Utilizing Hackathons to Foster Sustainable Product Innovation – The Case of a Corporate Hackathon Series

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***Abstract*—In order to remain competitive, software companies need to continuously develop new or advance existing products. In recent years, they have increasingly turned towards organizing hackathons for this purpose. During such events, teams of employees engage in intense collaboration over a short period of time to complete a project that is of interest to them. While research on hackathons has been growing steadily in recent years, there is a lack of studies focusing on the continuation of hackathon projects after an event has ended in particular in a corporate context. Our study aims to contribute to existing work in this area by focusing on a corporate hackathon series that was organized by a medium-sized Eastern European software company. Our findings support and extend prior research by indicating that teams consisting of members who aim to improve their skills, that engage in project focused preparation, focus on developing a functioning prototype that is aimed at the current customer base, easy to integrate, and related to existing products during the hackathon, had their projects continued in the case we studied. Moreover, we found indications for organizational commitment in the form of resources to continue a project after an event to predicate project integration. We also identified potential barriers towards this resource allocation related to prioritization and prior commitments of the organizational unit that was projected to continue a hackathon project after the event in the case we studied.**

***Index Terms*—Collaboration, Innovation, Hackathon, Project Continuation**

I. Introduction

Software companies have a continuous need to develop new or advance existing products in order to retain a competitive advantage in today's economy [1]. They employ different strategies using both external and internal resources to identify customer needs, develop project ideas, and integrate them into their product portfolio. Examples of such approaches are "voice-of-customer" [2] where customers serve as an external source of innovation or internal brainstorming [3] where employees jointly develop product ideas. In recent years, companies of varying sizes, including startups [4], [5], small-medium size enterprises [6], and large corporations [7]–[9] have started using internal hackathons to accompany brainstorming and other methods to foster internal product innovation. During these hackathons, employees form teams and engage in intense collaboration over a short period of time to complete a project that is of interest to them [10]. Projects typically focus on the development of a prototype – e.g. a piece of software – that can be presented at the end of an event [11] and later be integrated into the main product lines.

Research on hackathons has grown in recent years [12] in particular in the Software Engineering [6], [13]–[15] and HCI communities [7], [16], [17] due to them being perceived as a novel approach for collaborative software development. Most existing studies focus on the event itself though covering aspects such as fostering participation and diversity [15], [16], supporting newcomers [18], and organizing hackathons for specific communities [19], [20]. There is work focusing on the aftermath of hackathons, but they mainly study learning gains [21], [22] or community engagement [23], [24].

Few studies focus on whether and how hackathon projects get continued after an event, in particular, in a corporate context [7], [8]. This is surprising since continuation can be considered crucial for the integration of a hackathon prototype as teams cannot be expected to develop a fully functioning product during the short duration of a hackathon. Moreover, the aforementioned studies focused on a large-scale event that was organized by one of the largest software companies in the world. It remains unclear if similar findings can be expected for an internal hackathon of a small or medium-sized company that does not have similar resources. Building on this work, our aim is thus to extend our understanding of how hackathon projects can get continued after an event and be integrated into a company's main product line.

Prior work on project continuation has provided indication that the composition of a hackathon team and its activities before, during, and after the hackathon can be related to project integration [4], [7], [8], [19], [25]. We thus consequently ask the following first research question:

RQ$_1$. *How are team characteristics and team activities before, during, and after a hackathon related to the inclusion of a hackathon project into the main product lines of a company?*

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Moreover, studies in a corporate context also indicate that project continuation can, partially, be attributed to its fit to existing products [7], [8]. This leads us to also asking the following second research question:

RQ$_2$. *How are characteristics of a hackathon project related to its inclusion into the main product lines of a company?*

Finally, project integration requires managerial commitment [26], [27] since continuation activity can be expected to require resources after an event has ended. This aspect has not been extensively studied by prior research yet though. We, thus, also ask the following third research question:

RQ$_3$. *How is organizational commitment related to the inclusion of a hackathon project into the main product lines of a company?*

To answer these three questions, we conducted a case study of a corporate hackathon series organized by a medium-sized Eastern European software company. We studied a total of twelve teams that participated during two hackathons of the same company over the course of six months. We conducted interviews with team leads and team members four months after the first and three months after the second hackathon and administered a questionnaire directly after each event.

Our findings indicate that teams with members who aim to improve their skills, engage in project focused preparation, focus on developing a functioning prototype during the hackathon, work on ideas that are related to existing products, aim at the current customer base and are easy to integrate, had their projects integrated in the case we studied. Moreover, we identified organizational commitment in the form of resources to continue a project after an event has ended to predicate the integration of a hackathon project into the main product lines of a company in the case we studied. We also identified potential barriers towards this resource allocation which were mainly related to prioritization and prior commitments of the organizational unit that was projected to continue a hackathon project after the event. Based on our findings, we provide suggestions for companies that aim to utilize hackathons as a means to foster corporate innovation.

The contribution of this paper is, thus, twofold. First, it expands our understanding of how different team and project-related aspects can be linked to hackathon project continuation in a corporate setting. Second, it provides indication for the importance of resource allocation for the integration of hackathon projects into new or existing products, outlines potential barriers of this integration and discusses different approaches that participating teams and the company that organized the hackathon we studied took to achieve this.

The remainder of the paper is structured as follows. We will first discuss our work in relation to existing research (section II) in the context of hackathons (section II-A) and corporate innovation (section II-B). Afterwards we will outline our study design (section III), present our findings (section IV), discuss them in the context of related work (section V), elaborate on limitations (section V-A), and outline implications for future research and practice (section VI).

II. Background and related work

In this section, we situate our study in the context of existing work on hackathon project continuation (section II-A) and corporate innovation (section II-B) and discuss aspects that have previously been found to foster project continuation and corporate innovation.

A. Hackathons

Starting as competitive coding events in the early 2000s, hackathons have seen a steep rise in popularity in recent years. They are perceived to foster the creation of new and innovative technology [28], [29], tackle civic, environmental, and public health issues [23], [24], [30], spread knowledge [22], [31], and expand communities [16], [18], [32], [33]. This has led to hackathons being adopted in various domains ranging from entrepreneurship [4], [5] and small-medium size enterprises [6] to large corporations [7]–[9], (higher) education institutions [21], [34], [35], civic engagement groups [16], [36], [37], (online) communities [32], [38], [39] and others. Their wide spread of practical application has consequently also sparked an interest in research to study these events.

However, while there are a plethora of studies covering the event itself [17]–[20], insights into the aftermath of hackathon events are still scarce and fragmented at this point. In particular, the question of what happens to hackathon projects after an event has ended has received limited attention so far [11].

Existing studies on hackathon project continuation mainly cover continuation intentions [4], [6] rather than actual continuation behavior. Moreover, research on continuation intentions in this context has led to inconclusive findings. Carruthers et al. [40] found that most hackathon projects they studied did not get continued despite individual continuation intentions. Contrary to that, Nolte et al. [25] found that specific continuation intentions of a hackathon team can predicate technical continuation behavior. While we expect continuation intentions to be a potential antecedent of continuation behavior, we will mainly focus on continuation and integration behavior rather than continuation intentions in our study.

There is also work focusing on actual continuation behavior [7], [8], [25]. These studies, however, mainly focus on technical project continuation by the same individuals that attempted a hackathon project after the event has ended [25] while our aim is to study the integration of a hackathon project into the main product lines of a company. This is not necessarily the same because, in the study conducted by Nolte et al. [8], none of the teams that worked on a project during a hackathon were involved in its continuation after the event had ended. In their study they report on how activities of a team during, before, and after a hackathon can foster project continuation and discuss potential issues of teams to identify a suitable organizational unit to invest resources and take over their hackathon project after the event had ended. However, while they conducted their study at a large scale internal hackathon of a large organization, we will focus

on a smaller scale event at a medium-sized company that cannot be expected to have the same resources to continue hackathon projects after an event has ended. Moreover, our study also includes the aspect of corporate commitment, which has not been a strong focus of prior work on hackathon project continuation so far.

B. Corporate innovation

Successful product innovation can provide companies with a competitive advantage [41]. However, there is a dilemma for companies. On the one hand, there is pressure to develop and launch new products at a faster pace. On the other hand, product innovation continues to pose a significant risk [42] as evident by commercial failures or products that are developed but never launched [43]. To this end, different approaches have been explored for product innovation and, in particular, for generating ideas (ideation) to enhance existing or introduce new products. For instance, one approach to innovation is the so called "voice-of-customer" (VOC) methods [2]. These methods, encompass observing customers, focus groups, analysis of communities of enthusiasts [2], interviews, and web-based surveys [44] to capture the needs and requirements of customers and identify potential gaps between customer expectations and product features [2].

Companies also assess their external business context by examining trends, threats, and technologies to define new products or services. To this end, companies use, for instance, external business context analysis [45] or SWOT analysis [46] to identify trends, disruptive technologies [47], or patents that can be employed for product innovation [2]. Open innovation, i.e., using resources residing outside of the corporate boundaries, is another strategy companies have explored for product innovation [48]. The success of startups with product innovation has propelled larger companies to emulate startups [49]. At the core of such approaches lies the incremental development of products that are regularly validated with stakeholders [50]–[52]. However, the most popular method for product innovation is to capture ideas internally [2]. In this context, companies seek new product ideas from their own employees. One method to encourage and capture ideas internally is by organizing hackathons [4]–[9].

Given the creative and complex nature of product innovation, attention has been given to identifying factors that are critical for success, i.e., critical success factors (CSF) at a corporate level. For instance, it has been shown that investments in R&D [53], a corporate strategy for innovation [27], [54], a high-quality process for product innovation [26], and a climate supportive of innovation and learning [41] [26], are foundational success factors. Other CSFs operate on the level of teams and include factors such as, support and involvement from management [26], [27], high-quality teams [26], how teams are organized [26], pre-project preparations such as having a clear business case prior to start [54], and involving external parties, such as customers [55] or suppliers [56]. Our study aims to extend these findings by considering the potential influence of corporate commitment on hackathon project continuation and the integration of a project into the main product lines of a company.

III. Methodology

To answer the research questions stated in the introduction, we conducted a case study of a corporate hackathon series. In this study, we focused on two hackathons that were organized by the same company over the span of six months. In the following, we will elaborate on the context of the study (section III-A) before outlining out method for data collection (section III-B) and analysis (section III-C).

A. Setting and procedure

The two hackathons we selected for our study were part of an ongoing series of internal hackathons organized by a medium-sized Eastern European software development company that specializes in customer relationship management solutions. The series started in 2017, and we studied the fourth and fifth installation of the hackathon series which each lasted 48 hours and took place from May 23 to 25 and November 20 to 22 2019. During the first hackathon 51 participants formed 10 teams while during the second hackathon 67 participants formed 12 teams. Each participant could only join one team per hackathon. The hackathons were organized to foster internal innovation with their theme focusing on developing ideas that would increase customer subscriptions. Participation was voluntary and every employee of the company was invited to participate. The organizers provided incentives in the form of budgets for employee training and material prizes for teams that placed first to third. Moreover, the first-placed team in each hackathon was promised resources to continue working on their project and advance it to a shippable status after the event had ended. Projects were judged by an internal jury consisting of individuals from different departments.

For our study we selected a total of eight teams (4 per hackathon) that vary along two dimensions: (1) teams that won one of the three aforementioned awards and teams that did not win and (2) teams where most members did not participate in the prior hackathon and teams where most members did. For the first criterion we particularly focused on selecting 1st placed teams because of the stated commitment of the company that those projects would get continued. The latter criterion was chosen because teams that had participated in the prior hackathon can be expected to be more familiar with the format which in turn can lead them to be more productive. This criterion was only utilized for the second hackathon. Moreover, it should be noted that we were not able to recruit a team for the second hackathon that had no repeat participants. All teams had between 4 and 6 members with most teams having 5 (table I provides an overview).

B. Data sources

To answer the research questions outlined in the introduction (section I), we conducted interviews with participants four months after the first and three months after the second hackathon (fig. 1 provides an overview of the data collection

procedure). For each selected team, we aimed to interview the team lead and at least one additional team member. For team C, we were only able to interview the team lead. The interviews focused on questions about how teams formed and worked together during the hackathon ($\mathbf{RQ}_1$, e.g. *"How did you meet with your team members?"*, *"How did you organize your collaboration during the hackathon?"*), characteristics of the project they attempted ($\mathbf{RQ}_2$, e.g. *"What were the goals of your project?"*, *"Who would benefit from this project?"*), its reception after the event and potential follow-up activities after the event had ended ($\mathbf{RQ}_3$, e.g. *"What feedback did you receive about your project?"*, *"What progress have you made on your project since the end of the hackathon?"*). All interviews were conducted by the same member of the research team and lasted for an average of 22 minutes.

We also administered a questionnaire to all leaders and members of the selected teams directly after each hackathon. The questionnaire mainly consisted of multi-point Likert scales [57] that were previously tested and validated as part of a larger survey instrument [15]. These scales relate to the satisfaction of leaders and team members with their project ($\mathbf{RQ}_2$), their team process during the hackathon ($\mathbf{RQ}_1$), and their perception of the usefulness of their project ($\mathbf{RQ}_2$). The survey also included scales that covered the teams' continuation intentions [58] since those can be expected to affect continuation behavior after the event has ended ($\mathbf{RQ}_3$).

TABLE I
OVERVIEW OF DATA SOURCES AND PARTICIPANTS.

		Hackathon 1	
Team ID	size	Interviews	Questionnaires
A	6	A1 (lead), A2	A1 to A5
B	6	B1 (lead), B2, B3	B1 to B5
C	5	C1 (lead)	C1 and C2
D	4	D1 (lead), D2	D1 to D4
		Hackathon 2	
		Interviews	Questionnaire
E	6	E1 (lead), A2, B2	E1, A2, B2, E4, B1
F	5	F1 (lead), F2, F3	F1, F2, F3
G	5	G1 (lead), G2	G1, G2, G3
H	5	H1 (lead), H2, H3	H1, H2 to H4

C. Analysis procedure

With each team representing a single unit of analysis, we first reconstructed the stories of each team based on the interviews. For this, we utilized a strategy similar to thematic analysis [59]. Starting by familiarizing ourselves with the data, we then applied codes based on our three main research questions (section I). These initial codes were related to team characteristics and their activities ($\mathbf{RQ}_1$, e.g. *common work experience*, *previous hackathon participation*, *preparation*, *hackathon activities*), project characteristics ($\mathbf{RQ}_2$, e.g. *connection to existing products*, *prototype functionality*, *winning*) and organizational commitment ($\mathbf{RQ}_3$, e.g. *prizes*, *resource allocation*). Comparing the teams whose projects were integrated into the main production lines with those whose projects did not, we subsequently identified themes that can be related to project integration (e.g. *prototype beneficiaries*, *connection between project area and employee responsibilities*). Iterating the procedure, we refined these themes and created labels that served as a basis for the findings reported. We utilized the questionnaire data as an additional qualitative data point in our analysis since it did not appear feasible to analyze them from a quantitative perspective.

IV. RESULTS

In this section, we will outline our findings from the comparisons of the eight studied teams. We will discuss team (section IV-A, $\mathbf{RQ}_1$), project (section IV-B, $\mathbf{RQ}_2$), and company-related aspects (section IV-C, $\mathbf{RQ}_3$) that potentially had an influence on the integration of the hackathon projects attempted by teams A (first hackathon), E and F (second hackathon) into the main product lines (c.f. table II for an overview).

A. Team characteristics and activities

All teams except team H reported high levels of satisfaction with the way they worked together during the hackathon (*process satisfaction* in fig. 2). The relatively high standard deviation in the case of team H indicates though that this relatively low score might have been partially due to few members of the team being dissatisfied rather than the entire team. This assumption is supported by one team member stating that *"initial work wasn't really efficient, because nobody actually knew at that moment what we actually needed to do, what we needed to develop"* (H2). However, while most teams reported that they were satisfied with the way they worked together, only the projects of teams A, E, and F got continued. It thus appears that a teams' satisfaction with the way they worked together was not strongly connected to project continuation in the case we studied.

Since team collaboration can potentially be related to them having worked together before, we also assessed their common work experience. Most teams had indeed worked together prior to the hackathon, which is not surprising due to the size of the company. All of the members of team A had prior common work experience, while all but one of the members of teams B, D, and E had worked together before the hackathon. In the case of team C, three of the five members had worked together before the hackathon and two members of teams F and G had worked together with the remaining three members being from different organizational units within the same company. For team H, it is unclear if the team members had worked together before. Thus, common work experience did not appear to have a strong influence on project continuation in the case we studied.

For the teams that participated in the second hackathon, we also studied if they had participated in the first event. Team E had members of 3 different teams from the prior hackathon and one member that had not participated in that event. Moreover, two members of the team that won the first hackathon and two individuals that were part of the team who placed second were on this team. In the case of team G, two members had

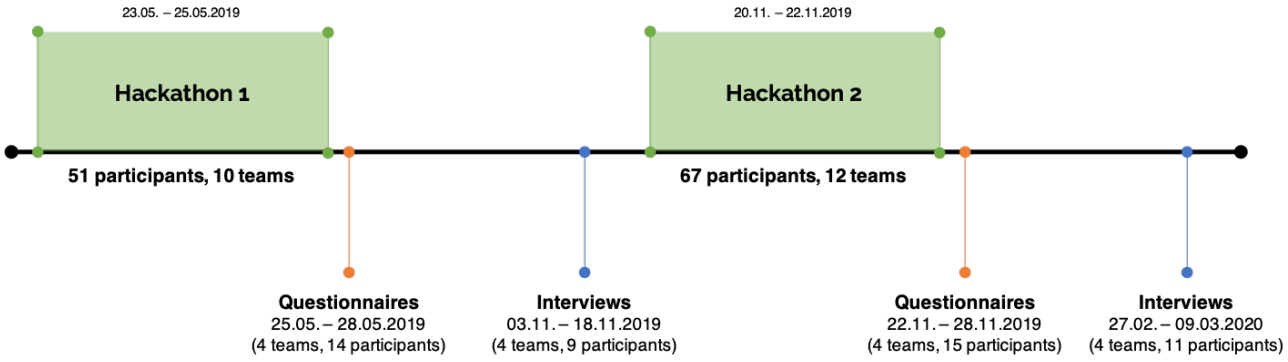
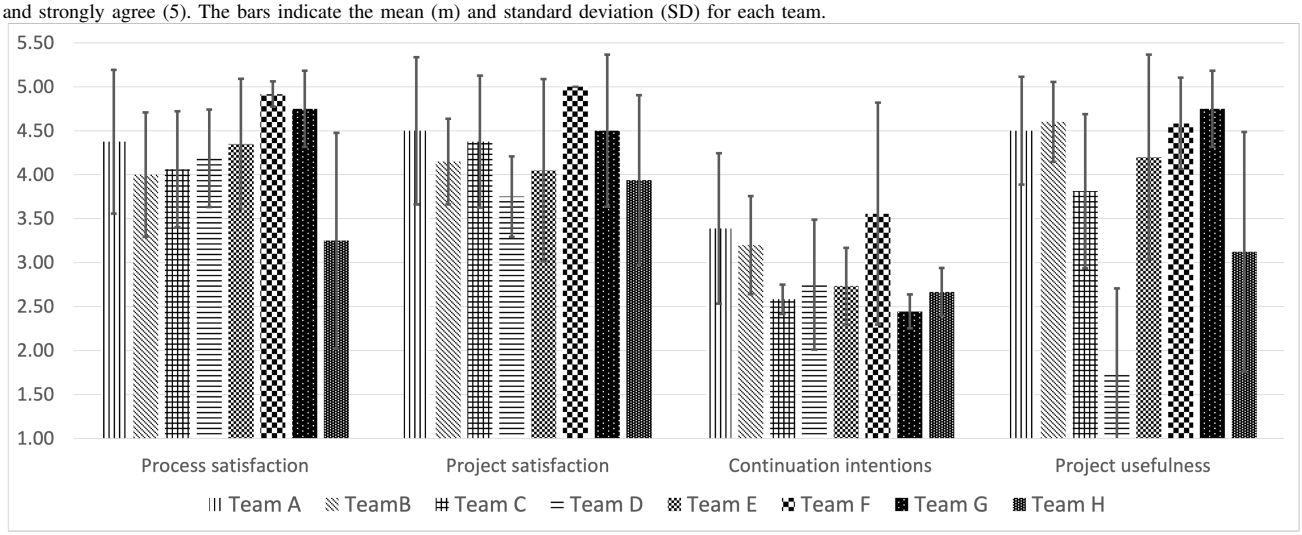


Fig. 1. Data collection points after each hackathon.

Fig. 2. Questionnaire responses by hackathon participants. All responses were given on 5-point scales which were anchored between strongly disagree (1) and strongly agree (5). The bars indicate the mean (m) and standard deviation (SD) for each team.



participated in the same team in the first hackathon. while for teams F and H, only one member had participated in the previous event. Participation in the previous hackathon thus only appeared to be connected to project continuation when almost the entire team participated in the previous event and was part of the winning or second place-team.

With respect to what motivated teams to participate in the hackathon, there was a visible disparity between the motivations of teams whose projects were continued and integrated compared to teams whose projects were not. All teams mentioned that they were partially motivated by the opportunity to network during the event (*"It was like a team building event"*, A1, *"work together with a different set of people that I usually don't work with"*, B3, *"to meet my fellow colleagues"*, H3) and by the possibility to learn (*"learn by working with people from other departments"*, D1). Winning one of the prizes at the hackathon was perceived as beneficial but not a key motivating factor (*"I didn't have an urgent need to win"*, C1). What sets teams whose projects got continued apart from the other teams was the focus of what they were aiming to learn. Teams whose projects did not get continued mainly aimed to learn about and connect to employees in other departments. In contrast, the members of teams A, E, and F focused on learning additional skills (*"improve my skills in problem-solving"*, A3) and about the companies' product portfolio (*"be more aligned with the product"*, F1).

Our analysis also identified differences related to how teams prepared for the hackathon. In addition to all teams forming prior to the event (*"we already had our team before the hackathon"*, G1), the teams whose projects got continued also created a detailed plan for their project (*"knew exactly where we wanted to go [and] had the full scope ready"*, E1) and team A even conducted *"first user interviews to get preliminary feedback"* (A1). Most other teams also engaged in preparation activities with team G *"meeting where we put together the scope, pitch and name"* (G1) of the project, team C doing *"some technical research"* (C1) and team D doing *"a bit of a background research on other companies that had a similar thing"* (D1). Team B did not specifically prepare for the event (*I hadn't planned to take part in this event earlier.*

TABLE II
COMPARISON BETWEEN TEAMS WHOSE PROJECTS GOT CONTINUED AFTER THE HACKATHON AND TEAMS WHOSE PROJECTS WERE NOT ALONG TEAM, PROJECT AND ORGANIZATIONAL ASPECTS. TEAMS A TO D PARTICIPATED IN THE FIRST AND TEAMS E TO H PARTICIPATED IN THE SECOND HACKATHON. LIGHT GRAY BACKGROUND INDICATES THAT A PROJECT WAS CONTINUED. HORIZONTAL LINES SEPARATE TEAM, PROJECT AND ORGANIZATIONAL ASPECTS.

	Team A	Team B	Team C	Team D	Team E	Team F	Team G	Team H
Team process satisfaction	high	high	high	high	high	high	high	mostly high
Common work experience	6 of 6	5 of 6	3 of 5	3 of 4	5 of 6	2 of 5	2 of 5	unclear
Previous hackathon participation					5 of 6, 2 each from 1st and 2nd place team	1 of 5	2 of 5	1 of 5
Motivation	networking, expand problem solving skills	networking	networking, learn about fellow employees	networking, learn about fellow employees	networking, learn about product portfolio	networking, learn about product portfolio	networking, learn about fellow employees	networking, learn about fellow employees
Preparation	project plan and user interviews	no preparation	technical research	project research	detailed project plan	project plan	project scope, pitch and name	background research
Activity focus	prototype	design and prototype	design and prototype	design and prototype	prototype	prototype	demo and prototype	scoping and prototype
Project satisfaction	high	high	high	high	high	high	high	high
Perceived usefulness	high	high	high	low	high	high	high	medium
Connection to existing products	feature extension	new feature	feature extension	stand-alone	feature extension	new feature	stand-alone	stand-alone
Complexity to integrate	low	low	low	medium	medium	medium	high	high
Prototype functionality	full	partial	not clear	minimal	full	minimal	partial	partial
Winning	1st	2nd	none	none	1st	2nd	none	none
Project beneficiaries	current customer base	general public	general public	internal	current customer base	internal	internal	internal
Continuation intention	medium	medium	medium	medium	medium	medium	medium	medium
Idea and org. Unit relation	no	no	yes	no	no	partial	no	no
Resources at org. unit.	hackathon part. is also org. unit leader	NA	hackathon part. also part of target unit	NA	pre-arranged resources	pre-arranged resources	pre-arranged resources	pre-arranged resources

I just decided on it a day before it started. So there was no preparation at all", B1). It thus appears that project-related preparation can be connected to project continuation.

Finally, our analysis revealed that teams whose projects got continued were mainly focusing on development-related activities during the hackathon. They had their project ready before the end of the hackathon (*"Friday, [...] pretty much the product was finished"*, E1), which in the case of team A was attributed to having *"a really strong back-end developer and [...] a really strong front-end developer"* (A2). The other teams, in comparison, spent considerable time *"going through the analysis and figuring out the problem and defining it really well"* (H1), which took time away from their time to develop a functioning product. Moreover, teams B and D reported issues related to their capabilities to develop a functioning prototype because they had *"engineers swapping"* (B3) or had a perceived lack of developers (*"if we had a developer on the team or maybe 2 developers, we could have had a much better result"*, D1). Thus, it appears that creating a stable team that mainly focuses on creating a functioning prototype during the hackathon can potentially predicate continuation activity after an event has ended. It should be noted though, that the lack of focus on creating a functioning prototype in particular in the cases of teams B and D could partially be based on them lacking sufficient development expertise.

B. Project characteristics

All teams reported similarly high levels of satisfaction with their projects after the hackathon had ended (*project satisfaction* in fig. 2). It is notable, however, that teams D and H did not perceive their projects to be particularly useful (*project usefulness* in fig. 2). Both projects were not continued.

One of the differences we identified between hackathon projects that were continued after the event and those that did not, was the connection between these projects and existing products. The projects of teams A and E extended a *"kind-of existing"* (E2) feature, while team F utilized existing resources for their projects (*"using [...] what we already have"*, F1). Other projects, such as those attempted by team G or H, aimed at creating something entirely new (*"reinventing the wheel"*, H1) e.g. the development of a *"community"* (G2).

Related to this, we also found that the projected complexity of integrating a project into the main product lines can be connected to project continuation. The projects of teams A, E, and F were perceived to be easy to integrate (*"the things we*

were presenting were already kind-of existing [...] and could be made public or shareable with little effort", E2) while the project of team H was considered to require considerable effort to get started (*"start of the project is really really huge and maybe cost-inefficient"*, H2).

In addition, we found that having a fully functioning prototype at the end of the hackathon can improve its chances of getting continued. Teams A, C, and E, had a *"90% working prototype"* (E1) while teams B, G, and H had a partially functioning prototype (*"everything was not properly coded. Some were pictures, some were hard-coded"*, B3) and teams D and F only had minimal functionality (*"our prototype was very, very basic"*, D1). It should be noted though that the projects of teams A and E won a price while the project of team C did not. It, therefore, seems reasonable to assume that prior commitment by management that the projects of the winning teams would get continued also had an influence on project continuation. This points towards creating a functioning prototype to predicate winning rather than directly predicating project continuation in the case we studied.

Finally, we found that projects that were aimed at the current *"customer"* (A1) base were more likely to get continued after the event had ended than projects that were aimed at the general public or at improving collaboration and work processes within the company (*"bringing salespeople together"*, G2). The exception in this context was the project of team F. This project *"would be something that would help [customer support] a lot"* (F3). It was thus also related to the current customer base in that it was expected to improve customer service, thus indirectly benefiting the customer.

C. Corporate commitment

None of the teams showed strong continuation intentions (*continuation intentions* in fig. 2). However, team A, as the winner of the hackathon, was promised that their idea would be implemented. They had the choice of developing the idea by themselves or to have the responsible organizational unit develop and integrate the idea into the product. The team decided to hand it over to the responsible unit because they *"would have to re-write it or change a significant amount of it"* (A1). However, the responsible unit did not manage to implement the idea due to them having *"other priorities or vacations, lack of resources, changing the office location"* (A1) and the project was put on hold *"till further notice"* (A1). Although the winning team *"could have still gone with the first option"* (A1), they *"didn't prioritize it"* (A1) due to having lost the enthusiasm as *"the momentum had passed"* (A1). The responsible unit implemented the idea eleven months after the hackathon but with no interaction with the winning team members.

One idea that was introduced in the May hackathon was fully implemented within less than five months after the conclusion of the hackathon. In this particular case, the team leader was *"also responsible for the same subject"* (A1), i.e., worked in the organizational unit that was responsible for the product. Therefore, the idea *"went well together with what were their responsibilities already"* (A1). Furthermore, the team leader had been working on a related product and was motivated to have the idea implemented.

The hackathon organizers, in addressing this issue, introduced an important change. After the May hackathon, the winning idea was given to the responsible unit to implement without any prior arrangements with that unit. In contrast, prior to the start of the November hackathon, management solicited a pre-agreement from all organizational units to ensure that resources were available for implementation of the winning idea. This was achieved by making reservations in the product roadmaps. Thus, the pre-agreement enabled the implementation of the top idea in the November hackathon.

We also found that team C presented an idea in the May hackathon that they thought should have been implemented. Their idea was *"basically a simple addition to [company name]"* (C1), had direct benefit for the customers, required relatively low effort *"but could make a huge impact"* (C1). Furthermore, the team members were part of the responsible organizational unit and the team leader presented the idea to their product manager after the hackathon. However, the product manager, due to leaving the company, never took the idea further and it was never implemented. It is noteworthy that team C did not present the idea to the new product manager but, rather disappointed, expressed their hope of the idea being *"listed somewhere as a good idea"* (C1).

V. Discussion

Our aim was to study hackathon project continuation in the context of a medium-sized software company and, thereby, build on existing work that was conducted in the context of a large corporation [8]. Our findings provide indications for different team- ($\mathbf{RQ}_1$), project- ($\mathbf{RQ}_2$), and company- ($\mathbf{RQ}_3$) related aspects that contributed to the integration of hackathon projects into the main product lines of the medium-sized software company where we conducted the study.

Related to the characteristics of a hackathon team and their activities before and during a hackathon, our study revealed that teams that were motivated to participate in a hackathon because they aim to improve their job skills rather than solely focus on networking were more likely to have their project continued in the case we studied. This finding is in line with prior work on project continuation in the context of a large corporate hackathon which found that individuals who aimed to acquire skills that would help them advance their career can foster project continuation [8]. Moreover, we found teams that engaged in project-focused preparation and focused on the development of a functioning prototype during the hackathon, had their projects continued in our study. Both aspects have also been reported to affect project continuation in prior work in the context of corporate hackathons [8] and corporate innovation [54]. It should be noted though that the development of a functioning prototype also points towards the necessity to have sufficient developer experience within a team. In addition, in our study, teams where most team members had participated in the previous event were more

likely to have their project continued. This finding stands in contrast to prior work which did not find indications for a relation between common hackathon experience and project continuation [25]. One potential explanation for this disparity can be related to our study focusing on two hackathons that were conducted within the same context and following the same goals. This can allow participants to adapt to the specific conditions, which was not the case in prior work [25]. Moreover, the team that retained most participants from the prior hackathon also won the 1st price at the second hackathon, which came with the promise of the company to continue that project. This aspect might thus also have contributed to the continuation of this particular project.

Moreover, in our study, projects that were connected to existing products were more likely to get continued. This finding is similar to that reported in prior studies in the context of corporate hackathons who found that projects which can be considered an evolution of existing products were more likely to get continued [8]. Furthermore, in the context we studied it was also important for teams to create a functioning prototype that was easy to integrate in order for it to be considered for continuation. Both aspects have not been discussed in prior work on project continuation. In contrast, existing studies point towards complex projects being more likely to show continuation activity [25]. This work, however, was conducted in an open-source context where technical complexity can potentially serve as a motivation for hackathon participants to continue working on their projects while it can be expected that companies would rather favor projects which do not require extensive resources to be integrated. In our study, we also found a connection between project continuation and projects targeting the existing customer base of the company that organized the event. This appears reasonable since having a clear business case – i.e. a strong customer focus – can be considered an antecedent of innovation success [54]. Moreover, it appears reasonable to target the existing customer base to retain customers rather than acquire new customers since the latter is costlier [60]. This aspect has not been extensively discussed in prior work on hackathon project continuation.

Related to corporate commitment, our study identified resource allocation as a critical aspect for hackathon project continuation and their integration into the main product lines of the company we studied. This does not come as a surprise since teams cannot be expected to create a shippable product during the short duration of a hackathon. Hackathon projects can rather be expected to require development resources after an event in order to reach a shippable state which in turn will require management support [26], [27]. In the case of the hackathon we studied, we identified two sources for this support. One source was the leader of a hackathon team that worked on a project that fit with the development plan of the organization unit that s/he was leading. S/he could thus allocate the required resources her-/himself. The second source came in the form of the hackathon prizes, which promised the winner of a hackathon sufficient development resources to turn their project into a product. This source, however, only came into fruition after the second hackathon when the company explicitly asked every organizational unit to set resources aside for a potential hackathon project after the event. During the first hackathon, the company leadership attempted to allocate resources after the event had ended, which appeared to cause significant delays. The aspect of resource allocation expands our current perception of hackathon project continuation in a corporate setting. Existing studies provide indication that hackathon teams can hand over their projects to organizational units they are not involved in [7], [8], but these studies do not report on whether or not that unit actually continued the project. Our findings also point towards a disparity between aspects that are under the control of a hackathon team and aspects that are not. While they can carefully select their members, prepare for the hackathon and develop an easy to integrate customer facing product they have only limited influence on whether or not they will win one of the prizes or on resource allocation after an event has ended unless the project can be continued in their realm of responsibility.

Finally, it should be noted that we did not find a strong connection between common work experience and hackathon project continuation in our study, which is in line with prior work on the topic [7], [8]. We also did not identify a connection between continuation intentions and continuation behavior. This could however be partially due to all teams stating similarly low continuation intentions. We can thus neither confirm nor deny prior findings in literature by Carruthers et al. [40] in the context of civic hackathons who did not find a connection between continuation intentions and continuation behavior or by Nolte et al. [25] who reported on the existence of this connection in the context of corporate events.

A. Limitations

The goal of our study was to complement existing work on the sustainability of hackathon projects in a corporate context. Specifically, we examined how team characteristics and activities, project characteristics, and corporate commitment were related to the inclusion of hackathon ideas into the main product lines of a medium-sized software company. These phenomena have not been extensively studied outside of the context of a large software company. Therefore, it is appropriate to conduct an in-depth case study [61] for the given research context. However, there are limitations related to our study design. We studied eight teams participating in hackathons working on specific projects within the setting of a single company with a specific size and a specific product portfolio. While we made theoretically-motivated case selections, it can be expected that a longer study time frame, different settings, different teams, and different projects might yield different results. Thus, there are limitations to the extent the results can be generalized, i.e., extended to apply to other corporate settings.

VI. Implications

The findings presented in this paper have a number of implications for research and practice. We found various

aspects that can help companies utilize internal hackathons to foster corporate innovation. Our results suggest that teams whose members aim to acquire new or improve their existing skills, that engage in project focused preparation, work on projects that are closely related to existing products, focus on the existing customer base of that company, and easy to integrate were more likely to have their projects continued and released as new products or extensions to existing ones in the context of the company we studied. If the main aim for the organizers of a corporate hackathon is to foster the development of innovative products, they should consequently consider fostering the distribution of project ideas within the company prior to the event. This would allow project teams to connect with organizational units that work on related products with which they could discuss their project idea both in relation to its usefulness for customers and its technical feasibility. Moreover, organizers could suggest for teams to utilize results from these discussions to develop a mature project idea and a suitable project plan so that team can focus on developing a presentable prototype during the course of a hackathon. Finally, they should suggest for teams to find a sufficient number of developers that can turn their project idea into a functioning prototype at the end of the event.

It should be noted though, that these suggestions might also have an adverse effect on innovation. Teams might become too focused on identifying connections to existing products and quick wins that appeal to the existing customer base, which might, in turn, be detrimental to the development of truly innovative products. Moreover, participating in a hackathon might lose its appeal for employees if they perceive them as just another work project. The aforementioned suggestions should, therefore, be perceived as optional rather than compulsory for teams to participate in a hackathon.

From an organizational perspective, our findings also revealed the crucial role of resource allocation in the context we studied. For hackathon projects to be integrated into the main production lines of a company, it was important that organizational units had sufficient resources to continue a project after the event has ended. Organizers of corporate hackathons should, thus, engage in conversations with organizational units that might be potential landing spots for hackathon projects prior to an event. In addition, it might be advisable to suggest for hackathon teams to discuss resource allocation within their respective unit prior to the event if they think that their unit might want to pick up their project after a hackathon. This suggestion could, however, again lead to the previously discussed narrowing of a project's focus, thus, preventing innovation.

Our findings also raise new important questions for researchers. How to facilitate match making-between hackathon teams and organizational units prior to an event? How much structure is necessary for a hackathon to have the desired outcomes? When does an event loose its appeal as a hackathon due to too rigid structuring? How to support the grooming of innovative products that focus on the general population rather than the existing customer base or that cannot be directly integrated into existing product lines?

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