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Making for humanity

- Why Makers Participate in Distributed Problem-Solving Humanitarian Projects

Abstract
There is a growing interest in makerspaces (collaborative workspaces for information and communications technology-powered design and production), maker events and maker culture as drivers of participative creation. Further, maker communities have a lot to offer as channels of fast, affordable and adaptable solutions. In need of a new business model and technological tools, some humanitarian organizations have demonstrated interest in these communities. However, no studies have empirically investigated maker's motivations for participating in humanitarian projects. To address this research gap, a qualitative semi-structured interview (N = 3) and a quantitative online questionnaire (N = 118) were implemented. As part of this study, a model of motivations to participate in distributed problem-solving was developed. The most significant motives for maker participation in humanitarian projects were found to be interest and enjoyment followed by relatedness, symbolic affinity and competence. The findings are discussed in terms of participation and motivation theories in a context of distributed problem-solving practices.

Keywords: motivation, participation, maker, humanitarian projects, NGO, communities

Introduction
In the last ten years, the number of people needing humanitarian aid has almost doubled, their context and needs have changed significantly, and the costs of providing aid have tripled (Betts & Bloom, 2014). The humanitarian sector is in urgent need of a new business model and technological tools to enhance preparedness and relief (Bessant et al., 2014). As channels of fast, affordable and adaptable solutions, maker communities (Anderson, 2012) have a lot to offer for the humanitarian sector. Recently, not-for-profit organizations in this sector, such as non-governmental organizations (NGOs), have demonstrated interest in maker communities. Field Ready, an NGO pioneering the use of 3D printers to manufacture disaster relief equipment locally, supports the online community of volunteers Humanitarian Makers which provide remote assistance by participating in design challenges and testing existing computer-aided design (CAD) files (James & James, 2016). In the same path, Amnesty International is using platforms (such as OpenIDEO) to crowdsource solutions to global issues.

Motivating the public to participate remains a weakness of community engagement strategies (Head, 2007). It can be inferred that these difficulties transfer to those cases where an organization seeks to engage a group of

people to address issues other than their social well-being or that will benefit others. The motivations to participate in crowdsourcing and open source practice have attracted significant interest, particularly with regard to digital products, such as software and application development (Lakhani & Wolf, 2005; Leimeister, Huber, Bretschneider, & Krcmar, 2009). However, little research exists in terms of why makers participate in humanitarian projects where there are seldom substantial material rewards. Understanding the whole range of maker motivations is essential for communicating in a way that attracts and engages them in innovation projects (Stacey, 2014).

The purpose of this study is to support maker engagement in humanitarian projects by providing humanitarian project organizers with relevant information about maker motives for participation. This paper analyses the importance of various forms of motivations to provide qualitative and quantitative answers to the following research question:

RQ. What motivates makers to participate in distributed problem-solving humanitarian projects?

We also develop and test a model of motivation based on goal-oriented motivations and motivations to participate in distributed problem-solving.
Based on a ranking of motivational constructs identified within a literature review, our study hypotheses are as follow:

H1: Product use-value is one of the most significant motives for maker participation in humanitarian projects.

H2: Interest is one of the most significant motives for maker participation in humanitarian projects.

Literature review

Motivation and self-determination theory (SDT)

Motivation refers to the degree to which an individual is 'activated', 'energized' or feels an 'impetus' to do something. This is a psychological phenomenon or state that varies in intensity (the strength of the impetus) and orientation (the underlying attitude or goal), both of which can affect the focus and quality (Ryan & Deci, 2000) or focus and effort – understood as time dedicated to a task (Roberts, Hann, & Slaughter, 2006) – with which it will be enacted. In this way, motivation affects performance – understood as a qualitative evaluation of how a task was performed with respect to one or several specific goals. There are many other factors that influence performance, such as relevant knowledge and skills.

Within the field of motivation psychology, goal-oriented behaviour is a causal product of motivation. Ryan and Deci's (2000) self-determination theory (SDT) is widely used and recognized to explain this type of behaviour. This theory makes a distinction between intrinsic and extrinsic motivations. Intrinsic motivations are defined as "the doing of an activity for its inherent satisfactions rather than for some separable consequence" (Ryan & Deci, 2000, p. 56). These motivations can be expressed as the satisfaction of psychological drives (such as enjoyment, competence, and relatedness) or task properties (such as task variety and complexity) that can satisfy these drives. These are associated with high-levels of learning and creativity, which are considered to reinforce effort levels (Roberts, Hann, & Slaughter, 2006). Extrinsic motivations have been associated with the "instrumental value" of the task or its "separable outcomes", such as rewards or punishment. SDT distinguishes between different types of extrinsic motivations based on the extent to which they are self-regulated or "internalized". These two groups of motivations can be organized along a continuum of internalization. At the lower end of the continuum are those categories of extrinsic motivation where the individual feels compelled to perform a task by an external force. At the higher end of the continuum are intrinsic motivations, where the individual feels compelled by the task itself.

SDT associates motivation with basic psychological needs rather than goals. This does not mean that behaviour is not enacted to attain specific goals. Instead, it means that these goals become motivating when they are associated with the satisfaction of basic psychological needs. Although some authors consider that a goal-based approach is more appropriate for studying motivation in virtual communities (Bishop, 2007), the needs-based approach is justified by research showing that the satisfaction of these needs can be used as a basis for predicting the level of performance and well-being in goal pursuit (Deci & Ryan, 2000). The three main needs identified are feeling autonomy (the need to feel oneself as the causal locus of one's actions), competence (the need to feel effective) and relatedness (the need to feel connected to others) (Ryan & Deci, 2000).

Makers and distributed problem-solving practices (DPS)

Making is closely related do-it-yourself (DIY), which is a broad term for traditional craft or tinkering activities, such as woodworking, taking place outside of a factory or other supportive infrastructure. Many makers develop products directly in their homes, garages or other places with relatively limited manufacturing tools, such as makerspaces (Anderson, 2012). Although the line is blurred, what distinguishes making from traditional DIY is the incorporation of information and communication technology (ICT) in the form of design tools (e.g, computer-aided design), production tools (e.g., subtractive or additive rapid prototyping machines like laser cutters and 3D printers) and product components (e.g., by including microcontrollers). The development of increasingly affordable ICT infrastructure and tools is gradually democratizing innovation while the standardization of materials and products that followed the industrial revolution have been particularly helpful to support collaboration, interoperability and modularity (Tanenbaum, Williams, Desjardins, & Tanenbaum, 2013).

Making is also referred to as digital do-it-yourself (DIY) and do-it-with-others (DIWO). Digital DIY is more adequate to describe those cases where individuals are working on their own and digital DIWO to describe those where several individuals are working together. There is a high level of interconnectedness between maker communities either through individuals that are part of more than one community or regional and international collaborations (Stacey, 2014).

The interconnectedness of maker communities and interoperability of the different ICT tools involved in making support distributed problem-solving (DPS). DPS is sometimes referred to as 'wisdom of the crowds' because it is considered to aggregate 'intelligently' millions of independent ideas supported by the development of the Web 2.0 and associated tools for decentralizing communication (Surowiecki, 2004).

Two popular distributed problem-solving practices (Lakhani, 2016; von Hippel, 2005) are open source practice and crowdsourcing. Brabham (2008, p. 81) underlines that open source practice involves "allowing access to the essential elements of a product (such as source code for software) to anyone for the purpose of collaborative improvement to the existing product, with the continued transparency and free distribution of the product through the various stages of open development." Open-sourced solutions and products thus belong to the public domain. Instead, crowdsourcing constitutes a form of outsourcing of labour meaning that solutions or products resulting from a crowdsourcing event become the property of the organization behind it.

One common form of DPS practice involves leveraging communities (Boudreau & Lakhani, 2013). Lakhani found that communities can be valuable sources of innovation because they "take responsibility for a collective output and integrate solutions across the entire spectrum of participants and tasks, […] involve joint problem solving, knowledge sharing, and accumulation over multiple problems" (2016, p. 118). Community approaches have had the largest impact in software development. The problem with this approach is that individuals may invest less in innovation as there are less opportunities for appropriation of the end result.

Makers, SDT and motivations to participate

Making is an activity that is intrinsically motivating: a passion (Dougherty, 2012) or something that is done 'playfully', because it is enjoyable to learn and create (Hatch, 2014). Kwon and Lee (2017) found that the most significant motivational factors in making, understood as developing and producing ideas, were symbolic use-

value and reward seeking and the most significant motivational factor in community participation, understood as asking or answering questions online and socializing with other makers, was product use-value. Further, although community participation was only found to have a slightly positive effect on making, it was found to have a significant impact on learning and performance. Community participation can therefore be considered to contribute significantly to the quality of making – not only for those actively participating in the community, but also those learning passively from it.

A literature review of studies on motivations to participate in three open source (Budhathoki & Haythornthwaite, 2012; Budhathoki, Nedović-Budić, & Bruce, 2010; Lakhani & Wolf, 2005; Roberts et al., 2006) and three crowdsourcing (Bretschneider et al., 2012; Kaufmann, Schulze, & Veit, 2011; Zheng, Li, & Hou, 2011) contexts was conducted. Based on the motivational constructs identified in these studies, we developed thirteen motivational constructs of our own (henceforth referred to as 'motives'). Following SDT's classification of motivation, these motives are split into two categories: extrinsic and intrinsic motivations.
The motives associated with extrinsic motivation are the following:

- Reward seeking

This is an extrinsic motive externally regulated by the promise of a reward, such as payment or a prize. Motivational constructs associated with reward seeking were found in four of the six studies: extrinsic motivation related to the pursuit of rewards (Roberts et al., 2006); monetary return (Budhathoki et al., 2010); payment (Kaufmann et al., 2011); to gain money (Zheng et al., 2011). Reward seeking was found to be the most motivational factor in the context of a paid crowdsourcing market (Kaufmann et al., 2011) and the second most significant motivational factor in an open source software development context (Roberts et al., 2006).

- Sanction avoidance

This is an extrinsic motive externally regulated by the threat of sanctions, such as being banished from a virtual community. A motivational construct associated with sanction avoidance was found in one study: action significance by external obligations and norms (Kaufmann et al., 2011), which is the compliance with obligations and norms to avoid sanctions. Sanction avoidance was not found to be a significant motive in this study.

- Symbolic surrender

This is an extrinsic motive regulated by introjection. It refers to those cases where an individual gives in to what are experienced as external norms, values or obligations. Although the values have been partially internalized, they are experienced as pressure. The individual can choose to surrender symbolically by doing what seems expected to relieve this pressure. Motivational constructs associated with symbolic surrender were found in four studies: feeling obligated to contribute as a user of the product (Lakhani & Wolf, 2005); trust in the way the system works (Budhathoki et al., 2010); indirect feedback from the job (Kaufmann et al., 2011), which is described as the prospect of receiving feedback from another person about the task performed; reciprocity, which is "a sense of obligation to give something back to the [organization behind a product used]" (Bretschneider et al., 2012, p. 3468). Symbolic surrender was not found to be a significant motive in any of the studies.

- Skill use-value, symbolic use-value, product use-value and distraction

These are extrinsic motives regulated by identification. They are associated with participating to obtain a separable outcome. The individual only participates for its instrumental value and could therefore easily choose another behaviour leading to a similar outcome. Skill use-value is the pursuit of skills that can lead to other separable outcomes, such as a better job. Motivational constructs associated with skill use-value were found in four studies: skill improvement (Lakhani & Wolf, 2005); learning and self-actualization (Budhathoki et al., 2010); human capital advancement (Kaufmann et al., 2011), which is associated with developing skills that can lead to future material advantages; learning to use a product more efficiently (Bretschneider et al., 2012). Skill use-value was among the second most significant motivational factors in open source software development (Lakhani & Wolf, 2005) and the third in crowdsourced work (Kaufmann et al., 2011). Symbolic use-value is the motivation to send a signal or symbolic message that can lead to separable outcomes, such as being noticed for a job

position. Motivational constructs associated with symbolic use-value were found in all six studies: non-product related needs (Lakhani & Wolf, 2005), such as enhancing professional status or reputation in the virtual community; status and career opportunities (Roberts et al., 2006); career opportunities, reputation enhancement, networking and social relation opportunities (Budhathoki et al., 2010); signalling (Kaufmann et al., 2011), which is described as doing something to send a strategic signal or message to others; to gain recognition (Zheng et al., 2011); capability signalling and recognition (Bretschneider et al., 2012), which are associated with getting positive reactions from others. Symbolic use-value was the most significant motivational factor in open source software development (Roberts et al., 2006) and the second most significant in a crowdsourcing contest (Zheng et al., 2011). Product use-value is the motivation to develop or improve a product that will be useful in obtaining a separable outcome, such as greater efficiency at work. Motivational constructs associated with product use-value were found in four studies: product use-related needs (Lakhani & Wolf, 2005); product use-value (Roberts et al., 2006); instrumentality, meeting own need and a wider project goal (Budhathoki et al., 2010); product improvement and individual needs for new product features (Bretschneider et al., 2012). Product use-value was the most significant motivational factor in two studies of the studies of open source practice (Lakhani & Wolf, 2005; Budhathoki & Haythornthwaite, 2012) and the third most significant in the third of these studies (Roberts et al., 2006). Finally, distraction is the avoidance of unpleasant psychological states, such as boredom, anxiety or stress. A motivational construct associated with distraction was found in one study: pastime (Kaufmann et al., 2011), which is described as boredom avoidance. It was among the third most significant motivational factors in this study.

- Symbolic affinity

This is an extrinsic motive regulated by integration. It refers to those cases where an individual participates because he associates separable values or meanings with an event, product, task or community that correspond to his own values or at least values he would like to uphold – such as those of a community he identifies with. Motivational constructs associated with symbolic affinity were found in four of the studies: a dislike of proprietary software and the belief that source code should be open (Lakhani & Wolf, 2005); a unique ethos, altruism, socio-political motives, supporting identity formation and community development (Budhathoki et al., 2010); action significance by external values and community identification (Kaufmann et al., 2011), where the first is described as compliance with values external to the task context and the second as being guided subconsciously by norms and values of the community within which the task is performed; identifying with the firm, which is associated with shared values, and altruism (Bretschneider et al., 2012). Symbolic affinity related to altruism and socio-political motives was found to be the second most significant motivational factor in open source wiki development (Budhathoki & Haythornthwaite, 2012).

Each of the intrinsic motives corresponds to a psychological drive or disposition. In detail, they are the following:

- Relatedness

Relatedness corresponds to the need to feel connected to others. Motivational constructs specifically associated with relatedness were found in three studies: enjoying working with the team (Lakhani & Wolf, 2005); social contact (Kaufmann et al., 2011), understood as part of participating; peer to peer communication (Bretschneider et al., 2012), which is associated with the need to feel connected to others. Relatedness was not specifically found to be a significant motivational factor in any of these studies, although one study found that intrinsic motivation was in general the most significant factor in a crowdsourcing contest (Zheng et al., 2011).

- Competence

Competence corresponds to the need to feel competent. It includes both obtaining confirmation of one's level of competence (for example, by obtaining feedback) and exerting one's competence (for example, through practice). Autonomy corresponds to the need to feel in control, to make decisions and be a causal locus. Competence and autonomy are closely related and are therefore sometimes associated with a same motivational construct. Motivational constructs specifically related to competence, autonomy or both were found in three studies: intrinsic motivation (Roberts et al., 2006), which was described as related to the needs for autonomy

and competence; the needs for self-expression, self-image, self-efficacy and freedom to express (Budhathoki et al., 2010); direct feedback from the job and task autonomy (Kaufmann et al., 2011). Autonomy was found to be the second most significant motivational factor in crowdsourcing work. Competence and autonomy were found to be the third most significant factors in open source wiki development (Budhathoki & Haythornthwaite, 2012).

- Interest and enjoyment

Interest and enjoyment correspond to those cases where a task is performed because it is inherently intellectually stimulating or agreeable. Interest and enjoyment are closely related and are therefore also sometimes associated with a same motivational construct. Motivational constructs specifically related to interest, enjoyment or both were found in four studies: intellectual stimulation (Lakhani & Wolf, 2005); personal enrichment, fun and recreation (Budhathoki et al., 2010); skill variety and task identity (Kaufmann et al., 2011), which are described as having to use a variety of skills and the tangibility of the task result; intellectual stimulation and fun (Bretschneider et al., 2012). Interest and enjoyment were among the second most significant motivational factors in crowdsourced work (Kaufmann et al., 2011). Interest was the third most significant motivational factor in open source software development.

Further, in order to identify the likely most significant motives overall, motivational constructs in each study were assigned three, two or one points depending on whether they were among the first, second or third most significant motivational factors in their respective study. A ranking of the motives was done by adding the points from motivational constructs associated with a same motive. The motives found to be most significant were product use-value and interest (7 points), autonomy (6 points) and reward seeking, symbolic use-value and enjoyment (5 points).

Creating a model of motivations to participate in distributed problem-solving

By combining the thirteen motives identified in the literary review with SDT, a model was developed (Figure 1). As none of the studies in the literature review took into account all thirteen motives, this model is more complete and is intended to support maker engagement in humanitarian projects by providing humanitarian project organizers with a framework.

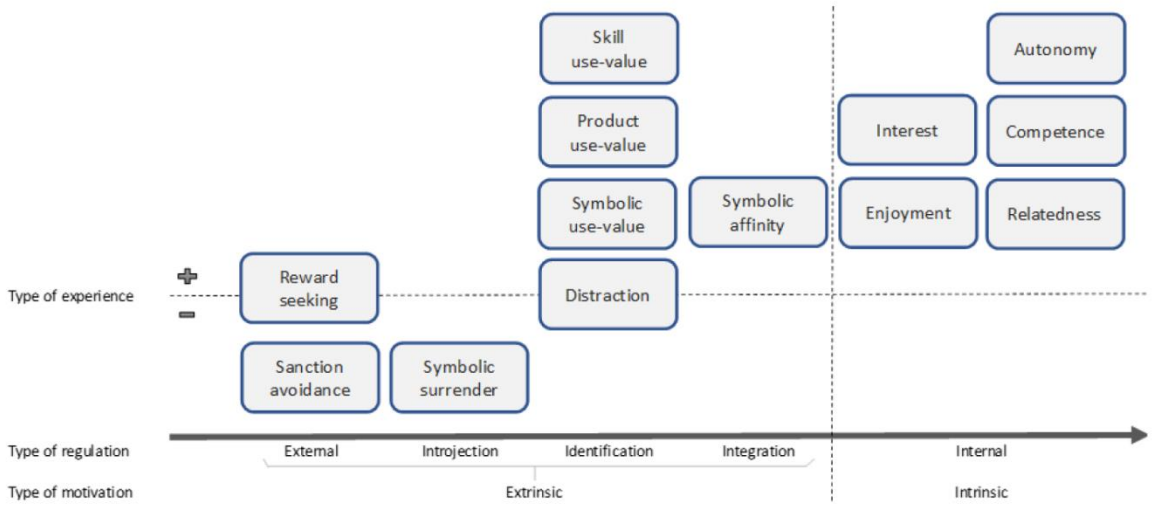

Figure 1. Model of motivations to participate in distributed problem-solving

The model is split horizontally (i.e. in relation to Ryan and Deci's (2000) continuum of internalization) and also vertically: two rows distinguish between those motives that are more likely to be experienced in a positive way (e.g. as related to personal goals and convictions) from those that are more likely to be experienced in a negative way (e.g. as external pressure or control).

Ranging from completely externally regulated to completely internally regulated, the motives developed are the following: reward seeking and sanction avoidance; symbolic surrender; skill use-value, product use-value, symbolic use-value and distraction; symbolic affinity; interest and enjoyment; autonomy, competence and relatedness. The last three motives are considered to be "deeper" forms of internal regulation, because they correspond to Ryan and Deci's (2000) three basic psychological drives.

Those constructs lying on the frontier separating positive from negative experiences can be experienced either way. For instance, distraction-motivated participation can be experienced negatively as "a waste of time" or positively as "a moment to relax". According to Ryan and Deci (2000), a task must satisfy to a certain a degree the needs for autonomy and competence to be experienced in a positive way. Some motives can be combined and even reinforce each other, while others conflict with each other. For instance, autonomy and competence can reinforce interest and enjoyment (Ryan & Deci, 2000) but sanction avoidance and symbolic surrender conflict with autonomy.

This model is used hereafter (i) to identify the most significant motives for maker participation in this context *and* (ii) to enable humanitarian project organizers to determine how these motives are regulated, how they interact with each other and how they contribute to engagement, learning, well-being, effort and creativity.

Method

Motivation has traditionally been studied by observing individuals' behaviour or asking individuals to report what motivates them. For instance, one popular way of measuring intrinsic motivation is by asking the individual to report on the level of enjoyment he associates with a task (Ryan & Deci, 2000). These self-reports can be collected using interviews or surveys. Online surveys are increasingly favoured, particularly for studying motivation in online contexts.

Our study was conducted in two stages. First, two qualitative semi-structured interviews and one open-ended questionnaire were used to test the completeness of our motivation model and develop a more specific and contextualized understanding of maker motives for participating in humanitarian projects. Then, an online survey was implemented on eSurvey Creator to test quantitatively the study hypotheses. Study participants in both stages had to meet two criteria: correspond to the maker profile and have experience participating in a humanitarian project as a maker.

The interviews and questionnaire were conducted in June 2017. The three participants were male engineers based in the U.S. and aged 24-54. All three were asked about how they participated in humanitarian projects, what enabled them to participate in this way, their motivations to participate and instances where they felt their participation wane.

The online survey contained a study-related question (How important were the following motivations in your decision to participate in humanitarian projects?) that had 13 items to measure the significance of the 13 motives in our motivation model. All of these items were measured using a 5-point Likert-type scale with 1 as "not important at all" and 5 as "extremely important". In addition, a form-of-participation-related question asked survey participants to select from a list the forms their participation took in these projects (i.e. Advice, Ideas, Design, Build, Program). The survey was actively shared between July and September, 2017 with eleven platforms or organizations associated with makers (e.g. Humanitarian Makers, Makers Unite, Manylabs, Nation of Makers, OpenIDEO, Maker Faire Zürich, Reddit, Tikkun Olam Makers) and received 118 valid responses. Based on the choice of platforms and organizations, we infer participants were mainly based in the U.S. or Europe. More than half of the 118 participants were aged 25-44 (60.2%), followed by those aged 18-24 (22.9%) and those aged 45+ (16.9%). In terms of experience, participants were equally split between those that had only participated in one humanitarian project (50%) and those that had participated in a few (50%). Around two-

thirds of the study participants (67.8%) had participated using technical skills (designing, building or programming). Of these, around one-third (33.8%) had participated using two or three different technical skills.

Results

The main objective of our study was to find out what motivates makers to participate in open innovation humanitarian projects. We found that, in overall, the most significant motives are interest and enjoyment followed by relatedness, symbolic affinity and competence.

Significant motives for maker participation in humanitarian projects

The first stage of our study provided qualitative answers to our research question. A first finding at this stage was that projects that combine multiple motivational factors are particularly engaging, especially those that allow participants to do something good (altruism) using their unique skillset (competence). For instance, interviewee 3 said: "I like solving problems...I guess that's why I am an engineer. If I can match my desire to solve problems with the alleviation of human suffering, then I'll choose those opportunities whenever I can."

A second finding was the importance of signaling the use-value of participating for the project's intended beneficiaries, which can be communicated via feedback from the beneficiaries or the project organizers. For instance, interviewee 1 spoke of 'gravitating' towards projects that many people have a need for and said: "If I contribute to something and then find out it's not effective, not useful, not wanted – that would probably kill the project pretty quickly for me."

A third finding was that interactions among makers can activate new interests that support learning and participation in new projects. For instance, interviewee 2 explained how a fellow maker had "triggered" in him a new interest to buy a 3D-printer, learn computer-aided design and participate in projects involving prosthetic designs.

The purpose of the online survey of the second stage was to determine quantitatively which are the most significant motivational factors in maker participation in humanitarian projects.

Items	*Mean*	*SD*
I hoped to win a prize	1.52	0.91
I was told that if I didn't, there would be bad consequences	1.38	0.76
I would have felt bad if I didn't participate	2.31	1.14
I wanted to develop a skill that I might need later on	3.36	1.08
I was working on a product that was also useful for me	2.59	1.28
It would send a good signal or message to others	3.18	1.26
I was looking for a distraction	1.97	1.05
It was something I had to do because of my values	3.54	1.17
I found it very interesting	4.12	0.79
I really enjoyed it	4.08	0.92
I could do it my way	2.81	1.21
It was an opportunity to use/test my skills/knowledge	3.53	1.04
It was an opportunity to do something with others	3.55	1.03

Table 1. Overall answers to question about motives for participating (Mean, Standard Deviation)

Table 1 shows the mean and standard deviation of each item of the study-related survey question (N = 118). The most significant motives were found to be interest (M = 4.12 out of 5, SD = 0.79) and enjoyment (M = 4.08, SD = 0.92). These motives were on average considered to be very important. The second most significant motives were found to be relatedness (M = 3.55, SD = 1.03), symbolic affinity (M = 3.54, SD = 1.17) and competence (M = 3.53, SD = 1.03). The third most significant motives were found to be skill use-value (M = 3.36, SD = 1.08) and

symbolic use-value (*M* = 3.18, *SD* = 1.26). These motives were on average considered to be moderately important. No significant differences were found in relation to age.

Figure 2 shows these results in relation to Ryan and Deci's (2000) continuum of internalization.

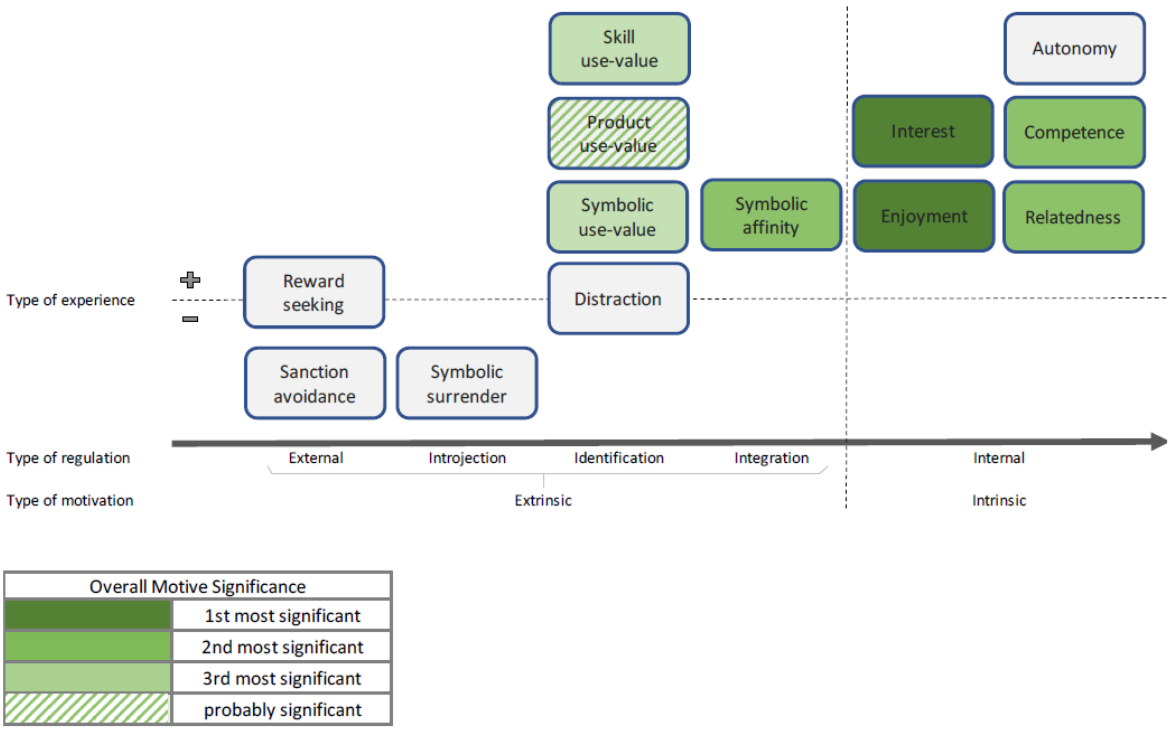

Figure 2. Significant motives for maker participation in humanitarian projects

In overall, it was found that the most significant motives for maker participation in humanitarian projects were interest and enjoyment, which are closely interrelated in this context, followed by relatedness, symbolic affinity and competence. Product use-value relative to the participant was not found to be significant at this stage. The overall results suggest that the significance of some motives for participation in distributed problem-solving (such as interest) may be stable across different contexts, while that of others (such as symbolic-affinity, relatedness and competence) are specifically significant in the context of maker participation in humanitarian projects.

Support to the completeness of the motivational model proposed
No new motives for participating in humanitarian projects were identified during the first stage of the study, which supports the completeness of the model proposed.

Discussion
The main objective of this study was to find out what motivates makers to participate in distributed problem-solving humanitarian projects.

All motives identified as significant for maker participation in humanitarian projects correspond to forms of intrinsic motivation or highly internalized forms of extrinsic motivation. Located on the right or 'high' side of the internalization continuum, the motives identified correspond to desirable forms of motivation associated with greater engagement, learning, well-being, effort and creativity (Ryan & Deci, 2000; Roberts et al., 2006) – which should support innovation and human capital building within virtual communities for innovation (Bretschneider

et al., 2012). Moreover, these motives are all likely to be experienced in a positive way – for example, as related to personal goals and convictions.

Interest and enjoyment were found to be the most significant motives for maker participation in humanitarian projects, supporting H2. Both are intrinsic motives regulated internally. Interest seemed to be primarily associated with finding solutions for technical challenges using very constrained resources. Enjoyment seemed to be associated with both the satisfaction of solving these technical challenges and the satisfaction of doing something good. These two motives were found to be deeply interrelated within this context. As those aspects that made participation most interesting and enjoyable were in direct harmony with the project goals, these intrinsic motives should not be associated with undesirable behaviours that could have a negative impact on project performance (Roberts et al., 2006) Instead, enjoyment-driven participation is associated with good performance, particularly in terms of idea quality (Bretschneider et al., 2012).

Relatedness and competence, two of the three second most significant motives, are also internally regulated intrinsic motives. Relatedness seemed to be associated with the need to interact with people with similar interests and build friendships. Competence seemed to be associated with the need to use unique technical skills – skills that participants felt particularly confident in.

Symbolic affinity, one of the three second most significant motives, is an extrinsic motive regulated by integration. Makers driven by this motive participate because the values or meanings they associate with the project community, the project itself or its beneficiaries correspond to their own values or at least values they would like to uphold. Within the context of our study, symbolic affinity was found to be primarily associated with altruistic values and identification with the project community. Identification with project beneficiaries was also found to be a supporting but not essential motive. Symbolic affinity was found to be particularly significant for participants that have participated in more than one humanitarian project. This is supported by Budhathoki and Haythornthwaite's (2012) observation that regular participants are motivated by the drive to support their community. Supporting the community, for example by sharing knowledge and experience, contributes significantly to the quality of making (Kwon & Lee, 2017).

Skill use-value and symbolic use-value, the third most significant motives, are extrinsic motives regulated by identification. Makers driven by these motives participate because of the opportunities to develop skills or send signals that can lead to separable outcomes, such as being noticed for a job position. These motives were particularly significant for the 18-24 age group. This can be explained by the fact that members of this age group are either completing their education or just starting their careers and therefore allocate more importance to opportunities to develop their professional skills and be noticed by potential employers. Participation driven by symbolic use-value is also associated with good idea quality (Bretschneider et al., 2012).

Although product use-value was not found significant during the second stage, there were indications in the first stage that it is significant. This divergence can be explained by a difference in types of product use-value. The survey tested for the significance of product use-value relative to the participant – this was found to be insignificant. However, participants in the first stage spoke about the importance of feeling that the product was useful for its intended beneficiaries. In other words, participants were not significantly motivated by how useful the product they worked on was for them, but how useful it was for its intended beneficiaries. H1 is therefore partially supported.

The positive and highly internalized motives for participation identified on the maker side of humanitarian projects indicate that the conditions are right for durable and productive open innovation for the humanitarian sector. It is up to humanitarian organizations to learn how to reach and engage these makers. Although most of the motives identified as significant can be self-activated, specific humanitarian projects still need to compete with other projects to reach and engage participants. In other words, our study has shown that many of those makers that have participated in humanitarian projects are individuals driven by feelings of altruism and the needs to be intellectually stimulated, experience enjoyment and relatedness, and feel competent. These drives

and feelings can be satisfied in different ways. In order to attract participants, humanitarian project organizers need to reach these individuals with information about their projects and engage them. As Leimeister et al. (2009) noted, organizational measures and tools can be designed to support behaviour activation by reinforcing incentives. It follows that humanitarian project communications and organization should be designed to support those motives that were found to be most significant.

Our study indicated that at least some makers participate in humanitarian projects because they allow them to satisfy multiple motives simultaneously – particularly altruism, competence, interest and enjoyment. Indeed, at least some makers are attracted to humanitarian open innovation projects because they prefer using their unique skillset to help others, which is both technically interesting and enjoyable. Humanitarian open innovation projects can communicate about this unique way of participating to stand apart from humanitarian projects that do not offer this. Competence, interest and enjoyment related to technical challenges can be incentivized by designing tasks that are varied, complex and allow for a certain level of autonomous work (Ryan & Deci, 2000; Zheng et al., 2011). Feelings of competence can also be reinforced by giving participants positive performance feedback (Leimeister et al., 2009) and interest by encouraging participants to share and discuss their work with makers internal and external to the project. Indeed, our study showed that makers interest each other in new projects. Relatedness and community identification can be incentivized by promoting the development of virtual communities for innovation – for instance, by providing online platforms that support communication between members and communicating in a way that emphasizes the shared identity. Skill use-value and symbolic use-value can be incentivized for young makers by framing participation as an opportunity to develop professional skills and signal competence to potential employers. Product use-value can be incentivized, on the one hand, by communicating as intensely as possible beneficiaries' satisfaction with the product and, on the other hand, by making sure participants get necessary feedback to develop useful solutions from project organizers or beneficiaries. External incentives, such as tangible rewards, competition pressure and threats should be avoided as they were not only found to be insignificant but can also be experienced as external behaviour controllers, thereby conflicting with positive internal motives.

With regard to the model developed, from a scientific perspective, it brings together motivational constructs from different studies of distributed problem-solving practices and Ryan and Deci's (2000) continuum of internalization. From a practitioner's perspective, this model provides a framework for identifying as many motives for participating as possible and classifying them relative to engagement, learning, well-being, effort and creativity in order to support engagement and qualitative participation in open innovation distributed problem-solving practices.

Conclusion

This study sought to find out what motivates makers to participate in humanitarian projects. For the purpose of this study, a model of motivations to participate in distributed problem-solving was developed. It was found that the most significant motives are interest and enjoyment followed by relatedness, symbolic affinity and competence. Symbolic affinity was found to be particularly significant with older and more frequent participants, while relatedness and competence were relatively stable motives across different age and participation frequency groups. Product use-value relative to the participants was found to be insignificant, although there were indications that product use-value relative to its intended beneficiaries may be a significant factor. Skill use-value and symbolic use-value were also found to be moderately significant, particularly with young makers starting their professional careers.

Limitations

This study had a number of limitations. First, there were some limitations concerning the study design. Motivation was studied based on self-report, which is vulnerable to different biases – especially social desirability bias. Second, there were some limitations concerning the impact of the study. Given the difficulty of reaching makers that had been involved in humanitarian projects and were willing to participate in our study, certain population groups were more represented than others: participants were all U.S.-based male engineers and most of the groups that agreed to share the survey were either based in the United States or in Europe. Third, there

were some limitations concerning data. Some respondents had not really been involved in humanitarian projects but in general social good projects. Although definitions of what a humanitarian project involves were provided for participants of the study, it is possible that other participants were also referring to general social good projects rather than humanitarian projects. Also, potentially relevant demographics such as more precise age groups, gender, employment status, profession and location were not studied.

Future research is needed to increase our understanding of maker motivations to participate in humanitarian projects. More quantitative research is needed to test the significance of different motives, in particular of product use-value with regard to beneficiaries. Qualitative research is also necessary to better understand certain motives within this context, such as symbolic use-value and skill use-value. It would also be useful to conduct further research to identify efficient communication- and task-design elements for incentivizing motivation based on motives identified as significant.

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