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A Method for Designing Digital Innovation Contest Measurement Models

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Abstract

As contests become more popular means for organizing digital innovation, the need for measuring contest performance increases. The Digital Innovation Contest Measurement-model (DICM-model), which is the basis for this study was designed based on a single case study, and its evaluation indicated that there is a need for a customizable methodological approach that can accommodate differences in organizational requirements for designing and refining DICM-models. Therefore, in this paper, we present a summary of the evaluation of the DICM-model and propose a nine-step method to design and refine DICM-models using a quality oriented approach. The proposed method is based on the Goal-Question-Metric and the Balanced Scorecard to elicit measures and to enable agility in measuring the fulfilment of measurement goals of innovation contests. Also, the method facilitates knowledge management to refine, record and communicate best practices. An ex-ante evaluation of the method indicates that the method provides practical support in designing and improving a DICM model. For future study, it is suggested to widen the scope of the method to aid in the design of measurement models for digital innovations using open data, in general.

Keywords: Digital Innovation Contest, Design of Measurement Model, Open Data Innovation, Goal Oriented Measures, Goal Question Metric

1 Introduction

The growth of open data is exponential (Kundra 2012) and its direct market, only in EU, is estimated to grow by 36.9% between 2016 and 2020 (Carrara et al., 2015). There are plenty of open data markets for the public to advance entrepreneurship, stimulate start-ups, and enhance services (Lakomaa and Kallberg 2013). Access to open data also facilitates social, and business value creation (Lindman et al. 2013) and is in turn enabled by innovation and openness (Jetzek et al. 2013). However, open data has no value unless utilized and yet little is known about the development of digital services from open data (Janssen et al. 2012).

Digital innovation is the process in which a product, process, or business model that is regarded as new, or that involves some significant changes, is developed and is embodied in or enabled by IT (Fichman et al. 2014). Pervasive digital technologies are increasingly penetrating deeply to radically alter the nature of product and service innovations in organizations (Yoo et al. 2012). For example, the Internet of Things

(IoT) is enabling the utilization of digital artifacts to combine digital solutions with well-established products (Atzori et al. 2010). Additionally, digital innovation contests have become important means to stimulate digital services innovation based on open data. In addition to enabling knowledge sharing in open data marketplaces (Smith et al. 2016), digital innovation contests stimulate open data service development (Juell-Skielse et al. 2014). Hence, managing the process of digital innovation contests is vital for the success of open data innovation.

Measurement is an important aspect of innovation management. A Digital Innovation Contest Measurement-model (DICM-model) is a model that is intended for measuring digital innovation contest and service deployment processes. For example, fulfilment of measurement goals, which are subsets of contest goals. Few innovation measurement models in the literature address digital innovation contests. Also, there is hardly any model to manage open data development using digital innovation contests (Ayele et al. 2015). Therefore, there is a need for digital innovation contest measurement models. Ayele et al. (2015) proposed a Digital Innovation Contest Measurement Model (DICM-model), which is the only model so far presented to evaluate the digital innovation contest and post-contest service deployment processes. However, the evaluation of the DICM-model as presented in Ayele et al. (2015) yet fails to fully enable the measurement of digital innovation contests and service deployment for a particular contest organizer. Also, the DICM-model can only partially measure a given innovation contest due differences in measurement goals of organizers relevant to their context. Moreover, the design of the DICM-model is based on a single case study, and its transferability is, therefore, considered limited.

In this paper, we present a summary of the evaluation of the DICM-model of Ayele et al. (2015) and propose a method for Designing and Refining DICM-models (DRD-method) for open digital innovation contests and succeeding service deployment using a design science approach. The DRD-method aims to tailor DICM-models to different operational and strategic measurement goals. It is informed by a paradigm called Quality Improvement Paradigm (QIP), which emphasizes continuous improvement, as well as the Balanced Scorecard (BSc), which enables identification of strategic measures. The QIP paradigm uses the Goal-Question-Metric approach (GQM) for articulating and evaluating operational measurement goals, and it is based on the Shewart-Deming Cycle Plan-Do-Check-Act (PDCA) (Basili el al. 1994). The combination of GQM and BSc is found to be useful for methodological tailoring (Buglione and Abran 2000; Aversano et al. 2004). The figure below, Figure 1, illustrates central concepts, in particular, DRD-method and DICM-model, and the relations between them.

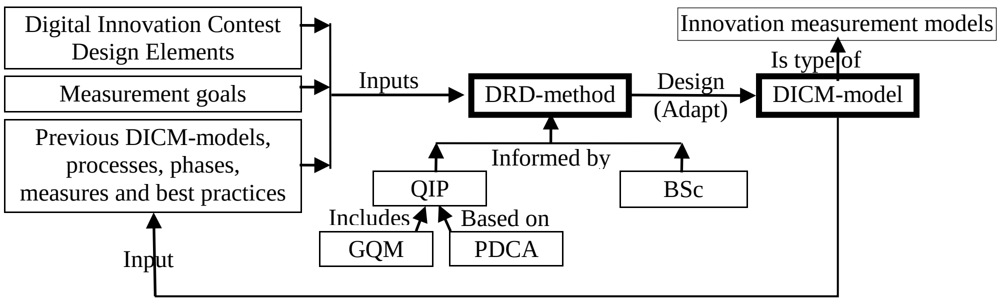

Figure 1: Central concepts, illustrating how DRD-method is built and the inputs used by DRD-method to design and refine DICM-models.

This paper has six sections. In the next section, we present a theoretical foundation of innovation measurement and innovation contests. The third section covers the research method followed by the design, presentation and evaluation of the proposed DRD-method in section four. Section five includes a discussion about the value and contribution of the DRD-method. Finally, we conclude the paper and discuss future research in Section six.

2 Theoretical foundation

Contests have become popular means to both spark and systematize innovation based on open digital resources (Hjalmarsson and Rudmark 2012). Contests can be used during early stages of innovation to stimulate ideation (Bullinger and Moeslein 2010), as well as to catalyze the development of prototypes for digital services in later stages (Osimo et al. 2012). A contest approach can in these situations be used to engage different innovators to collaborate and compete and to warrant that the novel solutions are developed that adhere to goals that organizers promote (Hjalmarsson and Rudmark 2012). Through contests, organizers act as innovation intermediaries (Juell-Skielse et al., 2014). For effective utilization of contests, organizers need an effective DRD-method for designing their DICM-models.

Measuring strengths and weaknesses in the innovation process can be achieved using models based on the innovation value chain (Hansen and Birkinshaw 2007; Ishak 2014). However, among available innovation measurement models and frameworks, only a few are designed to measure innovation contests and hence there is a lack of measurement models for digital innovation contests (Ayele et al. 2015). Therefore, Ayele et al. (2015) proposed the Digital Innovation Contest Measurement Model (DICM-model), which is based on the innovation value chain. The design of the DICM-model is inspired by the components of the innovation value chain presented by Erkens et al. (2013) which includes inputs, activities, outputs, and measures for each phase of the innovation value chain.

The DICM-model enables the evaluation of digital innovation contests using open resources and catalysed by contests (Ayele et al. 2015). It covers the Innovation Contest process and the succeeding Service Deployment process with three phases each. The Innovation Contest Process includes the phases: planning, ideation, and service design. The Service Deployment Process covers the phases: preparation, implementation and exploitation, i.e. to convert software prototypes to viable digital services and evaluate their diffusion (Ayele et al. 2015). Each phase consists of inputs, activities to convert inputs to outputs, outputs, and measures to evaluate leading and lagging indicators. A summary of the DICM-model is presented in Table 1 below. Despite its relevance as a means to catalyse open data service development and deployment using contests, the DICM-models applicability is limited as it is grounded only on a literature review and a single case study. Hence, there is uncertainty if the DICM-model supports differences in contest goals and is flexible enough to adapt to different contexts.

Table 1: Components of the two processes summarized.

	Innovation Contest Process			**Service Deployment Process**		
Phases	Planning	Ideation	Service Design	Preparation	Implementation	Exploitation
Inputs	Inputs are resources that organizers of a contest bring in to the contest					
Activities	Activities of work that contest organizers perform					
Outputs	The end result from each phase					
Measures	Measures related with leading and lagging indicators					

2.1 GQM: Goal – Question - Metric

Unlike the DICM-model, the Goal Question Metric approach (GQM) uses goals to define measures for innovation (Misra et al. 2005). The GQM was originally introduced for evaluation of defects in software engineering projects in NASA (Basili and Weiss 1984) and is widely used in software projects (Buglione and Abran 2000). However, GQM is also applicable in other disciplines such as software and information security (Savola 2008; Kowalski and Barabanov 2011; Kassou and Kjiri 2013), information systems (Kassou and Kjiri 2013; Esteves et al. 2003; Ganesan and Paturi 2009), and healthcare (Villar 2011). In the GQM paradigm, questions are derived from goals and metrics are derived from questions (Basili et al. 1994). The three levels: at the conceptual level (Goal), measurement goals are defined for products, processes or resources. At the operational level a set of questions are formulated to operationalize the specified goals, and finally, at the quantitative level measures are defined to answer the questions quantitatively. The measured data can be objective such as work hours spent on a task, as well as subjective such as level of satisfaction (van Solingen et al., 2002). Measures are adapted to quantitative values using Likert scales (Hansen and Birkinshaw 2007, Erkens et al. 2013; Ganesan and Paturi 2009).

The GQM approach is directly used or indirectly implied in identifying measures in some innovation measurement models. For example, Hansen and Birkinshaw (2007) use key questions to identify measures, Enkel et al. (2011) use questions to measure innovation maturity levels and Tidd et al. (2002) and Gamal et al. (2011) use a set of questions to assess dimensions of innovation in the “Diamond Model”.

2.2 Balanced Scorecard and Goal Question Metric GQM

The BSc is a multidimensional framework that relates objectives, initiatives, and measures to an organization’s strategy at all levels (Kaplan and Norton, 1996). The perspectives of BSc are Financial to measure business performance, Stakeholder to measure customer satisfaction, Internal Process to measure efficiency, and Learning & Growth to measure knowledge and innovation. The BSc enables identification of strategic measures to estimate the impact of open innovation (Flores et al. 2009).

The GQM and the BSc cover different aspects of measures in spite of the similarities they share in deriving metrics. For example, a higher level strategic perspective is missing in GQM, while strategic goals can be addressed using BSc (Buglione and Abran 2000). Also, the use of both approaches in combination is productive (Buglione and Abran 2000). There are similarities as well as differences between GQM and

BSc. For example, BSc uses goal-driver-indicator to derive metrics in a similar fashion as GQM does. The difference is that GQM applies to multiple contexts while BSc has a structure to facilitate the alignment of operational goals and business goals. Also, BSc's perspectives can be integrated by including GQM to elicit additional measures for each perspective of the BSc (Buglione and Abran 2000).

2.3 Quality Improvement Paradigm

The Quality Improvement Paradigm (QIP) has a six step cycle that emphasizes continuous improvement and is based on the Shewart-Deming Cycle Plan-Do-Check-Act (PDCA) (Basili et al. 1994). The PDCA is a widely known model for continuous process improvements; it explains how an organization plans, does what has been planned, checks to see if what has been planned is actually done, and acts on what has been learned (Johnson 2002). The QIP uses the GQM paradigm for evaluating and articulating a list of operational goals using measurement (Basili et al. 1994). The six steps of QIP are 1) characterize: understand environment and establish baseline with existing business process also use knowledge gained from previous projects, 2) set goals: identify goals, based on step 1, that lead to success in the project, 3) choose process: choose suitable processes based on step 1 and 2, 4) execute: execute processes and provide project feedback based on data collected on goal achievement, 5) analyze: at the conclusion of the project collect data and make analysis to assess current practice, identify problems, and make recommendations for future projects, and 6) package: combine knowledge gained from the current project with previous projects and store it for future projects.

3 Method

In this study, a design science approach was used as suggested by Peffers et al. (2007) to develop a method for designing DICM-models. The six activities of design science are: problem identification, objectives of a solution, design and development, demonstration, evaluation, and communication (Peffers et al. 2007). This work builds on the first design iteration of the DICM-model, presented by Ayele et al. (2015). In this study, we conduct a second iteration to design a method for developing DICM-models for innovation contests. Therefore, we include an evaluation of the DICM-model in the problem identification activity.

A literature study was conducted to identify research on goal oriented evaluation and its applicability in measuring innovation. We used a combination of keywords such as goal oriented measure, digital innovation contest, innovation measurement, open data innovation, goal oriented measures, and goal question metrics to locate relevant scientific works.

Evaluation of the DICM-model, as part of problem identification, was carried out using semi-structured interviews with supporting questionnaire involving 13 respondents. Thematic analysis was used to identify, analyze, and report themes and patterns of collected data (Braun and Clarke (2006). As a starting point for the analysis, we applied the so-called SWOT framework (Hill and Westbrook, 1997) to identify strengths, weaknesses, opportunities, and threats of the DICM-model. The respondents are experts in organizing digital innovation contests, see Table 2. Also, some of the experts are additionally experienced in managing idea competitions, and innovation contests where the outcome can be digital services, gadgets, and business ideas.

Table 2: List of respondents represented for simplicity as “RX” where R stands for the respondent and X stands for the index number.

Digital Innovation Contest	Role
R1: Nasa Space Apps Challenge 2015, Prototype Change Hackathon	Consultant (Sweden)
R2: Apps4Finland 2013	Project Manager (Finland)
R3: Electricity Innovation Challenge 2015	Organizer (Sweden)
R4: TravelHack 2011	Project Manager (Sweden)
R5: Volvo Truck Open Innovation Contest 2015	Project Manager (Sweden)
R6: Olympic City Transport Challenge	Project Manager (Sweden)
R7: Volvo Goods Distribution Challenge 2014	Project Manager (Sweden)
R8: Singapore Management University Youth Innovation Challenge	Senior Management (Singapore)
R9: Thessaloniki Innovation Zone	Development Manager (Greece)
R10: Open Stockholm Award 2011 and 2014 and UMIS project in Rio 2016	Project Manager (Sweden)
R11: Sweden Robot Hack 2013 and East Sweden Hackathon	Project Manager (Sweden)
R12: University of Nicosia Digital Championship	Project Manager (Cyprus)
R13: LU Open Innovation	Project Manager (Sweden)

4 Result

4.1 Problem identification

The evaluation of the DICM-model by Ayele et al. (2015) indicated that there is a need for an agile method to design DICM-models meeting differences in requirements of contest organizers. According to the experts, the model by Ayele et al. (2015) partially enables the measurement of innovation contests based on available data (R1, R2, R3, R4, R5, R7, R8, R12), but it lacks support to provide all relevant measures for a given contest (R13). Moreover, it lacks contextualization based on measurement goals. For example, (R8) argues that “*you may remove something not being relevant based on the motivation so for me the most important thing is the context*”. Additionally, the model lacks flexibility to customization; (R2) stated that “*it could also be useful to present the innovation model as modifiable e.g. by pointing out the possibilities in mixing phases or alike*”. For example, integrated process phases need integrated activities to be rearticulated (R8). Also, activities, inputs, outputs, and measures in each phase of a given contest are dependent on the context of the contest (R8). The DICM-model should in terms of guidelines be redesigned to increase its usability (R5, R8).

There is, therefore, a need for a method to design and refine DICM-models that aligns goals of a contest, in particular measurement goals, with the evaluation of the contest. The absence of a method to identify relevant measures, and the weaknesses of the DICM to fulfill its design objectives, encouraged us to develop a method to design and refine DICM-models that takes into account variations in the goals and designs of innovation contests as well as the utilization of available knowledge. For example, the model should include relevant inputs, outputs, activities, and measures to specific measurement goals.

4.2 Objectives of a solution

The objectives of the proposed DRD-method are based on the problem identification in Section 4.1.

1. To aid in designing DICM-models that measure the fulfilment of the measurement goals of innovation contests.
2. To aid in designing DICM-models that identify strengths and weaknesses in the innovation value chain.
3. To aid in designing DICM-models that support learning and knowledge management in the development of digital services.
4. To be easy to use by organizers of innovation contests.

4.3 Design and development of the method

The proposed DRD-method is used to design a DICM-model, refine it while in use, and facilitate learning and communication of best practices. The QIP, which has six steps and uses the GQM, was used to design a DRD-method. The six steps of the QIP are mapped into nine steps and are adopted to design the DRD-method grouped into three phases as illustrated in Figure 2. The first three steps in the QIP such as *Characterize*, *Set goals*, and *Choose process* are articulated as *Characterize contest environment*, *Set measurement goals*, and *Build measurement model* respectively in Phase 1 using GQM and BSc as measure eliciting techniques. The fourth step in QIP, *Execute*, is mapped into three steps in the new method such as *Analyze result*, *Measure*, and *Provide immediate feedback* in Phase 2. The fifth step in QIP, *Analyze* is mapped to *Analyze* in the third phase. Finally, the sixth step, Package, in QIP, is articulated into two steps such as *Package* and *Disseminate*.

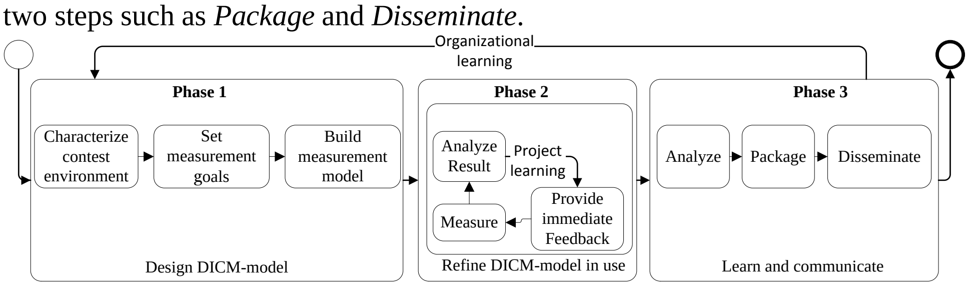

Figure 2: A nine-step DRD-method to design and refine DICM-models.

Phase 1: Design DICM-model

In this phase, organizers carry out the activities listed in steps 1, 2, and 3 to design a DICM-model for a specific digital innovation contest.

Step 1. Characterize contest environment

Characterizing is a step where organizers elicit contest requirements, understand contest goals to identify measurement goals, and design processes. Organizers can also use accumulated knowledge so that previously used models and best practices can be customized to current requirements. Theoretical foundations are also used to characterize innovation contests and post contest deployments.

Motivation for including Characterize step

According to R1 and R2 the DICM-model by (Ayele et al. 2015) needs to include a pre-planning phase before the planning phase. Similarly, Basili et al. (1994) suggest characterization as a step where understanding the environment based on available models, data, intuition, etc to establish a baseline with existing processes in the organization. Hence, old DICM-models from previous contests can be used as an input in this step. In this step, one can also use best practices as suggested in the characterize step by Basil et al. (1994). Similarly, previously used models can be customized to current design or customization endeavors. For example, continuous evaluations from earlier years or contests (R2) and periodically address feedbacks from previous contests (R8) was suggested. The DRD-method supports knowledge management (R12).

Step 2. Set measurement goals

Organizers can identify relevant perspectives such as financial, innovation, customer, and others to address strategic objectives. In addition to this, organizers identify and list goals specified by contest owners for each relevant measurement perspective. If goals are not specified in detail then organizers need to redefine goals and sub-goals to the most granular detail to enhance their clarity as base for measurement. In this step, organizers verify the relevance of goals and sub-goals identified by contest owners. In parallel with this, organizers can categorize these goals under perspectives of the digital innovation contest environment, for example the perspectives of BSc. Finally, questions need to be articulated to measure goal fulfilment.

Motivation for including the Set measurement goals step

The assessment of the DICM-model presented in Ayele et al. (2015) indicated that goals of a given contest are not fully measured. This because that the DICM-model, presented in Ayele et al. (2015) only measures the fulfilment of contest goals partially and hence needs a revised version of the model be customizable. Besides, innovation contests depend on the aim of the whole process (R4, R8 R11). Therefore, identifying goals is a crucial step in designing digital innovation contest. Questions can be derived from goals (Basili et al. 1994), and questions need to be articulated to measure goal fulfilment at each stage (R8). Goals and their corresponding measures can be identified under each perspective as illustrated in Figure 2. Similarly, questions are presented to identify or relate metrics (Hansen and Birkinshaw 2007; Enkel et al. 2011; Tidd et al. 2002; Gamal et al. 2011).

In cases where companies have innovation as one of their development strategies additional performance measures are required (R7). Therefore, innovation and other organizational perspectives can be included to measure strategic performance. The perspectives such as financial, customer, internal process, and learning and growth can be included. Also, the perspective people is added in the Balanced IT Scorecard (BITS) (Buglione and Abran 2000).

Step 3. Build measurement model

Organizers identify, define and describe processes, phases, inputs, activities, outputs and measures of their DICM-models based on characteristics and questions. Since questions are derived from goals and metrics from questions, the GQM paradigm is an important mechanism for building the measurement model. Identification of required data sources is also an important activity when building a measurement model. Qualitative measures such as market potential can be assigned scales with quantitative ordinal values with labels: very insignificant, insignificant, neutral, significant, and, very significant correspondingly.

Motivation for including the Build measurement model step

The innovation contest and the service deployment processes of DICM-model by (Ayele et al. 2015), are relevant according to most respondents. Despite this, additional inputs, activities, outputs, and measures were also suggested since the goals of each respondent is contextual. Therefore, one can take the two processes of the DICM-model and customize it using this method to identify relevant elements. However, some experts also suggested new processes and phases as discussed in the Theoretical foundation section. Digital innovation contest processes depend on goals of the whole innovation process (R4, R8, R11). Also, Basili et al. (1994) stated that, based on the characterization of the goals and the environment, organizers need to choose their processes. So organizers need to define their processes and identify phases, inputs, outputs, and activities if their processes are different from the processes of the DICM-models. Activities of DICM-models can be formulated from goals of innovation contest (R6, R11). Also, activities in cases when phases are merged into one phase need to be rearticulated and integrated measures need also be identified (R2, R5, R12). Metrics can be identified based on goals (R4). More specifically, identification of metrics is done by articulating questions from goals, then deriving metrics from these questions, and finally deriving metrics that can answer these questions (R8), (Basili et al. 1994). Additionally, goals can be mapped into perspectives as shown in Figure 2 to measure strategic objectives. To measure qualitative metrics quantitatively, a Likert scale can be used as illustrated by (Hansen and Birkinshaw 2007; Erkens et al. 2013). Organizers also need to identify data sources (R10).

Phase 2: Refine model in use

In this phase, organizers assess contests and service deployments by following guidances listed under Sections 1, 2, and 3. Hence, after measuring current phases of contest processes, organizers analyze the result and provide immediate feedback. The feedback itself is utilized to improve performance and make modifications to the model in Section 4.4, Measure. This Phase is iterative until the organizers decides to terminate the contest.

Step 1. Measure

In this step, organizers start the innovation contest by setting a timeline for each phase of the DICM-model within the deadline set by the contest owners. Similarly, if organizers support service deployment, they need to customize DICM to cover this phase by initially setting time for each phase. Organizers follow the timeline to execute activities in each phase of DICM using inputs to produce outputs and collect measures to provide execution feedback at each phase. Refine model in use is an iterative step with three sub-steps. The first step is Measure where organizers allocate or reallocate time for each innovation contest process and service deployment phase and starts executing activities; organizers also follow execution feedback if the phase in the innovation contest or service deployment is redone. Finally, the third sub-step is to provide execution feedback by compiling measured performances, and then finally organizers decide to conclude execution of current phase and continue to the next phase, or re-execute to the current phase of innovation contest or service deployment process.

Motivation for including the Measure step

Organizers start the execution of digital innovation contest or service deployment processes by allocating timeline for each process according to the deadline set by the contest owners (R11). In addition to these, organizers follow their model to execute activities to convert inputs into outputs at each phase, which is a recursive process (R12). Measures such as availability of resources can be used to monitor utilization of resources by comparing the cost and returns (R7). Also, project analysis and then feedback can be obtained after collecting data regarding assessment of goal achievement (Basili et al. 1994).

Step 2. Analyze result

In the second steps organizers start analyzing the collected measures to identify deviation and their root causes. Also, organizers suggest coping strategies of barriers encountered.

Motivation for including the Analyze result step

Measured phases need to be analyzed to provide feedback for improvement during execution as suggested by all respondents. Analyzing result to provide project learning is essential for quality improvement (Basili et al. 1994).

Step 3. Provide immediate feedback

In this step, organizers compile and communicate measured performances to suggest coping strategies for barriers encountered during the contest. Organizers refine the current measurement model to reflect the current contest situation, for example, if feedbacks indicate that there are inputs, activities, and or outputs which need to be incorporated or rearticulated in a given phase to reflect elicited refinements, then refinement suggestions are made to the measurement model.

Motivation for including the Provide immediate feedback step

Organizers measure to provide feedback during execution. Feedback control cycle is used for monitoring utilization of resources (Basili et al. 1994). For example some of the respondents claimed when evaluating the DICM-model: "*as I read it here this is some more like indicators to monitor well your contest is going or how well*" (R7)

Phase 3: Learn and communicate

This phase illustrates the management of knowledge by storing best practices after notifying problems collected during measurement to evaluate current practices and identify lessons learned. These experiences are then stored in the knowledge base and communicated to future organizers and scientific community as discussed in Steps 1,2, and 3 below.

Step 1. Analyze

At the conclusion of the contests organizers analyze measurement of data, analyze current practices to identify problems, record findings and make a recommendation of best practices.

Motivation for including the Analyze step

At the conclusion of each project, organizers need to analyze the data and information collected to identify challenges, to evaluate the current model and to record best practices and experiences to make future recommendations (Basili et al. 1994). All respondents agreed that the method facilitates identification of strengths and weaknesses, and fulfilling goals of contests.

Step 2. Package

Organizers update information gained from the current DICM-model if the current DICM-model is a customized design. If the current DICM-model is a new model, it will be stored as a new model with experiences gained from using it. Also, organizers combine the experiences gained as best practices, knowledge, gained in experience database to avail it for future projects.

Motivation for including the Package step

Combine and store experiences in the form of a model and other structured information to avail it for future projects (Basili et al. 1994). Continuous evaluation of DICM-models from previous contests (R2) to copy feedback is needed to improve performance (R8), as illustrated in the DRD-method's *Refine model in use* phase. At the end of the project, best practices, in a similar fashion as QIP, are accumulated and combine experiences for future utilization (Basili et al. 1994). In addition to the knowledge management facility provided by the DRD-method (R12), the DRD-method enables learning and increasing maturity (R4, R7, R9, R10, R12).

Step 3. Disseminate

The purpose of this step is to disseminate lessons learned from digital innovation contests. Lessons learned are communicated including the applicability of the measurement model to practice and science.

Motivation for the Disseminate step

The feedback cycle in this step is called capitalization cycle which provides performance information at the end of the project to enable reuse and accumulation of best practices in a similar fashion as QIP (Basili et al. 1994). The DRD-method in addition to its learning and increasing maturity capability, "*the method and the competition itself can aid to enable learning and increasing maturity*" (R10) has knowledge management capability (R12). Five of the six experts agreed that learning and increasing maturity can be adequately facilitated by DICM-models.

4.4 Evaluation of the proposed method

The designed method was orally presented to six experts (R3, R4, R7, R9, R10, R12) using examples and illustrations. An ex-ante evaluation of the method was conducted using semi-structured interviews of the six experts. The interview results were analyzed thematically in order to identify strengths and areas for improvements.

The evaluation indicates that all three phases of the method and their corresponding steps are considered valid (R3, R4, R7, R9, R10, R12). For example, (R9) promised to use the model, "*to the extent of our experience we will try to implement the methodology you propose in order to evaluate a future competition and will get back to you with the outcome and suggestions if any*" R9 also stated that "*at this stage I do not have anything to add or suggest for the methodology as I believe that the phases and the measuring points you propose are broad enough, in order to be incorporated in a wide range of competitions, and at the same time specific to the point that it guides the organizer through specific steps and thus assures a holistic approach*".

In addition, all design objectives illustrated in section 3.2 are reasonably met by the method. For example, the assessment of the DRD-method indicates that it aids in managing best practices, For example, R12 argues about the DRD-method as: "*this is where my remark falls, I think that this method will help organizers to advance their knowledge irrespective of whether they have formal knowledge representation method and those who do will benefit more, so everybody is going to learn but the majority in the organization will advance depending on whether these organizations have formal knowledge management or not*" (R12). All six respondents (R3, R4, R7, R9, R10, R12) agreed that the method aids in identifying strengths and weaknesses in the innovation value chain in addition to enabling the design of DICM-models that evaluates the fulfilment of measurement goals. Hence the analysis of measurement is a logical step. R6 also argued that the method aids in managing knowledge. The method enables learning and increasing maturity (R10). All six experts except (R3) agreed that learning and increasing maturity can be adequately facilitated by using the method.

5 Discussion

Open data provision creates the potential for social and business value creation (Lindman et al. 2013). Contests have become leading means to stimulate innovation of digital services based on open data and to facilitate the utilization of open digital resources (e.g. open data). Consequently, the availability of innovation measurement models for the contest domain driven by open data is vital for the success of efforts to innovate based on open digital resources. Thirteen innovation measurement models are analyzed by (Ayele et al. 2015) to position the baseline version of DICM-model in relation to existing evaluation models. None of these models address the domain of digital innovation contests using open digital resources to stimulate innovation. For example, the framework by Erkens et al. (2013) is designed for measuring open innovation with ideation as one of its methods. However, the framework by Erkens et al. (2013) is designed from the perspectives of innovation managers and performance consultants for organizations aiming to succeed in the market (Erkens et al. 2013). Hence, it doesn't cover the aspect of digital innovation contest in particular. The framework by Washizaki et at. (2007) assess software quality in designing embedded technology for robotics. Furthermore, some of the models discussed by (Ayele et al. 2015) are designed to measure innovation in product, process, marketing, and organization (Mortensen and Bloch 2005) while others are designed to measure innovation in nations, industry and organizations (Mairesse and Mohnen 2002). However, the baseline DICM-model (Ayele et al. 2015) is specifically designed on evaluating digital innovation contests and pendant service deployment processes and consequently adds a supplementary toolset for innovation measurement tailored for the contest domain.

The ex-ante evaluation of the baseline DICM-model by (Ayele et al. 2015) showed that DICM-models need to be adaptable to different contest conditions, measure different processes, including feedback loops and iterations and cover other inputs, outputs, and activities and measures than those included in the baseline version of the DICM-model. To address these limitations, we have in this paper introduced and empirically grounded a DRD-method to design and refine models for evaluating digital innovation contests. The method addresses the dynamic organizational requirements for adopting a DICM-model. The proposed DRD-method to adapt and refine DICM-models has three iterative phases with nine steps grounded in the QIP (c.f. Basili et al. 1994). Phase 1 enables the design and customization of DICM-models including feedback for customization and characterization from previous projects. The design of the customized DICM-model is then carried out using GQM paradigm and BSC. Models and frameworks such as the Innovation Value Chain (Hansen and Birkinshaw 2007), Diamond Model (Tidd et al. 2002; Gamal et al. 2011), Innovation Funnel Model (Morris 2008), Open Innovation Maturity Framework (Enkel et al. 2011), and Goal-Driven Measurement for Software Innovation Process (Misra et al. 2005) to identify measures. Phase 2 explains how innovation contest processes can be iteratively assessed to provide feedback and learning within the project. Finally, phase 3 is used to manage best practices by identifying problems, documenting best practices, and packaging lessons learned to facilitate re-use of experiences to adapt and refine the adopted evaluation model (c.f. Basili et al. 1994).

The nine-step DRD-method to adapt and refine DICM-models scores high in terms of relevance when cross-checked with the expert respondents' experiences. The majority of the experts especially point out the feedback loop as an important strength of the method. This feature supports the organizers of digital innovation contests to adapt the DICM-model during the contest, as well as to collect and package experiences that will support future digital innovation processes driven by open digital resources. This enables digital innovation contest driven by open data to not only be "one-time" events. The structured capability to package experiences and lessons learned enable organizers to evolutionary unleash the value open digital resources, e.g. open data, can create (Lindman et al. 2013).

Finally, the method has implications for the Innovation Value Chain approach to organize innovation. The Innovation Value Chain (c.f. Hansen and Birkinshaw 2007) provides a sequential and rather closed process as a basis for innovation measurement. The DICM-model offers a local crosscheck (Bielkowicz et al. 2002) that supports the notion that innovation processes are iterative (Kline 1985) and open (Chesbrough 2003) with feedback loops (Kline and Rosenberg 1986). Hence, innovation measurement must also be based on open innovation processes in a similar fashion as suggested by Edison et al. (2013) and be supported by tools that enable organizers to adopt DICM-models that adhere to the specific prevailing conditions.

6 Conclusions and Future Research

The aim of this paper was to propose a method for designing and refining measurement models for digital innovation contests. The DRD-method for designing and refining DICM-models was developed to provide DICM-models that are adaptable to different measurement goals and contest designs, measure different processes, including feedback loops and iterations, and include inputs, outputs, and activities corresponding to specific needs of different digital innovation contests. Based on the ex-ante expert evaluation, we conclude that the proposed method provides effective support in designing and refining a DICM-model. Also, we conclude that the method supports the reflection and refinement in use and provides a new foundation for organizational learning across several contests.

For future study, we suggest a more rigorous ex-post evaluation of the applicability and the generalization of the DRD-method to support the design of open innovation measurement models corresponding to variations in innovation goals and processes.

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