THE COLLABORATION OF CROWD WORKERS

Research-in-Progress Paper

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Abstract

Crowdsourcing is used for problem solving in different domains. A promising key to optimal solutions is collaboration among crowd workers. However, due to the distributed and asynchronous nature of crowd work, often with a large number of heterogeneous, anonymous and varying workers, crowd collaboration support is challenging. Thus, platform providers and crowdsourcers still struggle with or refrain from making full use of the potential of collaboration. The current state of research on this field explores this topic mostly for a specific domain, such as idea contests. This paper widens this scope and aims to validate a general process design framework for collaboration in crowdsourcing across various domains in an ongoing design science research project. To achieve this, we analyze current projects on crowdsourcing platforms with a conceptual process structure and a corresponding set of criteria for effective crowd collaboration support. We conduct a content analysis of ten real world projects to gain insights on their collaboration support features and collaborative interactions of crowd workers. This paper contributes to crowdsourcing research and practice by deriving recommendations for advancing the collaboration process design framework as well as for improving the conclusiveness of collaboration support on crowdsourcing platforms.

Keywords: Collaboration, Crowd Work, Crowdsourcing, Design Science, Content Analysis.

1 Introduction

Crowdsourcing refers to outsourcing tasks "*to an undefined, generally large group of people in an open call*" (Howe, 2006). The description of a crowdsourcing process by Howe (2008) pictures an alternative way for organizations to get access to more work force, which increasingly finds its way into corporate practice (Leimeister, 2016). But, organizations *"fail to harness the full potential of crowdsourcing"*(Piezunka and Dahlander, 2015). Due to the overload of user generated input (especially if unstructured and in text form) crowdsourcing platforms are unable to extract the relevant information and to process it properly (Barbier et al., 2012). The filtering process is a very cost intensive and time consuming task on crowdsourcing platforms (Blohm et al., 2013; Kittur et al., 2013; Zhao and Zhu, 2014; Zogaj et al., 2014). For example, Google needed three years and 3000 employees for 150 000 submitted solutions (Blohm et al., 2013) and IBM 50 senior executives for 46 000 solutions in several weeks (Bjelland and Wood, 2008). Not all of the contributions are qualitatively on an acceptable level and duplicates exist. To reduce the number of duplicates and improve the quality of solutions the wisdom of the crowd is helpful. Individuals from the crowd - crowd workers (Durward et al., 2016) - can recognize and link duplicates and, if they find any weakness or have suggestions, they can contribute to improve solutions. This process uses the collective knowledge of the crowd to inspect the problems involved in tasks to-

wards optimal solutions (Howe, 2008). While some tasks can be subdivided into subtasks and the subtasks can be accomplished independently by crowd workers, others need close collaboration of several crowd workers. Especially if tasks are complex and exceed the capacity and skills of any single individual, collaboration of heterogeneous actors has the potential to lead to better results, if orchestrated well (Bittner and Leimeister, 2014; Bowers et al., 2000; Langan-Fox et al., 2004; Wegge et al., 2008). However, with its characteristics that are very different from common small or large group collaboration, e.g. no stable teams or shared organization, no personal relationships among collaboration partners or face-to-face interaction, crowd collaboration may need novel or adapted collaborative work practice support.

Crowdsourcing research has recognized the collaboration between crowd workers as a main part for value creation (Agafonovas and Alonderiene, 2013). However, the current state of research on this field addresses this topic mainly with an exploratory focus on a specific domain. For example, the work of Kipp (2015) aims at improving the overall idea quality on Web based idea platforms (WBIP) by applying a tool supported collaboration process, which allows WBIP users to collaboratively elaborate on existing ideas on the WBIP. Hutter et al. (2011) study the effectiveness of crowd workers with competitive and collaborative behaviors compared to each other in design contests. They conduct an empirical study to investigate how the tension between those behaviors can influence the quality of work. Malhotra and Majchrzak (2014) use the knowledge integration process (Grant, 1996) to manage the crowd through collaborative idea contests. Their empirical study is used to derive management guidance to navigate the crowd through the collaborative idea finding process. Overall, several studies show that effective collaboration may have a positive impact on the quality of solutions (Armisen and Majchrzak, 2015; Fantoni et al., 2012; Hutter et al., 2011; Malhotra and Majchrzak, 2014). Despite these promising results concerning the potential of collaboration in crowdsourcing and apart from these individual initial explorations, recent work has identified a lack of common understanding of the collaborative interaction among crowd workers (Agafonovas and Alonderiene, 2013). Most of the well-known crowdsourcing platforms still fail to make users collaborate with each other in open calls that can reach up to thousands of crowd workers (Agafonovas and Alonderiene, 2013).

Thus, in order to develop effective collaborative processes for crowd workers, we need to gain deeper understanding on (1) the phases of an effective collaborative crowdsourcing process, including their content and order as well as (2) gaps and weaknesses of existing crowdsourcing projects with respect to the model process. A conceptual process structure for (1) has been proposed by Tavanapour and Bittner (2017). Therefore, the study at hand applies this process framework to analyze the collaboration among crowd workers in ten real world projects to gain insights on their current procedures and limitations. In particular, we explore for (2), which of the process phases and steps of the conceptual framework are prevalent in current crowdsourcing practice and where there are mismatches between the conceptual model and the status quo in practice. From this comparison, we derive recommendations for advancing the collaboration process design framework as well as for improving the conclusiveness of collaboration support in crowdsourcing platforms.

2 Methodology

2.1 Research Approach and Framework

This study is part of a larger design science research project (DSR) (Simon, 1996) (Gregor, 2006; Gregor and Hevner, 2013; Jones and Gregor, 2007). The DSR project aims to iteratively develop and implement the collaboration process design framework for crowdsourcing (CPDF) (Tavanapour and Bittner, 2017) as its central artefact. It will provide a general approach to understand, analyze, structure and design the collaboration process among crowd workers on platforms. We choose the DSR methodology as a reliable approach for solving a class of problems by showing the suitability of an iteratively adjustable artefact and contributing to the knowledge base by applying a rigorous approach to improve the constructed artefact (Gregor and Hevner, 2013). In particular, we follow the approach of Peffers et al. (2006), which is structured into six activities. In this paper, we present the results of one iteration of activities four and

five (Demonstration and Evaluation) of the initial framework. Activities one to three have been conducted and presented in Tavanapour and Bittner (2017). Activity six will be completed with this paper.

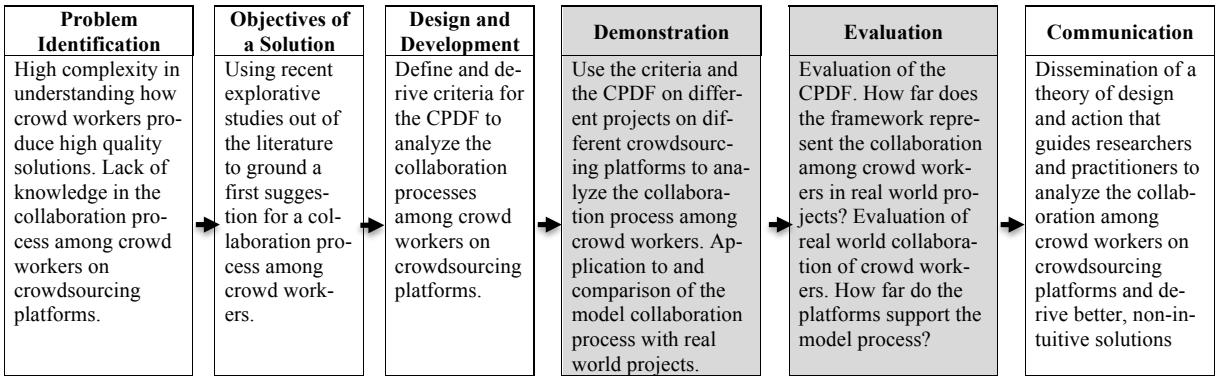

Figure 1. Design science research project

This paper analysis currently ongoing projects on crowdsourcing platforms with respect to the CPDF. The CPDF (see Figure 2) sets the scope of our analysis and considers the phases before, during and after the collaboration among crowd workers. It suggests a model collaboration process design for the interaction between crowd workers with the goal to accomplish tasks collaboratively.

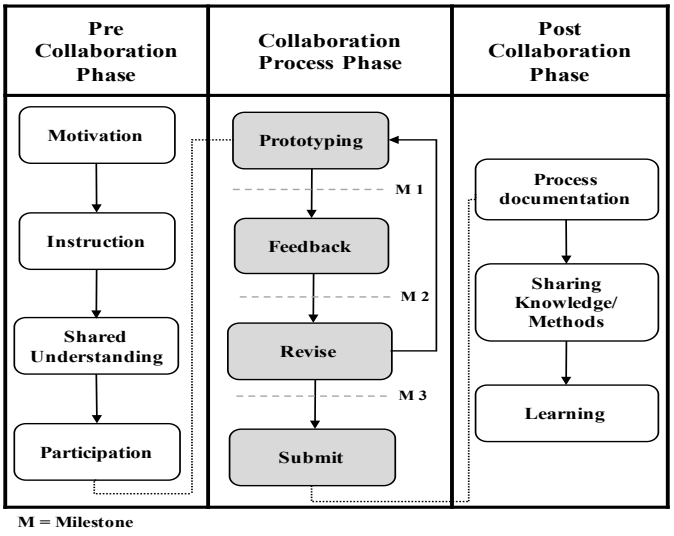

Figure 2. Collaboration process design framework for crowdsourcing (Tavanapour and Bittner, 2017)

The CPDF is compared to the situation on real world platforms derived from a content analysis of the platforms in the study at hand. Platforms were selected to represent a large diversity of domains and based on the criterion that new artefacts of some kind are created collaboratively by crowd workers. This includes also platforms that are not pure or distinct crowdsourcing platforms (such as e.g. Youtube) but that host open call projects that fall into this definition. Table 1 presents an overview of the considered projects that were considered in our content analysis, which is described in section 2.2.

2.2 Content Analysis

Content analysis according to the approach proposed by Mayring (2014) has been chosen to analyze the manifestation of the model collaboration process in the real world projects. It allows us to gather the range of collaboration support on platforms and insights about the collaboration among crowd workers directly from platform features and textual raw material produced by crowd workers to avoid biases inherent to indirect data collection methods, such as e.g. interviews. This data makes it possible to systematically identify differences of collaboration structures between platforms in comparison to the CPDF. We considered content from three different types of sources on the platforms: **features, documentation** and **contributions** in form of text and files. Features are provided by the platform owner,

contributions by crowd workers and documentation by crowdsourcers, platform owners and crowd workers. To conduct a content analysis, a category system for coding has been developed (Mayring, 2014). We defined every step of the CPDF (Figure 2) as a category. The content of each platform was coded (Coffey and Atkinson, 1996) to the categories below (Mayring, 2014).

C1 Motivation: This category distinguishes between extrinsic and intrinsic motivation (Chittilappilly et al., 2016; Frey et al., 2011; Hossain, 2012; Schultheiss et al., 2013; Soliman and Tuunainen, 2015). Hobbies, pleasure, and interests are examples for intrinsic motivators, while extrinsic motivation delivers some compensation for work (Hossain, 2012). This can, e.g. be remuneration (Frey et al., 2011) or fulfilling the desire to learn and improve one's own abilities (Soliman and Tuunainen, 2015). Extrinsic motivation can be further divided into financial (e.g. money or job opportunities), social (e.g. knowledge or experience) and organizational (e.g. career prospects or responsibilities) motivators (Hossain, 2012). The type of motivation can have an impact on the submitted contributions (Frey et al., 2011). The **criteria** we considered for the coding process of C1 are gamification (Dai et al., 2016), ranking-systems, acknowledgement process for users, payment process, and other monetary reward, which are mostly found in the platform features.

C2 Instructions: Instructions are common in the form of guidance for participating in projects, mainly found in the documentation provided by the crowdsources. The **criteria** we are searching for in the coding process for this category are general informative forms, pdfs, wiki-sites, listings, conditions, rules, FAQs, forums-sites and How-to for guidance on platform usage and project participation.

C3 Shared Understanding: This category considers the knowledge base of crowd workers and how the platform can be used to gather the needed knowledge for participating, to reduce the gap between crowd workers and increase the quality of contributions. Crowd workers have the opportunity to gather knowledge through the project specific description and files and by asking other crowd workers on the platform. If project specific information is not detailed enough for crowd workers, they may search other sources to gather the needed knowledge. However, if a crowd worker does not understand the contribution of other crowd workers s/he may ask the contributor questions to clarify any misunderstanding. For this category, the content types documentation and contributions were considered. The **criteria** for the content type documentations are open call specific description, files, wiki-sites, references, links, theories and methodologies. The **criteria** for the content type contributions are text segments with content specific question on others contributions.

C4 Participation: This category is focused on the type of participation of crowd workers. They can ask questions, create new content or solutions or comment on other contributions. The considered **content type** is **contributions** and the **criteria** are contribution types: posting ideas, creating designs, solving problems, accomplishing tasks or commenting on other contributions.

C5 Prototyping: This category considers the creation of first prototypes by crowd workers before they are shaped to artefacts. It is important to capture the contributions that lead to produce a first prototype. The considered **content type** is **contributions**. The **criteria** are posts and text segments indicating first prototypes (ideas, solutions, designs, source code etc.), text segments with suggestions or plans for a solution, elimination of suggestions and subtask definition and accomplishment for a specific suggestion or even prototype.

C6 Feedback: The feedback category captures any kind of feedback in relation to the first prototype. Two **content types, features and contributions,** are considered here. The **criteria** for **features** are any kind of positive or negative rating, e.g. like or dislike buttons, voting ranges or scales. The **criteria** for **contributions** are discussions about positive or negative aspects of a prototype and its values, highlighted deficits of a prototype, comments or remarks, any kind of re uploaded prototypes with highlighted areas, suggestions for preventing potential future problems, alternative prototype suggestions and upload of the same prototype with changed details or parts or areas.

C7 Revise: Here an improved or changed prototype is presented with the help of the feedback. To decide which feedback is essential for the prototype is a challenge for the crowd worker. The **content type** is

contribution. The **criteria** for coding text segments are discussions on suggested feedback by its pros and contras for prototypes and task completion that meets the requirements of the open call as well as adjusted prototypes with considered feedback.

C8 Submit: This category captures necessary formalities for submitting a solution. But before that the crowd workers have to meet the needs for submitting. All three **content types** are relevant here. We searched for the **criteria** forms, conditions, rules and specific format description in **documentation**, for converters, uploads and packaging in **features** and for text segments with shaping the final version of the solution, adjusting accomplished subtasks for a solution, described methods to bring the solution in an acceptable form to submit and shared experience about how to submit in **contributions**.

C9 Process Documentation: This category captures important knowledge on how crowd workers succeeded to create and submit a solution. In future projects this knowledge can help other crowd workers to solve similar problems. The analyzed **content types** are **documentation** and **contributions.** The **criteria** in documentation are referenced previous projects or recorded user interaction for specific ways to create solutions in pdfs, wiki-sites, listings, conditions, rules, FAQs and forums-sites. The **criteria** for the coding process in contributions are references to certain questions about how to handle problems in previous projects or contributions of other crowd workers and summing up the derivation process of submitted solutions.

C10 Sharing Knowledge/Methods: Exchanging specific knowledge among crowd workers is the focus in this category. To do so, the crowd workers need an interface for that. Either the platform has a forum for that purpose or knowledge sharing is possible in the project. A third way would be to establish a rule that successful solutions must explain the method of how the solution was formed (Fantoni et al., 2012). We considered **all three content types** and specified it by considering the exchange of knowledge or methods in reference to successfully submitted solutions.

C11 Learning: Not just the acquisition but also applying provided knowledge by crowd workers, crowdsourcers and the platform are covered by this category. For the **content type contributions,** the **criteria** text segments of realized solutions and subtasks with applied methods others analyzed.

The coding process is structured as follows. First, for each platform we gathered all available data for the different content types. Second, for all datasets we examined whether the criteria described in the category are satisfied or not. The coding process was done by two different individuals to minimize the subjectivity of the coding (Mayring, 2014).

3 Overview of Considered Crowdsourcing Projects

Table 1 summarizes the open calls that were analyzed and compared to the CPDF. Most of the platforms had multiple ongoing, structurally similar crowdsourcing projects. We considered projects with the focus on crowd workers collaborating with each other on tasks. Therefore, we also report projects on Youtube (9) and Reddit (10) that are not purely crowdsourcing platforms but can potentially contribute to an understanding of the necessary collaboration mechanisms. Table 1 takes the domain of each project into consideration to represent a wide variety of different platforms. The "overview" column gives a brief summary on the platforms and the types of open calls that were considered. The last column depicts the artefact produced. On most platforms multiple artefacts were produced in the same project.

Nr.	Platform Name	Domain	Scope of Platform	Artefact(s) Considered
1	Agentur für Arbeit	Government	The platform had multiple similar open calls that served the purpose to simplify and digitalize the job seeking process.	Ideas/ Designs
2	Postbank	Banking	The Postbank had a variety of open calls. The two specific open calls observed were a „hackathon" and a design contest for a mobile application.	Designs for Applications/ Source code

3	Starbucks	Food	Starbucks has an ongoing innovation contest. The most liked and popular ideas will be used in day-to-day business.	Ideas
4	OpenIdeo	Healthcare/ Education	Challenges observed were „How might we enable older adults to live their best possible life by preventing falls?" „How might we better prepare all learners for the needs of tomorrow by reimagining higher education?"	Ideas
5	Zooniverse	Science	Zooniverse hosts multiple projects. These projects use collaboration to evaluate scientific data to generate evidence or discover new data.	Task accomplishment
6	Cccinnovation-center	IT Healthcare	This open call is a code-a-thon that tried to integrate blockchain into the healthcare system.	Concepts and Designs/ Source code
7	NASA	Spacecraft	NASA hosted an open call in which they tried to produce a 3D printable design. The purpose of the design is to: „[...] build a 3D printed habitat for deep space exploration[...]".	Designs
8	Movingideas	Transportation	The open call was hosted by MovingIdeas in cooperation with the Deutsche Bahn (DB). The DB wanted to gather ideas to integrate robots into their business model.	Ideas
9	Youtube	Media	A media platform for entertainment. The collaboration projects consist either of certain channels that use ideas for future entertainment creation or ongoing channels that use feedback to iterate on their product.	Channels/ Ideas
10	Reddit	Media	Another platform for entertainment. In this case the collaboration observed is mainly in ongoing threads or „subreddit" creation. The direction in which the „subreddits" go is driven by users.	Threads/ Subreddits

Table 1. Crowdsourcing Platforms within the Analysis

4 Findings

This section summarizes the results of the content analysis (see Table 2). A category is marked as covered, if one or more of the criteria of the category are fulfilled. We chose this kind of presentation to investigate, whether the process steps of the CPDF (Tavanapour and Bittner, 2017) correspond to real world projects or not. Furthermore, the categories and the coding scheme can be used to identify, which process steps are skipped or where the collaboration process in real projects differs from the framework.

Category/ Project Nr.	Pre Collaboration Phase				Collaboration Process Phase				Post Collaboration Phase		
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11
1	X	X	X	X	X			X	X	X	
2	X	X	X	X	X	X		X	X	X	
3		X	X	X	X			X	X		
4	X	X	X	X	X	X	X	X	X	X	X
5		X	X	X		X		X	X	X	
6	X	X	X	X	X			X		X	X
7	X	X		X	X			X		X	
8	X	X	X	X	X	X		X	X	X	
9	X	X	X	X	X	X	X	X	X	X	X
10	X	X	X	X	X	X	X	X	X	X	X

Table 2. Matches between criteria and platforms

In the Pre Collaboration Phase a majority of platforms in the study fulfilled the criteria in each category. The motivation category only has two projects that did not take the measures as predefined in the CPDF

to motivate the participants either intrinsically or extrinsically. The instruction and participation category show that all ten projects or platforms fulfilled the characteristics defined in the framework. Only project number seven didn't meet the requirements given in the framework for the shared understanding category.

In the Collaboration Process Phase huge gaps and structural differences were found in comparison to the framework especially in the feedback and revise category. Only project five did not meet the criteria

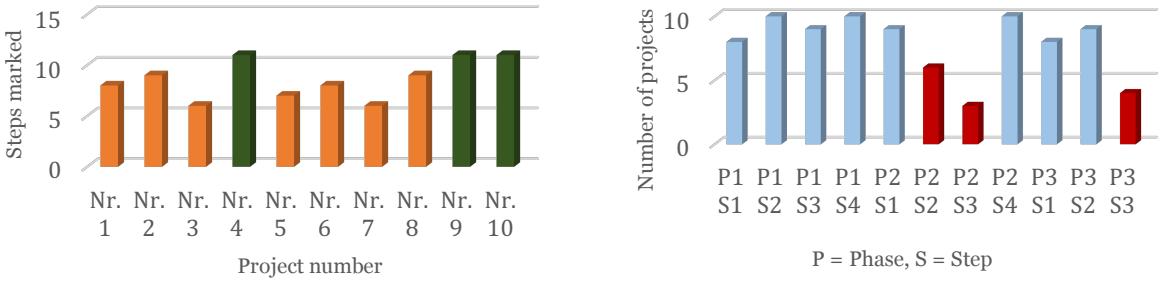

Figure 3. Analyzed projects in comparison

for the prototyping category as prototyping was an essential part of nearly every open call. The feedback category shows that four of the ten projects were missing features and structures for giving appropriate feedback. Only three projects covered the revise step of the framework. The revise step is overall the most lacking one. A huge problem in this step is that submissions often happen before the actual feedback step. Most negative feedback found in the content analysis was also not helpful towards the improvement of the produced artefact. However, all platforms took measures to ensure the correct submission of the finalized product. In the process documentation category eight out of ten platforms documented finished projects. Only project three didn't meet the criteria. Huge differences were found in the learning step as in six projects the crowd workers didn't use the available information to learn new methods or knowledge that can be applied for future open calls. Platforms often covered a huge variety of domains with their open calls. Thus, knowledge obtained in vastly different topic areas couldn't be used properly to optimize the collaboration process.

It can be concluded that even though there were large differences in the design and implementation of some categories, the majority of platforms were close to meet either all or a big part of the criteria. Figure 3 shows that no project addressed less than six categories. Three out of ten projects mapped completely to the CPDF categories. Two out of these three platforms were from the media domain with focus on ongoing collaborative crowdsourcing as their main business model. The third platform, though coming from another domain, still has the same focus. On average, 8.6 out of eleven possible categories or roughly 78 % could be identified on the platforms. Figure 3 also shows, how many projects fulfil the prerequisites of specific steps. Most categories or columns were widely represented in the projects. The three steps which fell behind were the feedback, revise and learning steps (dark color in Figure 3, right hand side), with six, three and four marked columns respectively. The biggest issues were observed in the revise step as only three out of ten projects supported any kind of revision for the artefacts.

4.1 Recommendations for Improving the CPDF

From the comparison of real world crowdsourcing projects and the initial version of the CPDF, we find that the initial framework generally matches a great variety of crowdsourcing projects. Thus, the initial demonstration of the framework's applicability is successful. From the evaluation, in line with the iterative DSR approach towards generalizable design knowledge, we derive the following potentials for adapting the framework to model de facto collaboration processes on crowdsourcing platforms even more conclusively and realistically. First, the framework needs to expand the prototyping, feedback and revise steps by designing more detailed and less general process steps that may guide the collaboration among crowd workers towards optimal solutions. For the prototyping step, we can learn from projects 1 and 2, that the crowd workers may gather initial suggestions, describe as well as assign task-packages

and elaborate on different tasks to create the prototype. With respect to the strongly varying quality of provided feedback in projects 2, 4, 5, 8, 9 and 10, we suggest to add to the CPDF that other crowd workers should verify the feedback completeness and legitimacy. This crowd control mechanism might also be of value to be integrated in the revise step, as in projects 4, 9 and 10, relevant feedback was ignored, but other less relevant feedback was considered. Furthermore, the submit step should be expanded with a step that describes the integration of sub products by crowd workers that results in the end product, as we observed in projects 1, 2, 4, 9 and 10. All these changes necessitate an adjustment of the criteria in section 2.2 to cover the new and extended process steps.

4.2 Recommendations for Designing Improved Crowdsourcing Practices

By applying the conceptual framework to ten real world projects, we found that collaboration process support was more conclusively implemented in projects within the media domain than in others. In particular, little process support could be identified for the feedback and revise steps in the Collaboration Process phase as well as for the Post Collaboration Phase in general and the learning step in particular. The feedback and revise steps are at the core of the quality control for submissions and need to be considered as the main source for the cost-effective derivation of qualitatively improved end results. The learning step fosters the users' long-term motivation to participate and is relevant to continually qualify the platform users for future open calls. Thus, crowdsourcers and platform providers should consider to adopt the functionalities and strategies proposed in the CPDF in order to implement more structured collaboration support for those steps. They may use the three projects with the most conclusive coverage of the framework, which we identified in this study, for orientation concerning specific design options for the lacking features. Designers of crowdsourcing platforms, who aim to implement collaborative work practices, can turn to the CPDF to point them towards helpful collaboration support features. They can furthermore use the CPDF to analyze their platforms and specific projects concerning the effective manifestation of the aspired collaboration support features and interaction patterns following the blueprint approach presented in this paper.

5 Conclusion

This paper contributes to crowdsourcing research by deriving recommendations for advancing the collaboration process design framework as well as for design practice by deriving recommendations for improving the conclusiveness of collaboration support in crowdsourcing platforms from the comparison of the CPDF conceptual model and practical status quo. Our findings can be used to design improved collaboration processes for crowdsourcing platforms by identifying the weaknesses of their collaboration processes concerning the criteria of the CPDF or adopting support features or strategies from the more comprehensive platform examples presented. Furthermore, the criteria and the framework should be used to evaluate other (currently ongoing) collaboration processes on crowdsourcing platforms for weaknesses or novel support features that are not represented in the current framework. Future research shall iteratively advance the framework and the criteria by starting the next iteration described in the DSR approach according to Figure 1 and consider the recommendations presented in this paper. One possible entry point for this can be the Design and Development step of the approach by Peffers et al. (2006) by conducting expert interviews with platform providers to address their perspective on the feasibility and usefulness of framework and identify potentials for improvements. Moreover, future research should investigate with a larger scale empirical study, whether the identified differences and gaps in process support between the projects are driven by different domain needs or other project characteristics or if projects with current gaps in functionality would also benefit from the steps proposed by the framework and found in other projects. This investigation may advance the understanding on whether one general framework for crowd collaboration support is useful and appropriate or if different support steps should apply to different types of crowd collaboration. It may bring us one step closer towards a generalizable design theory for crowd collaboration support.

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OpenIdeo https://challenges.openideo.com/challenge/future-of-highered/refinement (accessed 25.02.2017)

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