Technology and Innovation Management at Hamburg University of Technology

Working Paper

Lead User Method vs. Innovation Contest – An Empirical Comparison of Two Open Innovation Methodologies for Identifying Social Innovation for Flood Resilience in Indonesia

Moritz Goeldner*, Daniel J. Kruse & Cornelius Herstatt

November 2017[1]
Working Paper No. 101

Hamburg University of Technology (TUHH)

Institute for Technology and Innovation Management

Am Schwarzenberg-Campus 4
D-21073 Hamburg

Tel.: +49 40 42878 3777
moritz.goeldner@tuhh.de

www.tuhh.de/tim

*corresponding author

[1] A previous version of this working paper was presented at the 9th International Social Innovation Research Conference (ISIRC) on December 12th – 14th, 2017

Abstract

Organizations in the humanitarian sector often face problems that are hard to solve owing to their complexity and high hidden solution knowledge. We investigate two problem-solving governance mechanisms in the case of floods in Indonesia. In our study, we compare the costs and benefits of two open innovation tools for identifying social innovation: an innovation contest and the lead user method. An innovation contest is a challenge among participants, who submit potential solutions to a problem that is posted in an open call. In contrast, the lead user method is a structured search process to identify innovators who have already developed solutions for their own needs or those of their peers. While innovation contests have seen significant attention, there is very little evidence that the lead user method is a suitable tool to identify social innovation. In our study, the contest yielded more than twice as much submissions as the lead user method (60 vs. 25). Our analysis reveals that concepts obtained by the lead user method score significantly higher in overall quality as well as regarding use value, feasibility, degree of elaboration, and social impact. The concepts' novelty do not significantly differ between the two groups. We discuss these findings against the background of the humanitarian sector being torn between capacity overload and the need to overcome a one-size-fits-all approach. By transferring two recognized governance forms for innovation identification from the private sector to the humanitarian sector, we introduce a new path towards empowering local innovators to solve humanitarian challenges.

1 Introduction

Organizations in the humanitarian sector face complex problems such as enduring poverty and environmental degradation, which are difficult or even impossible to solve (Dorado and Ventresca 2013). Social innovations are an important piece in solving such complex or even *wicked* (Rittel and Webber 1973) social problems (OECD 2012). Despite substantial efforts to define and clarify its meaning, the concept of social innovation is still considered ambiguous (Cajaiba-Santana 2014). However, a recent comprehensive review reveals its two core components: social innovation entails "1) a change in social relationships, -systems, or -structures, and 2) such changes serve a shared human need/goal or solve a socially relevant problem" (van der Have and Rubalcaba 2016, p.1932). For solving complex (social) problems, indigenous knowledge is considered to be a valuable source of innovation (Dentoni et al. 2012; Norton 2012). Being embedded in the informal sector, which is commonly located outside humanitarian organizations' boundaries, indigenous knowledge is hard to obtain (Saxena 2015). Thus, to govern the search for relevant knowledge is a crucial task for managers in the humanitarian sector.

Following a problem-solving perspective (Nickerson and Zenger 2004) in the private sector, several strategies to solve complex problems by opening the boundaries of a firm are subsumed into an emerging paradigm, open innovation (Chesbrough 2006). In brief, open innovation assumes that both internal and external ideas are valuable to organizations. Studies of open innovation's governance implications indicate that increased links to and knowledge flows from various external partners lead to improved innovation outcomes (West and Bogers 2014). These sources of external knowledge range from users to suppliers and universities, and can be obtained using various tools (Felin and Zenger 2013). To name a few, innovation contests, user integration, corporate partnerships, corporate venturing, licensing, and open source platforms form part of the open innovation toolbox (e.g. Bercovitz and Feldman 2007; Keil et al. 2008; Chatterji and Fabrizio 2014).

Based on the conceptual work of Felin and Zenger (2013), the choice of open innovation governance form for problem-solving depends on a problem's complexity and the extent of hidden knowledge.

Applying this solution space to the humanitarian sector, tools that address complex problems with a high extent of hidden knowledge seem most appropriate, owing to indigenous knowledge's stickiness (von Hippel 1998). Stickiness of information is understood as the costs involved to transfer a unit of information from its point of origin to another site in useable form (von Hippel 1998). A popular example for sticky information is knowledge regarding user needs (e.g. Lüthje et al. 2005). Thus, to solve a complex social problem, one way to identify and integrate indigenous knowledge into a humanitarian organization's innovation processes is to focus on user-directed innovation.

Integrating users at different stages of a product development process in the private sector has been recognized as a valuable tool by both managers and scholars (Kristensson et al. 2004). Particularly during the early stages, the front-end of innovation, customers are valuable sources of ideas and even product concepts (Lüthje and Herstatt 2004). Evidence is mounting that a crowd of users has the potential to develop new product and service ideas (Poetz and Schreier 2012) and can properly evaluate them (Magnusson et al. 2016).

Despite its multisectoral nature, there is very little empirical evidence on how user integration may be beneficial to actors in the humanitarian sector. We seek to close this gap by applying two state-of-the-art innovation tools in the humanitarian sector: the lead user method and an innovation contest.

Although there is an extensive body of literature on user innovation, research needs to take a closer look at different problem solving governance forms' specific benefits and costs (Felin and Zenger 2013). We compare two of those governance forms according to their specific benefits and costs in the context of recurring floods in Indonesia. Following the problem-solving perspective outlined earlier, enhancing resilience towards natural hazards, such as floods, is regarded a complex problem (Blackman et al. 2017). We opted for the innovation contest tool as comparison unit, since it is also associated with high hidden knowledge (Felin and Zenger 2013). Further, innovation contests have increasingly attracted attention from scholars and managers for integrating consumers into the fuzzy front-end of innovation processes (Piller and Walcher 2006; Ebner et al. 2009).

The international humanitarian sector is described as a global system built from loose connections among humanitarian actors such as international agencies, NGOs, states, or the Red Cross/Red Crescent Movement (Davey et al. 2013). Concerning the nature of innovations in the humanitarian sector, scholars and practitioners have highlighted the need to leverage social innovation (OECD 2012), with an emphasis on localizing aid (McGoldrick 2015). In short, there is a shared commitment to complement the currently predominant top-down approach with the introduction, validation, or extension of bottom-up solutions that foster and build on existing innovative capabilities and systems of local communities (Bloom and Betts 2013).

Backed by literature from both open innovation and social innovation, we aim to answer the following research questions:

- How do innovation contests and the lead user method differ concerning the quality of identified social innovations?
- How should managers in the humanitarian sector choose the most appropriate one for their purpose between these two tools?

By answering these research questions, we address the notion that the humanitarian sector is "under obligation to professionalize" (Besiou et al. 2011, p.80) and needs "more sophisticated approaches" (Ramalingam et al. 2015, p.21) for identifying social innovation in an interconnected world. In other words, we seek to help professionals to find a needle in the haystack.

The remainder of this paper is structured as follows: In Section 2, we discuss the study's theoretical background. In Section 3, we outline our methodology on the comparison. In Section 4, we present the empirical findings, and in Section 5, we discuss the findings. Finally, we propose implications for further research and practice.

We conducted this study with the International Federation of Red Cross and Red Crescent Societies (IFRC) and Red Cross Indonesia (Palang Merah Indonesia, PMI) in Indonesia, a country often affected by floods.[1]

2 Theoretical Perspectives

2.1 Problem-solving Governance

Generally, a problem occurs when an individual, team, or organization wants to achieve a certain goal without immediately knowing how to achieve it (Baron 1988). Thus, problem-solving is "any goal-directed sequence of cognitive operations directed at finding that unknown" (Jonassen 2004, p.7). Thus, it is crucial that organizations understand *where* appropriate knowledge is located in order to effectively search for it (Lopez-Vega et al. 2016). In open innovation, search can be local (i.e. close to a firm's current knowledge) or distant (i.e. far away from a firm's current knowledge) (Lopez-Vega et al. 2016). Findings suggest that increased connections to and knowledge flows from a set of external partners lead to improved innovation outcomes (West and Bogers 2014). In this context, scholars have recently started to look at open innovation's governance implications (Jeppesen and Frederiksen 2006; Leiponen and Helfat 2010).

2.2 Problem Complexity and Hidden Knowledge

Recent work by Felin and Zenger (2013) conceptualizes a search space for (an incomplete selection of) problem-solving governance mechanisms using open innovation. These tools are ordered according to the two dimensions *problem complexity* (simple/complex) and the *degree of hidden knowledge* (low/high) (see Figure 1). Problem complexity refers to the structuredness of innovation problems, ranging from ill-structured (i.e. poorly defined initial states or indefinite problem-solving spaces), to well-structured (i.e. well-defined initial states and known elements, explicit approaches to problem-solving, and known criteria for solutions) (Fernandes and Simon 1999). Complex problems involve an extensive collection of highly interdependent knowledge sets, choices, and elements that need to be creatively recombined to compile valuable solutions (Kauffman 1993; Levinthal 1997). The magnitude of knowledge set interactions affects a problem's decomposability level, and thus the problem-solving governance structure (Ethiraj and Levinthal 2004). In the case of complex problems, high uncertainty regarding the nature of interdependencies fosters centralized design choices guided only by a basic understanding or a theory of the interaction patterns (Felin and Zenger 2009). Further, the centralization level in these solution search processes increases with problem complexity. This leads to a hierarchy that is authority-based in case of moderately complex problems and consensus-based in case of complex problems (Nickerson and Zenger 2004). In contrast, the solution search process for simple problems can be extensively decomposed and decentralized, motivating independent actors with their own distinct local knowledge to autonomously assess their choices (Felin and Zenger 2013) – in other words, search processes for solving simple problems follow a market-based structure (Nickerson and Zenger 2004).

[1] Source: Global Risk Data Platform, http://preview.grid.unep.ch/index.php?preview=graphs&cat=3&lang=eng , accessed on 2016-11-05.

The hiddenness of knowledge is particularly relevant in the context of governing problem-solving for innovation (Felin and Zenger 2013). A manager's decision on how to search the relevant knowledge for a given problem entails a tradeoff based on whether or not the manager is aware of its location. Being aware of where the relevant knowledge is located allows for centralized identification and decisions on whether to acquire or hire it. Here, governing mechanisms can be employment contracts, hiring a consultant, or forming an alliance. Alternatively, being unaware of where the relevant knowledge is located makes it necessary to broadcast a problem (Felin and Zenger 2013). Broadcasting a problem means initiating a self-selection process by requesting those who most likely possess the relevant knowledge to self-identify and offer proposals for solving the problem at hand (Jeppesen and Lakhani 2010). Tools that enable such problem broadcasting can be innovation platforms or contests for simple problems or more theory-guided governance forms that focus on user-directed innovation, such as the lead user method for complex problems.

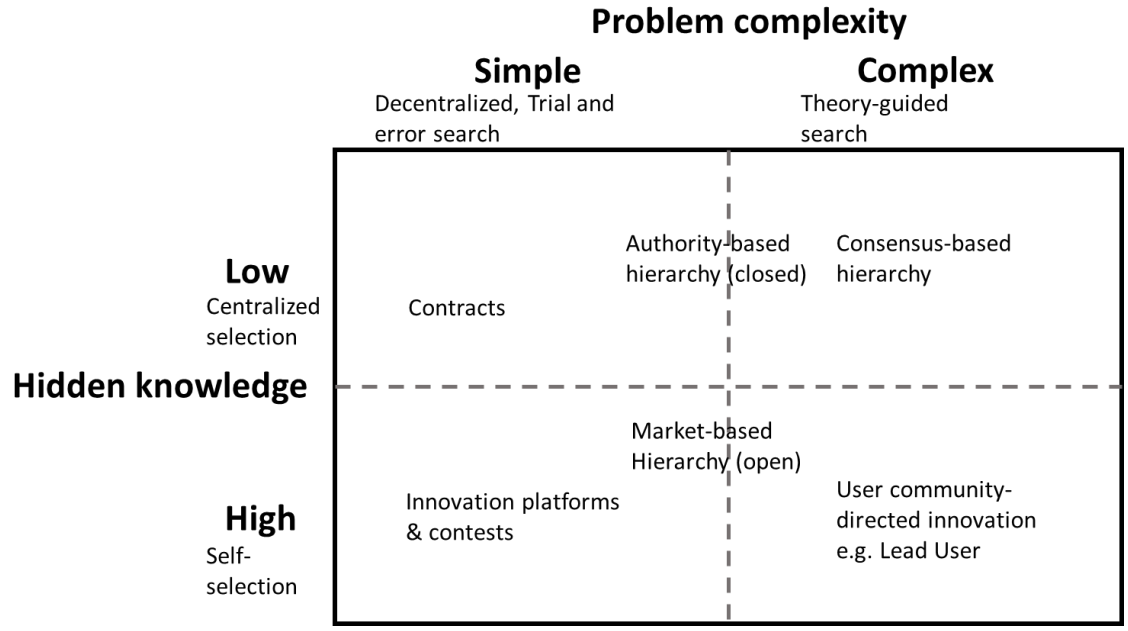

Figure 1: Problem Complexity and Hidden Knowledge (adapted from Felin and Zenger 2013)

In terms of problem complexity, enhancing resilience towards natural hazards such as floods is considered a complex problem (Blackman et al. 2017). Indonesia has undergone 141 flood-related disasters between 2005 and 2014, with an estimated financial burden of around US$ 11 billion.[2] The extent of hidden knowledge in the humanitarian sector is high, as indigenous knowledge as a valuable source of innovation is generally hard to obtain (Saxena 2015). Following Felin and Zenger's (2013) conceptualization and our focus on open (or non-hierarchical) forms for governing innovation, we decided to compare the two open innovation tools: the lead user method and an innovation contest.

2.3 Open Innovation: Integrating Customer Needs into Product Development

As firms tend to struggle to internally gather and develop new ideas (Dushnitsky and Lenox 2005; Henderson 1993), scholars and practitioners are becoming increasingly interested in valuable knowledge located outside the firm (Cohen and Levinthal 1990). These activities, focused on opening the firm's boundaries – commonly referred to as open innovation (Chesbrough 2006) – provide benefits in terms of accessing and exploiting external knowledge (Fabrizio 2009). Research into user innovation

[2] Source: United Nations Office for Disaster Risk Reduction (UNISDR), www.unisdr.org/we/inform/publications/47804, accessed on 2017-09-13.

has found that individual users may benefit from using a product and can also be an important source of innovation when integrated into a firm's new product development process (von Hippel 1998).

2.3.1 Innovation Contests

Scholars and managers have shown increasing interest in inviting a crowd of persons to contribute to their early innovation processes in order to co-create value together (Piller and Walcher 2006; Ebner et al. 2009; Prahalad and Ramaswamy 2004). An innovation contest is a competition among participants who use their skills, experience, and creativity to provide a solution for a particular challenge defined by an organizer within a given timeframe (Piller and Walcher 2006; Bullinger et al. 2010). These submissions are then assessed by an expert jury according to predefined criteria and awarded a prize according to their performance (King and Lakhani 2009; Hofstetter et al. 2017). The expert jury usually incorporates company representatives and/or external experts whose domains of expertise should match the contest's topic (Amabile et al. 1996). Although contest setups vary from depending on the structural composition (one stage vs. multiple stages) and the contest's competiveness (Lampel et al. 2012), a regular innovation contest's structure can have four phases (Krämer 2014): 1) setup, 2) realization, 3) evaluation and awarding, and 4) follow-up. In the context of innovation management, idea contests mostly seek to generate creative ideas with consumers or other external partners, identifying users who are particularly innovative (e.g. lead users), and/or gathering innovation-relevant information and knowledge, such as information on unsatisfied customer needs (Lampel et al. 2012; King and Lakhani 2009). Innovation contest organizers are mostly firms, but can also be individuals, public organizations, or non-profit organizations (Bullinger et al. 2010). A contest is commonly initiated using an open call, and participation is mostly for a limited period (Jeppesen and Lakhani 2010). Innovation contests have recently gained significant attention (Boudreau et al. 2011; Haller et al. 2011; Adamczyk et al. 2012). Jeppesen and Lakhani (2010) emphasized the extensive range of opportunities of innovation contests when used for problem-solving. In the humanitarian sector, several organizations such as the innovation foundation NESTA, the Humanitarian Innovation Fund, or the UK-based Department for International Development (DFID) have successfully used innovation contests to identify innovations (Rush et al. 2014). In contrast to the private sector, where participation in innovation contests is commonly incentivized by monetary rewards, a study by Füller, Hutter, and Fries (2012) for identifying social innovation revealed that non-monetary incentives such as supporting a social project are an attractive alternative for many participants.

2.3.2 The Lead User Method

The dominant view of innovation has been that it happens solely within firms: companies innovate and sell new products and services to customers. In the past few decades, this view has been challenged, since there is increasing evidence that the locus of innovation may also be outside a company's boundaries: with users (Gambardella et al. 2016). While manufacturers seek to benefit from selling a product or service, users develop innovations on their own and benefit from using them (von Hippel 2009).

The lead user method is a structured process to identify user innovation. *Lead user* was coined by Eric von Hippel and describes users who "face needs that will be general in a marketplace – but face them months or years before the bulk of that marketplace encounters them, and who are positioned to benefit significantly by obtaining a solution to those needs" (von Hippel 1986, p.796). These two characteristics were later defined as trend leadership and high expected benefit from the innovative solution (Hienerth and Lettl 2017). The rationale behind trend leadership is that customer needs tend to evolve over time along underlying trends in the marketplace (Schreier and Prügl 2008). Persons at the leading edge of

such a trend will encounter new needs significantly earlier than regular users. The high expected benefit from the innovative solution builds on the lead users' motivations: By innovating, they solve their own problems, particularly if manufacturers are not (yet) able or willing to do so (Lüthje and Herstatt 2004). As users seek to use an innovation rather than sell it, users often openly reveal their innovations to other users or even to manufacturers (Harhoff et al. 2003).

The lead user method is a four-step process to identify user innovators (Lüthje and Herstatt 2004). Its main purpose is to identify product or service concepts for companies, which later develop these concepts further. According to Lüthje and Herstatt (2004), it has the following steps: 1) the start of the lead user process, 2) the identification of needs and trends, 3) the identification of lead users, and 4) concept design. The lead user method has seen significant attention from scholars and managers (von Hippel 1986; Lüthje and Herstatt 2004; Schreier and Prügl 2008; Hienerth and Lettl 2017). While scholars have opened several research avenues to study lead users and their innovations from various perspectives (Hienerth and Lettl 2017), practitioners in the private sector have regularly used and adapted this method to identify innovative user-developed solutions to complex problems (Lehnen et al. 2016).

Humanitarian actors usually focus on countries of the so-called Global South. Although anecdotal evidence (Viswanathan and Sridharan 2012) in the literature on the *Base of the Pyramid* (BOP) and research on *grassroots innovations* in rural India (Gupta et al. 2003) refer to the creative and innovative capabilities of consumers in those emerging countries, user innovation studies have almost exclusively been conducted in countries in the Global North (van der Boor et al. 2014). Only recently, there has been a perception shift from classifying consumers in the Global South as passive recipients towards a source of innovation (Praceus 2014; Krämer 2014).

2.4 Social Innovation

Social innovation is an emerging field that has evolved mainly in the past decade. A diverse range of definitions and meanings reflects its multidisciplinary nature as a practice-led field that includes varying practices across countries, cultures, and fields of action (Julie Caulier-Grice et al. 2012). However, a recent comprehensive review reveals its two core components: social innovation entails "1) a change in social relationships, -systems, or -structures, and 2) such changes serve a shared human need/goal or solve a socially relevant problem" (van der Have and Rubalcaba 2016, p.1932). Most approaches define social innovation focus along its outcome (Sharra and Nyssens 2010). In distinction to economic innovation, social innovation focuses on social change rather than on profit-maximization (Murray et al. 2010; Mulgan et al. 2008). Social innovation is about "identifying and delivering new services that improve the quality of life of individuals and communities" (OECD 2011, p.20) instead of "exploiting new markets for the sake of exploiting them" (OECD 2011, p.21). Another key aspect of social innovation is the motivation for its development. For instance, NESTA describes social innovation as "inspired by the desire to meet social needs which can be neglected by traditional forms of private market provision and which have often been poorly served or unresolved by services organized by the state." (Harris and Albury 2009, p.16). Social innovations "can be developed by the public, private or third sectors, or users and communities […]" (Harris and Albury 2009, p.16).

2.5 Empirical Field: The Humanitarian Sector

Humanitarian actors such as international agencies, NGOs, states, or the Red Cross/Red Crescent Movement are loosely connected in a global system with a wide range of operations: emergency responses in conflict situations or after natural disasters, livelihood support, early recovery, risk reduction, preparedness, conflict resolution, peace-building, and support for displaced populations in

acute and protracted crises (Ramalingam and Mitchell 2014). Further, the future of humanitarian action will be shaped by various challenges, including the politicization of aid, the proliferation and diversification of new actors, the increasing assertiveness of states and insistence on sovereignty, new technologies, and security issues (e.g. Armstrong 2013; IFRC 2013). Some observers claim that these overwhelming humanitarian needs will overload the system's capacities to respond and push humanitarian organizations towards a *breaking point* (McGoldrick 2015). The main problem is seen in the fact that the system is still applying a one-size-fits-all approach and is not flexible enough to adapt to the specific contexts of its operations (Abby Stoddard et al. 2015). Bloom and Betts (2013) draw attention to this fundamental imbalance when they claim the existence of "two worlds of humanitarian innovation". They see the risk that the increasing debates on humanitarian innovation will become primarily focused on top-down approaches, focusing on innovation management within organizations, and may not consider bottom-up approaches that embrace local and indigenous capabilities and systems that are already in place. Additionally, the importance of local actors in humanitarian action has been increasingly recognized by the humanitarian community, scholars, and donors in the past two decades (Ramalingam et al. 2013). The notion of localizing aid stems from the late 1980s, when humanitarian actors began to consider local knowledge and attitudes via the concepts of participation, capacity-building, and accountability (Mitchell and Slim 1991). Since both innovation contests and the lead user method focus on gathering external hidden knowledge, recognizing that indigenous knowledge is a valuable resource (McGoldrick 2015; Saxena 2015), their implementation contributes to current debates on aid localization in the humanitarian sector.

2.6 Hypotheses

Resulting from this literature review, we propose a set of hypotheses regarding the quality of the concepts identified by the innovation contest and the lead user method. Based on the literature (Poetz and Schreier 2012; Piller and Walcher 2006; Amabile et al. 1996), we used the established variables novelty, use value, feasibility, degree of elaboration, and social impact for assessing the concept quality.

A concept's novelty (or originality) is associated with extent of innovation: incremental innovations possess lower novelty, whereas radical innovations have higher novelty (Magnusson et al. 2016). An innovation contest uses an open call to attract a large audience of people from diverse backgrounds and educations (Jeppesen and Lakhani 2010). In contrast, lead users are very specialized and possess strong technical expertise, since they are able to find and implement solutions according to their needs (Franke et al. 2006). While ordinary users may think about an idea, lead users know about potential solutions' technical limitations and will therefore develop less novel solutions compared to people who submit their concepts to a contest (Magnusson 2009). In sum, we hypothesize:

> *H1: Concepts submitted to an innovation contest have higher novelty than concepts identified using the lead user method.*

Use value specifies a solution's ability to actually solve the problem it addresses (Amabile et al. 1996). Lead users' main motivation to develop solutions is to use them, addressing mainly their needs and those of their peers (von Hippel 2009). The contributors to a challenge are motivated by financial (Boudreau et al. 2011) or, in the case of social innovation, also by other incentives (Füller et al. 2012) and do not develop a solution according to their needs or those of their peers. Thus, we propose:

> *H2: Concepts identified via the lead user method have higher use value than concepts submitted to an innovation contest.*

Feasibility is a criterion to assess how easily a concept could translate into a commercial product, considering both technical and economic aspects (Magnusson 2009). This requires technical knowledge (a.k.a. solution knowledge) about the product and about potential ways to disseminate the product (Schweisfurth and Herstatt 2016). Lead users have high technical expertise (Lüthje et al. 2005), whereas contributors' technical knowledge to a contest is distributed more widely (Boudreau et al. 2011). Further, lead users are often embedded in a network of peers, in which they exchange ideas, receive feedback, and further develop their concepts (Hienerth and Lettl 2011). Thus, we hypothesize:

H3: Concepts identified via the lead user method are more feasible than those submitted to an innovation contest.

Degree of elaboration indicates a concept's current sophistication level (Piller and Walcher 2006). While submissions to an innovation contest may range from idea sketches to prototypes, however, these concepts are often not yet implemented, since the starting point was an open call (Adamczyk et al. 2012). In contrast, lead users have already faced specific problems for a long time, and therefore have at least a working prototype in place for own use. Further, there is evidence that successful user innovation is further developed and commercialized by lead users (Shah and Tripsas 2007), making the product even more elaborate. In sum, we propose:

H4: Concepts identified via the lead user method are more elaborate than those submitted to an innovation contest.

Social impact is a measure that indicates the extent to which a concept's benefits outweigh the negative consequences of floods related to individuals, organizations, and social macro-systems (IFRC 2011). This is particularly important to managers in the humanitarian sector who seek to maximize their work's social impact on people in need. Lead users must develop a proper solution to fit their needs and those of their community, since they are dissatisfied with existing solutions (Lüthje and Herstatt 2004) offered by the public and/or or the private sector. In our case, recurring floods in Indonesia pose a potentially life-threatening risk, providing a very high incentive to innovate. In contrast, we assume that only a few contributors to a contest are directly affected by floods and their consequences, since the open call reached out to a large sample of people across the country and not only to flood-prone areas. Thus, we suggest:

H5: Concepts identified via the lead user method have a higher social impact than those submitted to an innovation contest.

3 Methodology

Both tools were implemented by two separate core teams, consisting of four persons for the implementation of the lead user method and consisting of three in the innovation contest. Both teams were supervised by the same senior innovation manager from IFRC. Further, several persons from IFRC and PMI supported the process of both teams irregularly. Studies on innovation contests emphasize their efficiency, especially for ideation (King and Lakhani 2009). In contrast, the lead user method, as a theory-guided search tool, is usually very time-consuming (Lüthje and Herstatt 2004; von Hippel 2005). We were able to confirm this assumption in our study (Cooper et al. 2017). Over four months, the implementation of the lead user method took about twice as much capacity (four team members assigning about 50% of their time, resulting in two full-time employees) as the innovation contest (three people assigning about 30% of their time, resulting in one full-time employee).

3.1 Methodology Innovation Contest

Following the process as indicated by Krämer (2014), the procedure had four phases:

3.1.1 Phase 1: Set-up

A preparatory workshop was conducted by the core team formed by the IFRC, the PMI, and additional flood resilience experts. Since the contest organizers aimed for a broad thematic scope, they included only a few specifications and subthemes. Only individuals or organizations based in Indonesia could apply, and the organizers intended to prioritize innovations that have already been piloted in some form. PMI announced a reward of grant funding for the two best submissions (CHF 3,500 and CHF 2,500) in each subtheme as well as one of CHF 5,000 for the best overall idea.

3.1.2 Phase 2: Realization

The contest organizers posted the challenge on the local Red Cross (PMI) website, used social media networks, national media, emails, phone calls, and postings on various web pages in order to enable maximum outreach. For instance, the PMI volunteer network incorporated about 50,000 volunteers organized in chapters across the country.

3.1.3 Phase 3: Evaluation and awarding

The contest yielded 60 submissions. The evaluation process was a four-step process. After (1) an internal pre-screening, (2) a formal review was conducted by three independent teams. They used a set of six criteria for this desk-based assessment of the submissions: novelty, viability, relevance, inclusiveness, partnerships, and cost effectiveness. After (3) a final internal selection, (4) nine submissions were invited to pitch their concepts at the 1st Innovation in Flood Resilience Conference in Jakarta before a jury that selected the three most attractive ideas during the event.

3.1.4 Phase 4: Follow-up

Following the contest, the PMI began to support the people behind the three most attractive ideas in their development endeavors for the long term in terms of coaching and providing access to their network.

3.2 Methodology: Lead User Method

Following the lead user method, as introduced by Lüthje and Herstatt (2004), the procedure had four steps:

3.2.1 Step 1: Start of the lead user process

The project started with a kick-off workshop in Jakarta with the core team formed by the IFRC, the PMI, and a team of consultants. Additionally, some flood resilience experts joined the meeting. Together, the team defined the project scope aligned with the scope of the contest. The experts' opinions on the main drivers and trends regarding floods in Indonesia were gathered as well.

3.2.2 Step 2: Identification of needs and trends

To thoroughly understand the needs, drivers, and trends regarding floods in Indonesia in the frame of the project scope, the team members began to extensively scan the literature, the Internet, and online databases. They identified an initial set of experts, which was the starting point for the pyramiding search. This search approach led to 210 experts, of which 116 responded over the course of the project (a 55.2% response rate). Next, the team members conducted 48 interviews, mostly via phone, in which they used a semi-structured interview guideline to gather the experts' opinions, first, on the main drivers of floods; second, on solutions to foster resilience they have come across during their work.

These experts were located in 11 countries and were from four approximately equally distributed organization types (governmental, NGO, university, company). At the end of step 2, the core team met for a workshop to select the most relevant macro-drivers (four) and the micro-drivers of floods in Indonesia (five).

3.2.3 Step 3: Identification of lead users

To identify lead users, the team used three approaches: the networking-based approach (a.k.a. pyramiding), the screening approach, and desk research.

Pyramiding is based on the idea that experts in a field know one another. Thus, when talking to an expert during the project, the team members asked for recommendations regarding other flood resilience experts in Indonesia. Using the screening approach, they conducted a short survey in two languages (Bahasa Indonesia and English) based on a few questions concerning floods and possible solutions. The survey was supposed to reveal which of the participants is either a lead user or knows one they would recommend. The team members also conducted extensive desk research to identify relevant experts and user innovations reported in web sources. Part of step 3 was an 11-day field trip across Indonesia to meet and interview five lead users and four experts, and to visit five flood-prone villages.

3.2.4 Step 4: Concept design

The last phase was framed by the 1st Innovation in Flood Resilience Conference in Jakarta. The team brought together nine lead users for a cross-cutting knowledge exchange and fruitful discussions, presentations before audience of mostly experts in flood resilience or business scaling, and a marketplace in which every lead user had a booth to present their idea to the attendees during the conference.

3.3 Methodology: Data Evaluation

All concepts collected using the innovation contest (60) and the lead user method (25) were summarized into a text of 150 to 200 words by an independent and technically skilled person who was not involved in the implementation of the two tools. All concepts were blinded concerning an idea's source (contest vs. lead user method). A brief summary of selected concepts appears in Appendix 1. These were assessed by five senior experts from the humanitarian or engineering sector. Based on their experiences, all experts had extensive market and technical knowledge in their sector. One expert was Indonesian, two had worked in Indonesia for several projects, and one had extensive experience in other South-East Asian countries. The evaluators were not involved in the data acquisition and had no access to the descriptions of concepts beforehand. The experts did not know one another. They were trained concerning the evaluation criteria in a personal phone call (Krippendorff 2004). We used a web-based tool to present the concepts one after the other in random order to the evaluators.

The concepts' quality was assessed using the established variables novelty, use value, and feasibility (Amabile et al. 1996; Poetz and Schreier 2012; Magnusson et al. 2016). The degree of elaboration (Piller and Walcher 2006) and the social impact were also assessed, emphasizing the need for more elaborate and socially valuable innovations in the humanitarian sector (IFRC 2011). We measured all five variables on a five-point Likert scale (ranging from 1 = *very low* to 5 = *very high*).

We calculated the reliability between the five evaluators using Krippendorff's alpha for each abovementioned dimension. Krippendorff's alpha is a conservative statistical measure to assess the agreement between several evaluators (Feng 2014). The values for novelty, use value, feasibility, degree of elaboration, and social impact were 0.26, 0.15, 0.30, 0.43, and 0.23. The overall value for all

observations was 0.27. Yet, these values indicate that there is fair agreement (Landis and Koch 1977) between the evaluators only. Commonly, alpha values above 0.67 are considered meaningful (Hayes and Krippendorff 2007). However, some studies indicate that alpha values below 0.67 can also be meaningful, depending on the empirical field (Artstein and Poesio 2008). Yet, our study results must be analyzed with these fair agreement levels in mind. One interpretation may be that the evaluators had very diverse backgrounds and views on flood resilience: One had more than 15 years' experience in the humanitarian sector (of which a significant part was in South-East Asia), while another expert had worked for more than eight years on fairly technical aspects of flood resilience in a German research institution. One expert was an experienced researcher from an Indonesian university, and the two others were a researcher and a consultant from New Zealand who both worked in disaster risk reduction in Indonesia. Further, there is evidence that cultural distance (Hofstede 1993) affects the assessment of aspects such as novelty and use value (Hempel and Sue-Chan 2010; Lan and Kaufman 2012). In the following, we will use the average value of all five experts. Further, we calculated the mean value of all five dimensions as an indicator of the overall concept quality.

4 Results

First, we found that there was no overlap between the concepts identified via both tools, although a lead user could have applied for the innovation contest. This indicates that the two tools addressed different target groups in this study. Now, we will look at the five dimensions (Table 1). The concepts obtained via the innovation contest (3.12) have marginally lower novelty than those via the lead user method (3.25). H1, which proposed that novelty of the concepts obtained via innovation contest is higher, is rejected. Regarding use value, the concepts submitted to the innovation contest were evaluated with a significantly ($p = 0.049$) lower score (3.04) compared to the lead user method's concepts (3.32). Thus, H2, which proposed a significantly higher difference on use value, is accepted.

Table 1: Concept Quality: Average Novelty, Use Value, Feasibility, Degree of elaboration, and Social impact for Contest vs. Lead User Concepts

	Contest (n = 60)		**Lead user** (n = 25)		
	Mean	SD	Mean	SD	Mann-Whitney-U test Z-value (p value)*
Novelty	3.12	0.60	3.26	0.66	-1.037 (0.300)
Use value	3.04	0.60	3.32	0.47	-1.965 (0.049)
Feasibility	3.14	0.71	3.62	0.46	-3.013 (0.003)
Degree of elaboration	2.43	0.72	3.51	0.53	-5.481 (0.000)
Social impact	3.20	0.66	3.62	0.43	-2.667 (0.008)
Average	2.99	0.44	3.46	0.31	-4.537 (0.000)

Note: * We used Mann-Whitney U-tests, since the data were not normally distributed.

The evaluation of the dimension feasibility resulted in a significantly higher value ($p = 0.003$) for concepts surfaced via the lead user method (3.62) compared to the innovation contest (3.14). Thus, H3, which proposed a significantly higher feasibility, is accepted. Concerning the degree of elaboration, the

lead user method's concepts (3.51) had a significantly higher value ($p < 0.001$) compared to the innovation contest's concepts (2.43). Accordingly, H4, which proposed a higher value, is supported. Regarding social impact, the innovation contest (3.20) scored significantly lower ($p = 0.008$) compared to the lead user method (3.62). Thus, H5, which proposed a higher value for social impact for concepts identified via the lead user method, is supported. Comparing the overall quality index and therefore answering RQ1, the concepts obtained via the lead user method (3.46) score significantly higher ($p < 0.001$) compared to the submissions to the innovation contest (2.98).

For further analysis, we clustered the 85 concepts surfaced via both tools into seven categories: tangible products, nature-based solutions, educational solutions, apps and software, community-based solutions, service and business model innovations, and grassroots solutions. Looking closely at these categories (see Table 2), we see that some are distributed fairly similarly (nature-based solutions: 20% vs. 17%) between the two tools, while others differ considerably (tangible products: 43% vs. 12%). Further, each category's overall quality differs among the categories. While both tools yielded comparatively similar concepts for the education (3.30 vs. 3.32), the difference in other categories such as community-based solution (2.80 vs. 3.71) as well as service model and business model (2.64 vs. 3.71) is strikingly high.

Table 2: Concept Categories and Average Quality for Contest vs. Lead User Concepts

	Contest (n = 60)			**Lead user** (n = 25)		
	n	%	Av. quality	n	%	Av. quality
Tangible products	26	0.43	2.87	3	0.12	3.35
Nature-based solutions	10	0.17	3.00	5	0.20	3.55
Education	5	0.08	3.30	1	0.04	3.32
Software and apps	10	0.17	3.28	3	0.12	3.35
Community-based solutions	7	0.12	2.80	5	0.20	3.71
Service and business models	1	0.02	2.64	3	0.12	3.71
Grassroots solutions	1	0.02	2.96	5	0.20	3.23
Sum	60	1.00	2.98	25	1.00	3.46

In short, although there was a higher number of submissions via the contest, concepts surfaced via the lead user method scored higher overall, on average. Looking at the subcategories, concepts identified via the lead user method had significantly higher values on use value, feasibility, degree of elaboration, and social impact compared to the innovation contest submissions. Concerning novelty, the results show a slightly higher value for concepts obtained via the lead user method, but without a statistically relevant difference.

5 Discussion

We sought to investigate problem-solving governance mechanisms for a complex problem faced by humanitarian organizations. Following the framework outlined by Felin and Zenger (2013), the concepts obtained via two open innovation tools for identifying innovative solutions for enhancing flood resilience in Indonesia – the lead user method and the innovation contest – were evaluated by five independent experts. The evaluation included five dimensions: novelty, use value, feasibility, elaboration, and social impact. We also calculated the average of these five criteria as an overall quality indicator.

Above all, our findings show that both tools are valuable for generating novel ideas – in comparable quality. However, a closer look reveals considerable differences between the two tools. Solutions surfaced via the lead user method scored better on the overall quality index, also in terms of the single dimensions use value, feasibility, degree of elaboration, and social impact. Particularly the latter dimension is of high – if not the highest – relevance for humanitarian organizations. Further, a high use value of solutions seems even more desirable when facing complex or wicked problems, which are defined among others by their circular causality and contradictory certitude regarding a proper solution (Dorado and Ventresca 2013). The same reasoning applies for the higher elaboration revealed in our findings for the solutions identified via the lead user method. Successfully scaling up useful solutions to enhance their impact is a challenge the humanitarian sector constantly struggles with (Bold et al. 2013). Here, higher elaboration is a useful indication of the likelihood of a successful nationwide scale-up. In short, when only looking at both tools' benefits, the lead user method seemed better suited to humanitarian organizations' distinct needs.

However, a comprehensive evaluation of a tool involves not only the benefits but also its implementation costs. We can state clearly that applying the lead user method is more time-consuming and requires more capacities than the innovation contest. Since humanitarian organizations commonly struggle with overloaded capacities (McGoldrick 2015), an innovation contest may therefore be a more appropriate tool. This depends particularly on the main goal to be achieved by implementing such a problem-solving tool. Imagining a generic innovation process that entails the three consequent steps ideation, prototyping, and implementation, our findings indicate a different fit between the two tools. While both tools showed a similar quality regarding their benefits for the ideation phase, a comprehensive evaluation that also includes the costs makes innovation contests look more suitable. Thus, when the goal is to generate as many ideas as possible without using significant capacities, our study indicates that an innovation contest is the more appropriate tool (60 submissions vs. 25 lead user concepts). In contrast, if the overall goal is to identify innovations that have already been implemented, and thus, have demonstrable feasibility as well as high social impact, the lead user method is better suited.

Further, our findings suggest that both tools differ regarding the solution category they reveal. This is relevant if a humanitarian manager has a clear understanding of the needed solution. The innovation contest yielded predominantly tangible products, early warning systems, and app-based solutions. In contrast, the lead user method generated more nature-based and community-based solutions. Thus, while the solutions from the innovation contest are somewhat standalone products, solutions surfaced via the lead user method are more embedded in the local context and thus entail higher sticky knowledge (von Hippel 1998). Our findings also indicated that solutions based on this indigenous or grassroots knowledge are not proactively submitted to innovation contests, but have to be identified by actively searching for and going into affected communities. Thus, the lead user method offers a

counterbalance to the humanitarian system's current approaches, which are mainly top-down (Bloom and Betts 2013).

6 Implications, limitations, and further research

6.1 Theoretical Implications

We have made two primary contributions to theory and practice. First, we contribute to the innovation literature by testing and confirming the framework on problem-solving governance mechanisms outlined by Felin and Zenger (2013). We chose two innovation tools – the innovation contest and the lead user method – and compared their results regarding the problem of how to enhance flood resilience in Indonesia. Following the four-field matrix, flood resilience is regarded as a problem of high complexity for which the solution space entails a high extent of hidden knowledge. While the lead user method is suited for both high problem complexity and a high extent of hidden knowledge, the innovation contest works best when applied to less complex problems and a high extent of hidden knowledge. We could confirm that the lead user method – as outlined in the framework – is better suited to identify solutions to complex problems when there is much hidden knowledge. Although the innovation contest yielded satisfying results concerning novelty, the overall problem seemed to be too complex.

Second, our paper contributes to the social innovation literature by confirming that both tools are well suited for identifying local innovations concerning flood resilience in Indonesia. Building on erratic literature on user innovation in the Global South (Praceus 2014; Krämer 2014; van der Boor et al. 2014), we suggest that, compared to the innovation contest, the as yet unknown lead user method is a well-suited tool to identify local innovations in all countries across the globe. This suggestion addresses the need to implement more sophisticated approaches, "ensuring quality of results in innovation identification and search […]" (Ramalingam et al. 2015, p.21) in the humanitarian sector. Further, we provide initial evidence on how user innovation theory may be a promising path to identifying indigenous innovation in the humanitarian sector. By transferring a recognized method for innovation identification from the private to the humanitarian sector, we have opened a new path to empowering local capacities for disaster risk reduction.

6.2 Managerial Implications

The humanitarian sector is torn between overloaded capacities and the need to overcome a one-size-fits-all approach. Against this background, our findings lead to two primary implications for managers in the humanitarian sector.

First, an organization's choice regarding which tool to implement to collect solutions to a given problem generally not only entails the balancing of costs and benefits, but is also dependent on the overall goal. Struggling under the burden of increasing humanitarian needs and overloading capacities, the humanitarian sector is in great need for efficient tools to identify solutions to the broad range of problems it faces. Thus, when the goal is to generate as many ideas as possible by using as few capacities as possible, the innovation contest is the more appropriate – and increasingly more popular – tool. In contrast, addressing the need to overcome the – still prevalent – one-size-fits-all approach, humanitarian managers seek tools to identify solutions specifically tailored to the local context. Our findings suggest that the innovation contest yields predominantly standalone solutions, while the lead user method results in solutions that are more embedded in the local context. Thus, when the overall goal is to identify innovations that have already been implemented and thus have both demonstrable feasibility

and significant social impact, the lead user method is better suited. In short, and answering RQ2, a humanitarian manager must thoroughly understand a problem in order to be able to specify a solution space upfront. Further, a solution search's overall goal must be clarified and balanced with available capacity.

Second, our findings illustrate that users have developed a notable number of bottom-up innovations across Indonesia and were able to scale them to a considerable stage on their own. However, it is unclear how humanitarian organizations can deliver access to their diverse resources in order to scale innovations even further and to increase their impacts. This should be discussed with local entities, such as NGOs or universities, to enhance local actors' roles in the humanitarian sector.

6.3 Limitations and Further Research

The study results were accompanied by only fair levels of agreement among the five evaluators, possibly caused by their very diverse backgrounds. Although some studies indicate that these fair levels can be meaningful, depending on the empirical field (Artstein and Poesio 2008), our findings must be analyzed against the background of this limitation. Further, the contest and the lead user method were conducted by two independent teams. To minimize team composition's effect, we suggest for future projects set up a core team that leads both studies in parallel. Further study limitations point to a number of promising future research trajectories. Addressing these would broaden our understanding of innovation tools' effectiveness in humanitarian aid as well as the interconnections between user innovation and social innovation.

First, further research should also include a comparison between open innovation search strategies and their closed counterparts for a more systematic exploration of key contingency factors (Salge et al. 2013). This would not only enhance our understanding of key success factors for using open search strategies, but would also contribute to the understanding on suitable tools for identifying local innovations. Building on this, the lead user method and the innovation contest should be applied in other target areas and/or regions to prove their universal applicability in the humanitarian sector or to allow for adaptations.

Second, researchers should look further into the various underlying factors that motivate users to innovate in order to broaden our understanding of how local innovations emerge in the humanitarian sector (Bloom and Betts 2013) as well as how they can be identified and supported.

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8 Appendix

Appendix 1: Summaries of Selected Concepts

	Contest	Lead user method
Tangible products	A standalone flood early warning system for villages	A low-cost rain gauging device already used in several villages to warn about massive rainfall
Nature-based solutions	Using Phytoremediation for cleaning rivers of heavy metals	A fast-growing grass that forms a dense, permanent hedge, preventing soil loss from runoff
Education	A program to include disaster risk reduction into the educational system in Indonesia using volunteers and games	A green board game that seeks to share knowledge about environmental issues and to changing community behaviors towards waste management
Software and apps	A digital waste bank system to increase waste recycling and to prevent waste from being dumped in rivers	An app that provides users with a social and hyperlocal ecosystem in which users can exchange information about hazards
Community-based solutions	Building a social network and early warning system by connecting people living upstream and downstream from a river	A river restoration movement that involves cleaning a river from waste and educating about the consequences of improper waste management
Service and business models	An integrated waste management system to reduce the amount of waste dumped in rivers	A virtual currency that incentivizes local communities to cultivate mangrove trees as a natural flood protection measure
Grassroots solutions	Rainwater purifier based on natural materials	A boat made from banana trees