mixed including both monetary and non-monetary components. The web sites also provided information about the open data sources available to the participants, making it possible to evaluate the design element "Data" [4]. But it was more difficult to find published information about "Needs", "Value" and "Novelty". In order to be able to value this the web sites had to include a detailed program or statement of provision of mentoring or the arrangement of meet-ups. In order to gain a better understanding about these design elements it is necessary to perform a more in-depth analysis of the contests using for example observation and interview as research methods.

The above discussion points towards the need for establishing a comprehensive toolbox for designing the components that comprise a digital innovation contest. The pre-process before the contest has to be constructed using design elements that define for example who to target as participants, what the aim is with the innovation contest, what effects that the organizer wants to achieve, which resources must be

made available etc. Also the contest process must be designed using design elements defining contest rules, mentorship and guidance, prize, evaluation, data provision, facilitation etc. In addition, the results from the analysis in this paper propose that a comprehensive toolbox must have design components that support the organizer to design the post-process following the contest. The reason is to meet the objective with the contest. As stated in Fig. 1 an aspect in the post-process is hence to decide what level of support should be provided after the contest. If the organizer aim to provide high level of support then a systematic post-process has to be designed in order to achieve this level; contrary, if the organizer aim to provide no or little support after the contest then this conscious decision means that the organizer release the control of the open innovation process when the contest ends.

Finally, we noticed that several of the innovation contests would benefit from providing more information to developers. Missing information could be anything from what type of prizes that will be handed out to if the competition has any type of forum or community made for contact between different participants. There are also cases of unclear rules, such as if anyone can participate in the competition or if participation is restricted to a certain age group or inhabitants of the area where the competition is being held.

7. Conclusion and future research

In this paper our research questions were:

What are the functions of digital innovation contests in open data markets?
How are digital innovation contests designed in order to support the post-contest process?

We found that digital innovation contests play the role of innovation intermediaries in emerging open data markets. Depending on their design they perform more or less of the functions of innovation intermediaries to overcome gaps that hinder co-operation between actors, e.g. articulate end user needs, attracting developers, filtering and combining competences and supporting commercialization and protecting intellectual property rights.

We have defined a key design element for innovation contests, namely "Post-contest support". It includes five attributes: unavailable, low, medium, high and very high. This design element can be used by organizers of digital innovation contests to define the level of support they provide for the post-contest process where the participants' digital service ideas or prototypes are finalized, implemented and operated in order to reach a significant user base. The key design element adds to the available key design elements for innovation contests presented by [3,4].

In addition, we contribute with an analysis of the designs of current digital innovation contests. The analysis serves as a reference to organizers of digital innovation contests.

For future research we intend to further the understanding of open data markets and the role of digital innovation contests using systems analysis. Moreover we propose to develop guidelines and tools for organizers of digital innovation contests to design contests that better meet the needs of a particular open data market, be it local, national or sectoral.

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Appendix 1

List of innovation contests included in the investigation.

Innovation contest	Web address
1746 Hackathon	http://www.rio.rj.gov.br/web/hackathon/
2013 Data Design Diabetes Innovation Challenge	http://redesigningdata.com/ddd/
American Energy Data Challenge 2014	http://energy.gov/articles/energy-department-launches-competition-encourage-creation-innovative-energy-apps-built-open
ApPalermo: Palermo Open Data Contest 2014	http://www.epsiplatform.eu/content/appalermo-palermo-open-data-contest
Apps for development competition 2014	http://data.worldbank.org/developers/appsfordevelopment
Apps for Europe 2014	http://www.appsforeurope.eu/competition
Apps per la inclusión social 2014	http://inclusiosocial.hackathome.com/
Apps4Edmonton 2014	http://contest.apps4edmonton.ca/
Apps4Finland 2013	http://www.apps4finland.fi/en/
Apps4Halifax 2014	http://www.apps4halifax.ca/
Apps4Ottawa 2013	http://www.apps4ottawa.ca/en
BCN apps cultura 2014	http://appscultura.hackathome.com/es/
BigApps NYC 2013	http://nycbigapps.com/
Cairo transport App Challenge	http://cairo.hackathome.com/
Canadian Open Data Experience 2014	https://www.canadianopendataexperience.com/pages/competition
Codemocracy 2013	http://codemocracy.se/
Gothenburg Distribution Challenge 2014	http://www.gdc2014.se/
Hack for Sweden 2014	http://hackforsweden.se/
Infojobs App challenge 2013	http://infojobs.hackathome.com/
ITS In Your Pocket 2014	http://www.itsinyourpocket.com/
LODLAM (Linked Open Data in Libraries and Museums) 2013	http://lodlam.net/about/
Open Cities App Challenge 2014	http://opencities.net/app_challenge
Open Data Challenge 2014	http://www.landregistry.gov.uk/campaigns/open-data-challenge
Open Data Challenge Series 2015	http://theodi.org/challenge-series
Open data for development challenge 2014	http://www.acdi-cida.gc.ca/acdi-cida/acdi-cida.nsf/eng/DEN-1223131242-PCZ
Open Stockholm Award 2014	http://www.openstockholmaward.se/
Phillipine transit App challenge 2013	http://philippine-transit.hackathome.com/
Sanitation App challenge	http://sanitation.hackathome.com/
Stockholm Innovation Award	http://www.stockholm-life.se/en/Calendar/City-of-Stockholms-Innovation-Award/
Take Action Open Data Challenge 2013	http://www.qlik.com/us/landing/open-data-challenge-winner
Travelhack 2013	http://www.travelhack.se/
Visualise open data 2013–2014	http://www.theguardian.com/news/2013/feb/12/government-data-free-our-data