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Conceptualization refinement of hackathon for innovation management

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Abstract: Although hackathons have become a popular phenomenon beyond the IT industry, the current use of the concept is ambiguous. Good theory building is preceded by construct and conceptual clarity. Consequently, clearly defined concepts are essential. Therefore, this paper addresses the concept definition of hackathon as innovation contest. Following the conceptualization model of Podsakoff et al. (2016), this paper studies the refinement of hackathon concept, focusing on its construct of necessary and sufficient attributes. As results this paper presents the discovered nine necessary and sufficient attributes of the hackathon concept and compares them against 29 hackathon event cases studied with e.g. action research methodology. The results will benefit both academics studying hackathons and companies who aim to enhance their innovation management, especially in the fuzzy front end of innovation.

Keywords: hackathon; conceptualization; concept; conceptual clarity; definition; innovation contest; radical collocation; virtual hackathon; coopetition; innovation management;

1 Introduction

Innovation contests have been arranged at least since the early 18th century (Maccormack et al., 2013) with wealth of well-known yielded innovations in different domains e.g., agriculture, food, automobile, aviation, mathematics (Adamczyk et al., 2012). The aim of innovation contest is to deploy product or service solutions (Maccormack et al., 2013), but it is used for other purposes, such as promoting sustainability (Adamczyk et al., 2012). Especially the prize-based contest have been particularly successful in attracting unconventional individuals that overcome difficult challenges (Hutter et al., 2011). Hackathon is one type of innovation contest and method where individuals compete in teams (Halvari et al., 2019). The hackathon was popularized first in the IT community, where it shaped into organized contests with pitches and prizes to produce functional prototype applications (Leckart 2012; Zukin and Papadantonakis 2017). Later the method was widely adopted in other sectors and domains besides coding (e.g. Suominen et al. 2019). In the literature, there are many benefits reported of hackathon methodology, such as yielding a rich mix of ideas (Rosell et al., 2014), potential in community and culture building (Komssi et al., 2015), resource for learning (Kayastha, 2017; Porras et al., 2019), crowdsourcing solutions, attaining public engagement and collaboration between citizens (Gama, 2017), and finding new potential employees (Komssi et al., 2015; Pe-Than and Herbsleb, 2019). The benefits explain the popularity the events and method in various sectors as well as widespread and diversified use. However, the usefulness of hackathon results have also been criticized (Komssi *et al.* 2015; DiSalvo *et al.* 2014). Due to the proliferation both the concepts of innovation contest (Adamczyk et al., 2012) and hackathon, are often misunderstood amongst both academics and business people. Confusion is guaranteed with event organizers that have commercialized the hackathon term for advertising purposes.

As a phenomenon, hackathon is a novel, and its research is mostly exploratory and descriptive. Descriptive prior studies present the hackathon phenomenon in many respects in detail, e.g. regarding their design elements or choices (Komssi et al., 2015; Pe-Than et al., 2019; Porras et al., 2018). However, the hackathon as a concept is still not thoroughly defined. Yet, the clear concept definition is the foundation for all the research, and it is vital to articulate the fundamental attributes of a concept clearly. Therefore, the aim of this paper is to contribute to the construct clarity (Molloy and Ployhart, 2012; Podsakoff et al., 2016; Suddaby, 2010), i.e. to the extent to which the conceptual definition of hackathon is precise, having robust categories that distill the phenomenon into sharp distinctions that are comprehensible to the community of innovation.

Halvari et al. (2019) used the three first phases of conceptualization model of Podsakoff et al. (2016) to create the preliminary definition of the hackathon concept. Using scientific literature regarding hackathons, Halvari et al. (2019) discovered the eight necessary and sufficient attributes of hackathon as a concept. Their preliminary definition was:

> "a hackathon is one type of innovation contest, a short time-bounded event with a challenge to be solved creatively in coopetition and with the radical collocation of teams, whose output is recognized in a ceremony at the end of the event." (Halvari et al., 2019).

Yet, to a concept to be clearly defined, the conceptualization model of Podsakoff et al. (2016) requires concluding the fourth phase: *"4) Refinement of the conceptual definition"*. Therefore, the research question of this study is as follows:

How the hackathon definition and its necessary and sufficient attributes are modified so that the concept is precise to attain the conceptual clarity?

In the pursuit of our goals, the paper is structured as follows: in the introduction, we first acknowledge the need to clarify the concept of hackathons and present the current stage of the concept definition. In the second section, the theory regarding innovation contests, hackathons and conceptualization according to Podsakoff et al. (2016) are presented. The third section introduces the research design. The fourth section portrays the results of our 29 case studies. In the fifth section, the discussion and further research, we contemplate the results of our conceptualization of the hackathon and its impact on innovation management theory and practice.

2 Construct and concept clarity and conceptualization process

Innovation management is a novel field of study, therefore its theory building and concept development are still in early phases. Thus most of the studies are exploratory and descriptive (Saunders et al., 2008). The constructs and concepts are essential building blocks of theory, and the importance lies in the precise concept definition (Jarvis et al., 2003; Mackenzie, 2003; Podsakoff et al., 2016; Suddaby, 2010) Yet in management theory, both construct and conceptual clarity are an ongoing challenge (Locke, 2012; Podsakoff et al., 2016; Suddaby, 2010). There are several benefits for clear constructs: 1) they facilitate communication between scholars, 2) improved clarity of constructs enhances researchers' ability to empirically explore phenomena and 3) clear constructs allow for greater creativity and innovation in research (Suddaby, 2010). Good theory requires clear constructs that are *"simply robust categories that distil phenomena into sharp distinctions that are comprehensible to a community of researchers"* (Suddaby 2010, p. 346). This phenomenon is defined as construct clarity. Constructs manifest as conceptual definitions and construct clarity is an attribute of these conceptual definitions. Construct clarity is the extent to which the definition in an article is precise and scholars in a community and literature agree upon it. (Molloy and Ployhart, 2012) The formulation of a good definition should be carried out by using unambiguous terms to specify the construct's conceptual theme consistently with prior research, and clearly distinguishing the construct from related ones (Mackenzie, 2003). Furthermore, *"a good definition should also specify the extent to which values of the construct are expected to differ across cases, conditions, and time."*(Mackenzie 2003, p. 325) Multidimensional constructs should be conceptualized in a manner, that the relations between the subdimensions and the superordinate constructs should be specified (Jarvis et al., 2003; Mackenzie, 2003).

Moreover to construct clarity, also conceptual clarity is lacking, but required in management literature (Locke, 2012; Podsakoff et al., 2016), since: *"If one does not have a clear idea of what the concept means, it is difficult to identify related concepts or to specify whether they are antecedents, consequences, or correlates of the focal concept"* (Podsakoff *et al.* 2016, p. 166) In their extensive studies of conceptualization, Podsakoff *et al.* (2016) have used the recommendations of well-known scientists e.g., DiRenzo, 1966, Locke 2003, substantially and compiled them to guidelines for concept definition in article *"Recommendations for Creating Better Concept Definition in the Organizational Behavioral, and Social Sciences"*. In fact, concepts are about ontology, and besides

definition, concept development requires decisions the important elements of the entity. Podsakoff *et al.* (2016) define the concept as follows:

> "[ ] cognitive symbols (or abstract terms) that specify the features, attributes or characteristics of the phenomenon in the real or phenomenological world that they are meant to represent and that distinguish them from other related phenomena."

Halvari et al. (2019) applied the first three stages (Figure 1) of Podsakoff et al. (2016) presented model for better concept definition and they introduced initial concept definition of hackathon with the necessary and sufficient structure. The missing fourth stage of the concept definition is the refinement of the conceptual definition and it is performed by self-assessment with questions, such as "What do you mean by that?" and with soliciting feedback from peers (Podsakoff et al., 2016). Yet, the concept definition process is iterative by nature the four stages may overlap to some extent.

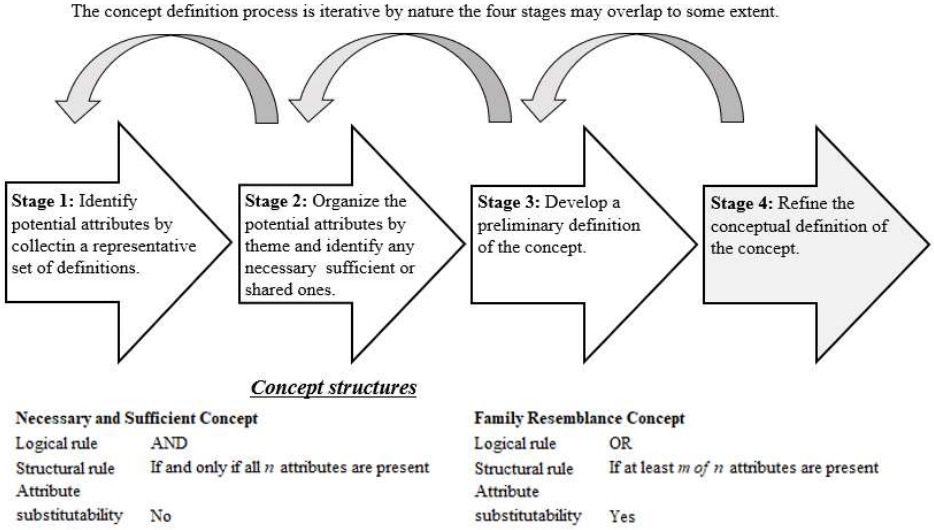

Figure 1 Four stages of conceptualization (Podsakoff et al. 2016)

3 Hackathon as a phenomenon

Innovation contest

Innovation contest according to Adamczyk *et al.* (2012) is:

> "IT-based and time-limited competitions arranged by an organization or individual calling on the general public or a specific target group to make use of their expertise, skills or creativity in order to submit a solution for a particular task previously defined by the organizer who strives for an innovative solution."

According to Adamczyk *et al.* (2012) innovation contests lack theory as phenomenon, and theoretical framework would benefit the investigation of various aspects. The majority of research on innovation contests is qualitative and descriptive, yet action research with

mixed methods would be suitable to examine the different causalities and interventions. Adamczyk *et al.* (2012) discovered five categories for innovation contest research: two multicategories of economic and management perspective, and three subordinate focus categories: education, innovation and sustainability. Bullinger and Moeslein (2010) identified ten design elements: media, organizer, task/topic specificity, degree of elaboration, target group, participation, contest period, reward/motivation, community functionality and evaluation. Later Adamczyk *et al.* (2012) identified five novel design elements such as 'attraction', 'facilitation' and 'sponsorship'. Hutter *et al.* (2011) focused specifically in the innovation contests that are virtual and arranged among special communities in platforms and found different behaviours ranging among participants from competitive, co-operative and co-opetitive.

Hack' a 'thon

The term hackathon is a combination of 'marathon' and 'hacking' with roots in MIT in the 1960s where students gathered to code 'hack' in self-imposed 24-hour 'marathon bursts' (Leckart, 2012). Since then, the hackathon has popularized first in the IT community, where it shaped into organized contests with pitches and prizes to produce functional prototype applications. Recently hackathons has spread to other domains and usages besides coding (Leckart, 2012; Zukin and Papadantonakis, 2017). In addition to name hackathon, these particular types of innovation contests are named with the abbreviation of hack' or 'thon, such as datathon (Li et al., 2017), markathon (Calco and Veeck, 2015), hack days, edit-a-thons, mapa-thons (Filippova et al., 2017).

Hackathon has three phases; pre-hackathon, hackathon (event) and post-hackathon processes (Rosell *et al.* 2014; Komssi *et al.* 2015a; Granados and Pareja-Eastaway 2019a) and in its broadest form it includes the all stages of innovation process (Halvari et al., 2019). Design elements have been in the focus of the recent research of innovation contests (Adamczyk et al., 2012), as well as hackathons (Pe-Than et al., 2019; Pe-Than and Herbsleb, 2019). The design elements most likely do have a great impact on the success of the hackathon event, and thus should be considered prudently in advance before the event. Moreover, the quantity of competitors, the effect of free entry and the effect of prizes have also been studied in innovation contests. There is evidence that adding competitors shifts expected outcomes downward and free-entry is only recommended for problems with high-uncertainty (Boudreau et al., 2011). Furthermore, prize-based contest on a commercial platforms can effectively recruit skilled individuals to apply their knowledge to problems (Lakhani et al., 2013). Yet still, the difference between design element and concept attributes is clear. With concept attributes the aim is to answer to the question what phenomenon is or is not. In turn, design elements answer the question how hackathon should be designed or how it was conducted.

Halvari *et al.* (2019) concept includes three themes; 'short time bounded event', 'co-opetition' and 'radical collocation' and eight necessary attributes and sufficient features: 'duration', 'team', 'challenge', 'creation process', 'ceremony process', 'collaboration' 'co-location' and 'consistency'.

A hackathon is a team coopetition (Halvari et al., 2019) where the teams collaborate intensively (Almirall et al., 2014; Briscoe and Mulligan, 2014). The duration of a hackathon event is short and time-bounded (Briscoe and Mulligan 2014; Kienzler and Fontanesi 2017; Filippova et al. 2017; Chowdhury 2018; Angarita and Nolte 2019; Granados and Pareja-Eastaway 2019; Pe-Than et al. 2019). 'A semesterathon' and

'summerathon' are workshops that have similarities with the hackathon students innovate industry projects during the whole semester or summer (Avalos et al., 2017).

The term 'collocation' was mentioned in Pe-Than and Herbsleb (2019) article, but the fact that the participants come together and form teams was mentioned far more often (Angarita and Nolte, 2019; Gama et al., 2018; Granados and Pareja-Eastaway, 2019; Kienzler and Fontanesi, 2017; Pe-Than et al., 2019; Rosell et al., 2014). When the team members are in same physical space for the duration of project, it is called a 'radical collocation' (Pe-Than et al., 2019; Pe-Than and Herbsleb, 2019; Teasley et al., 2000) and it is seen especially helpful in coordination, problem-solving and learning (Teasley et al., 2000). In general the collocation seems to speed up the software development and facilitating enduring relationships (Trainer et al., 2016) and improving productivity (Teasley et al., 2000).

The innovation contests that are targeted at a wide dispersed crowd are often arranged virtually and there are also examples of virtual hackathons, which popularity has increased (J Jussila et al., 2020). The first insights on running global virtual contest with 100,000 developers from 156 nations was given by Krook and Malaika (2020). Virtual collocation does exist (Pawar and Sharifi, 2018) and in the virtual collocation, the integration between the teams and individuals happens typically by utilising information and communication technologies (ICT) (Lohikoski et al., 2015). The crowdsourcing, co-creation and open innovation, applications such as web-based toolkits, virtual concept testing and virtual worlds have benefitted the virtual co-operation and collaboration (Hutter et al., 2011). The collaboration technology plays an integral part in the success of distributed groups to perform well (Finholt, 2010) and the collocation to be successful, the ICT infrastructure, preparing the virtual environment and facilitation have a key role (J Jussila et al., 2020).

Team result is the team response for the given challenge, a team output of the creation and ceremony processes. Goal however, is outlined prior to the event and challenge refers to the mission of the hackathon. (Halvari et al., 2019) The term that ISO 56000 (ISO 2020) uses for goal, target, purpose, intended outcome, operational criterion is **an objective** and those are set to meet the organization innovation strategy and policy. There may be multiple goals or objectives for the hackathon, such as building the company innovation culture, learning the innovation methods, building team spirit in organization. Yet, the challenge refers to the factual idea generation and deployment of the idea. (Halvari et al., 2019)

Ideation and deployment both are part of innovation process. Ideation it is a process of generating, sharing and evolving ideas and concepts, and deployment is where the entities or the resources are brought to effective action. The term effective is notable, as it refers to the planned activities that are realized and planned results are achieved. (ISO 2020). Based on the descriptive hackathon literature, Halvari et al. (2019) draw the conclusion that hackathons always involve some kind of intensive and consistent creative process, which aim is to innovate and create something new. When the creative process of hackathons is viewed thought the ISO-standard view, the innovation processes should be designed in such way that suits the innovation initiative (ISO, 2019). According to ISO (2020), innovation is new or changed entity that realizes and redistributes value. How novel and valuable the innovation is, depends on the perception of the organization and relevant interested parties. Innovation is a realized value that is an outcome of innovation process that is planned and carried out in controlled conditions.

Hackathon creation process is followed by a ceremony process, the climax of the hackathon event. Teams present ideas, demos and/or prototypes mostly by using different pitching practices. In the end of the ceremony process, the organizer gives recognitions and

typically also prizes for potential solutions. (Halvari et al. 2019) To sum up, hackathon contest includes a consistent creation process that starts the hackathon event and the ceremony process ends the event.

4 Research design

Since hackathon as a concept is missing theoretical roots, this research applies exploratory nature of research. This research is a continuum of a preliminary hackathon concept definition process by Halvari *et al.* (2019), that followed the recommendations of first three steps by Podsakoff *et al.* (2016). Applying the sequential fourth step, i.e. 'Refinement of the conceptual definition', this study finalizes the concept definition process of hackathon. The refinement of the concept with its attributes was carried out by exploring 29 pcs comprehensive original cases (Dyer and Wilkins, 1991) in industrial or educational context. The selection criteria for cases was inclusive: cases were called 'hackathon' with physical or virtual access for the researchers and experts to the event and its materials. The cases were studied with action research methods with multiple data collecting and analysis methods, e.g. surveys and unstructured interviews, or observed (participatory observation), by applying data, method and researcher triangulation. Three multi-disciplinary researchers and two innovation subject matter experts from the industry were involved in the triangulations.

Prior to the fourth, i.e. refinement step, iteration on the previous three steps was conducted by comparing the characteristics of the attributes identified earlier from the literature to the selected 29 cases. The aim is that the refined attributes are as unambiguous and discrete as possible, simultaneously preserving the true nature of the phenomenon. The fourth step of Podsakoff *et al.* (2016) method 'Refinement of the conceptual definition' includes self-assessment of each attribute with asking questions and asking subject-matter experts, colleagues and peers. Self-assessment and questions such as (e.g. regarding team): what do you mean by a team? What if we remove the team from the attributes, what does it mean? What if we only have a one team? What if the teams have only one participant? were valuable. All suggested changes and refinement of the attributes were first compared with the literature, dictionary and then finally with ISO 56000 (ISO, 2020).

5 Results

By applying Podsakoff *et al.* (2016) suggestion for better concept definition, hackathon concept refinement produced some adjustments on themes and attributes, along with clarification on sufficient features of a hackathon. Phase 4. *'Refinement of conceptual definition'* recommends asking more specific questions about the concept and explaining the phenomenon. The *type of property* and *entity* (Podsakoff et al., 2016) specifies to which phenomenon hackathon concept refers and where it is applied. A combination of *'co-creation'* and *'co-opetition'* is more descriptive phenomenon than initial themes by (Halvari et al., 2019); hence they were selected as themes. The themes also limit the hackathon concept, which is why, e.g., it is not meaningful to compare the characteristics with competitions with no relation to innovation or innovation methods that have no competition element.

Comparison of innovation contest definition and hackathon

The innovation contest is ontologically at a higher-order construct than hackathons (Podsakoff et al., 2016); that is, a hackathon is a particular type of innovation contest (cf. Adamczyk *et al.* 2012). Table 1 shows the comparison of definitions of innovation competition Adamczyk *et al.* (2012) and the initial definition of the hackathon (Halvari et al., 2019). The definitions differed in some respects; Definition of innovation competition explains it to be domain-specific, and an organization or individual arranges it.

Table 1 Innovation contest definition Adamczyk *et al.* (2012) vs hackathon concept definition (Halvari et al., 2019)

Theme	***Innovation competition definition by Adamczyk et al. (2012)***	***Hackthon definition by Halvari et al. (2019)***
Definition	"IT-based and time-limited competitions arranged by anorganization or individual calling on the general public or a specific target group to make use of their expertise, skills or creativity in order to submit a solution for a particular task previously defined by the organizer who strives for an innovative solution."	"A hackathon is one type of innovation contest, a short time-bounded event with a challenge to be solved creatively in coopetition and with the radical collocation of teams, whose output is recognized in a ceremony at the end of the event."
Domain	Specific domain	-
Time	Time-limited	Time-bounded
Duration	-	Short
Concept	Competition	Hackathon
Upper category	-	One type of innovation contest
Organization	Arranged by an organization or individual	-
Participant	General public or specific target group, make use of their (participant) expertice, skills or creativity	Team, Participant
Target	Submit solution Previously defined particular task	Output Challenge
Location	-	Radical collocation
Process	Strive for an innovative solution	Solve challenge in coopetition, creatively, cooperation, recognition in ceremony process in the end of the event

These two differences were compared with 29 case-studies and previous literature of hackathon. The analyze evidenced that: 1) Hackathon as an innovation contest is not IT-domain or domain-specific (Leckart 2012; Zukin and Papadantonakis 2017; see Table 4). Therefore, the domain should not be included in hackathon definition. 2) Hackathon, in its current form, is always organized event (Table 2 and **Error! Reference source not found.**).

Table 2 Organization of hackathon

Source	*The article refers to the event being organized*
Pe-Than and Herbsleb 2018	"The STScI's motivation for **running** these events [ ]"
Rosell et al. 2014	"[] if **organized** with care and significant preparation, internal hackathons [ ]"
Chowdhury 2012	"Microsoft and Nokia have each **hosted** hackathons [ ]"
Granados & Pareja-Eastaway 2019	"[ ] analytical interviews with participants and **organisers** in two hackathons"
Li et al. 2017	"[ ] **organized** the first clinical data conference and health datathon in China, [ ]"
Lodato & DiSalvo 2016	"[ ] being informal gatherings to **well-established** and well accepted events."
Lewis et al. 2015	"Hackathon events have been **organized** to address social challenges [ ]"
Maaravi 2018	"**Organisers** of hackathons vary from corporates and NGOs to universities and government agencies [ ]"
Porras et al. 2019	"[ ] but that then leads to the difficulty and problem setting to understand what **organizing** of these events actually mean."
Gama et al. 2018	"The teacher had experience in **organizing** hackathons [ ]"
Briscoe & Mulligan 2014	"At many hackathons, the judges are made up of **organisers** as well as the sponsors of the event."
Leckart 2012	The **organizers** claim each of its hackathons has yielded at least one project that makes it to Apple's or Android's app store.
Zukin and Papadantonakis 2017	"Aangel Hack, a leading for-profit **organizer** of public hackathons, managed [ ]"

Although hackathon has its roots in self-organized 24-hour coding events (Leckart, 2012), in its current form, hackathon requires both prior and event-based organization. Post-hackathon measures should not be neglected, although they are not necessary and sufficient for the existence of a hackathon. The role of the organizer had been given too little attention in the initial definition by Halvari *et al. (*2019). Although, the existence of an organizer was incorporated in description of (5) collaboration attribute, the role is far more significant than the organizer is discerned during the event. For these reasons, the hackathon concept was introduced a new necessary attribute and organizer, facilitator and/or interested party into sufficient attributes.

Podsakoff et al. (2016) refer Goerz by saying that defining and conceptualizing phenomena with necessary and sufficient concept structure is considered the more clear and standard approach for defining the concept than family resemblance structure. Table 3 presents the final hackathon concept classification criteria, necessary and sufficient features which all are discrete. The concept attribute is either present or not. Besides, some of the features are also countable, i.e., number of teams, number of participants in the team, number of challenges. Therefore, the definition of hackathon is:

> *"A hackathon is one type of organized, goal-driven innovation contest, a short time-bounded event with a challenge to be solved creatively in coopetition and collocation of teams, whose results are presented and recognized in a ceremony at the end of the event."*

Table 3 Hackathon concept

		Hackathon Concept	
Logical rule		AND	
Structural rule		If and only if all 9 attributes are present	
Attribute substitutability		No	
Theme		***Attribute***	***Sufficient feature***
	1	Organization	n>=1 internal and/or external organizer
			n>=1 internal and/or external facilitator
			n>=1 interested party
Co-opetition	2	Short time bounded event	t< week
	3	Collocation	Team in 1 space
			1 space contains n>=1 teams
	4	Challenge	n>=1 challenge
	5	Ceremony process	n>=1 recognition
			n>=1 presentation of achieved results
	6	Team	n>1 teams
			n>1 participants per team
	7	Goal	n>=1 interested party objectives
Co-creation	8	Collaboration	n>=2 participants interaction in team
	9	Creation process	Consistent ideation and deployment
			n>=1 results

Table 4 The research consisted in total 29 case studies is a summary of 29 case-studies that were conducted between 2014–2020 by applying action research and observations. Our study provided more detailed information regarding the hackathon and revealed that virtual hackathons have become more prevalent in recent times. Hackathon is an *organized short time-bounded event* that consists of creation and ceremony processes. The organization requires, that there is an organizer, a facilitator and interested party who may be the same person. Hackathon is *team* co-opetition. In other words, there are more than one teams, and to be a team, there must be more than one participant per team. In contrast to crowdsourcing ideas or innovations, participants may not be aware of who is involved in this ideation or innovation and often do not cooperate in teams but rather compete individually for creating the winning solution (Kärkkäinen et al., 2016). Team participants must *collaborate* at least among the team. The analysis evidenced that there was also the *collaboration between teams* and the team may form during the hackathon (e.g., participants switch or join teams during the hackathon.) The *goal* is an interested party objective. An interested party is the one who is interested in results to be achieved. Typically, that party also provides the prizes, gifts and *recognitions* for the teams. According to our case studies, the organizer, facilitator and interested party may be the same, e.g., in company's internal hackathons, especially in smaller and informal events. To be an innovation co-opetition, there must exist *a challenge* to be solved and challenge result *recognition*.

Table 4 The research consisted in total 29 case studies

	Radical						*Virtual*	*Non-hackathon*	*Total*
	2014	**2015**	**2016**	**2017**	**2019**	**2020**	**2020**	**2019**	
Number of cases	3	6	5	7	1	1	5	1	29
Domain	Multi domain e.g., ICT, marketing, education, manufacturing industry, municipal								
Average number of teams*	8	12	14	11	11	5	10t	6	
Number of participants / case	8 - 100*[2]						7t - 20t*[2]	40	
Country of origin	Finland, Sweden, Latvia, Estonia, Lithuania,						Finland, Sweden, EU, Global	Finland	
Organization	yes						yes	yes	
Number of goals	>=1*[3]						1-37	6	
Short time-bounded	yes						yes	no*[4]	
Number of challenges and goals	>=1*[3]						1-37	6	
Consistent ideation and deployment (days)	1	1	1-2	1-2	1	2	1-3	no*[4]	
Collaboration	yes						yes	yes	
Collocation	yes						yes	yes*[4]	
Ceremony process	yes						yes	no*[4]	

* The number of teams was not available for each case. Each team has approximately 4 participants. Number of teams = number of participants / 4

*[2] The number of participants was not available for each case. Each team has approximately 4 participants. Number of participants= number of teams x 4

*[3] Each case has a goal. The number of goals is not available for each case.

*[4] Non-hackathon case was fragmented and lasted four weeks. The collocation and collaboration were both virtual and radical. There was one-day consistent radical collocation when teams co-created ideas, but the final results were not delivered during that day. The short presentation of un-finished ideas was presented during the radical collocation.

Challenge is defined by the interested party, and it is derived from the goal. According to case studies, there may be several challenges and interested parties in the same hackathon. *Collocation* refers to the shared location, either radical or virtual, where the team members are in the same space. The same space may consist of several teams. The collocation may be a) *radical* where the team members are in the same physical space, or b) *virtual*. Our case studies of virtual hackathons evidenced the fact that virtual collocation and co-creation can also work over the internet. In the literature, there was also found innovation contests that were arranged virtually utilizing IT technologies (Hutter et al., 2011). In the hackathon, teams are visible for each other. During the *creation process*, teams ideate and deploy the *result*. Particularly the creation process must be carried out in collocation. *Ceremony process* in minimum includes the presentation of achieved result and recognition of the results, sometimes also winner/s. The pitching technique is usually applied in the presentation. There are various methods for selecting the winners (e.g., jury, vote among participants).

6 Discussion

This article contributes to the literature of innovation management methods, particularly to the conceptual and construct clarity of (Molloy and Ployhart, 2012; Podsakoff et al., 2016; Suddaby, 2010) of hackathons. This study is a continuation of the research by Halvari *et al.* (2019) that initially defined the concept of hackathon via conceptualization process recommended by Podsakoff *et al.* (2016). Here, the focus is specifically on the *"Stage 4. Refining the conceptual definition of the concept"* of the conceptualization process (Podsakoff et al., 2016). By answering the research question: *"How the hackathon definition and its necessary and sufficient attributes are modified so that the concept is precise to attain the conceptual clarity?",* our contribution is provided by refining the conceptual definition of the hackathon concept.

A concept definition should describe *the type of property* the concept presents (Podsakoff et al., 2016). In their study Halvari *et al.* (2019), initially defined hackathon as one type of an innovation contest. Our results comply with this part of their concept definition and confirm, that as multidimensional construct, ontologically, hackathon belongs into a higher-order construct of innovation contests as a particular type, thus providing conceptual and construct clarity both to the concept of hackathon and innovation contest.

Furthermore, regarding the subdimensions of hackathons, our results confirms the prior study of Halvari *et al.* (2019), that hackathons include both the concepts of co-creation and co-opetition. Moreover, our results confirm that hackathon as concept include the previously defined five necessary and sufficient attributes of team, collaboration, challenge, creation process, ceremony process. Adding to the previous results, as a result of this study we introduce four new or revised attributes: short time bounded event, organization, goal and collocation. Our results revealed, that for example the role of the organizer is far more critical than initially assumed. In total, 28 of our case studies were compliant with the nine identified necessary and sufficient attributes, but one case study was not. Thus, it can be classified as non-hackathon or *'whackathon'*, the one exception to the rule. We noticed that case event was not consistent, and the collaboration fragmented, which affected the hackathon duration, too.

The major contribution of our study is that, our results showed that the *entity* of the hackathon concept can be described discretely, which adds to the previous studies and particularly enhances the conceptual clarity of hackathon.

Our study confirms the dynamic nature of hackathon concept, that has been revealed in previous case studies of its history and emergence (e.g. Leckart, 2012) Furthermore, we contributed with our case study by contradicting the domain specificity the previous case studies regarding both hackathons (Briscoe and Mulligan 2014; Almirall et al. 2014) and innovation contests have claimed (Adamczyk et al., 2012). In other words, hackathons are not domain specific. Naturally, proliferation has impacted the dissolution of formerly claimed domain-specificity. Additionally, our results revealed the impact of technology diffusion. That is, that radical collocation is not the only suitable collocation for the hackathon. Besides radical, the collocation can be virtual, and its popularity is rapidly increasing. This result confirms the result of Jussila et al. (2020) single case study, that virtual hackathon is an emerging phenomenon, thus virtual collocation should also be taken into account in hackathon definition.

Therefore, we conclude that hackathon as concept contains nine necessary and sufficient attributes of 1) organization, 2) short time bounded event, 3) collocation, 4) challenge, 5) ceremony process 6) team, 7) goal, 8) collaboration, and 9) creation process. In other words, organized innovation contest events that typically include 'hack' or 'thon' in their name can be classified hackathons if they meet those nine necessary and sufficient criteria. Furthermore, the *entity* of the hackathon concept can be described discretely. Hackathon as a concept has a dynamic nature, but it is no longer domain-specific, and its collocation can manifest both in radical and virtual form. Thus as a result of the four-phased conceptualization process, we define *"A hackathon is one type of organized, goal-driven innovation contest, a short time-bounded event with a challenge to be solved creatively in coopetition and collocation of teams, whose results are presented and recognized in a ceremony at the end of the event."*

For further research, virtual hackathons provide exciting opportunities to explore hackathon methodology, as well as virtual teams and their co-creative collaboration. For researchers, the radical collocation is not compulsory for observation: collaboration platforms and other ICT tools provide an enormous amount of data for scientific purposes. Therefore, we suggest further comparative research on the fundamental differences of virtual hackathons compared to radically collocated ones.

For practical implications, conceptual clarity, i.e. clearly defined concepts, are pivotal for innovation management. In previous research, organisation and planning the hackathon event was partly overlooked. Understanding the hackathon concept will help practitioners to design goal-achieving events, avoid missing necessary elements or disregard the joint effect of elements. Therefore, grasping the essence of hackathon, virtual collocation can be better catered for collaboration, for example.

Our findings will benefit academics studying innovation management, particularly those focusing on innovation contests or hackathons. Additionally, practitioners operating in various domains, aiming to enhance their innovation processes, will gain from this study: it gives a condensed conceptualization of what the hackathon is as an innovation contest.

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