Gamifying Knowledge Sharing in Humanitarian Organisations: A Design Science Journey

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Abstract - Humanitarian organisations provide invaluable work to improve the lives of individuals impacted by natural and anthropogenic hazards. While humanitarian organisations are highly knowledge intensive, they often fail to manage knowledge effectively. Providing adequate incentives to foster knowledge sharing on a knowledge management system is a challenge for many organisations. It is especially important in the humanitarian context where organisational efficiency leads to saving more lives. We argue that gamification (i.e., the integration of game-like features, such as points or badges in non-game systems) is a viable solution to address the lack of knowledge sharing often encountered. To do so, we embark on a design science journey with Doctors Without Borders to investigate how gamification within (e.g., using a personal profile) and outside (e.g., using a connected ambient object) a knowledge management system can improve knowledge sharing. Our findings demonstrate that well-designed gamification can increase engagement and knowledge sharing, in particular for altruistic individuals.

Keywords: Knowledge sharing; Humanitarian organisations; ICT4D; Gamification; Design science

1. Introduction

On 12 January 2010, an earthquake struck the Haitian capital of Port au Prince, killing more than 220,000, injuring over 300,000 and forcing 1.3 million people into temporary shelters. Unfortunately, the massive humanitarian response was rather ineffective (De Ville de Goyet, Grünewald, & Sarmiento, 2011). Knowledge management - "the generation, representation, storage, transfer, transformation, application, embedding, and protection of organisational knowledge" (Schultze & Leidner, 2002, p. 218) - is especially important in emergencies, during which the relief effort's coordination is paramount (Day, Junglas, & Silva, 2009). Improving knowledge management in a humanitarian context not only increases organisational efficiency, but also saves lives. Providing actionable support for effective knowledge management is therefore a key element in this endeavour. Even though knowledge management systems (KMS) are designed to provide support (Alavi & Leidner, 2001) and many humanitarian organisations use them, these organisations still struggle to manage them efficiently (Hume & Hume, 2015; Renshaw & Krishnaswamy, 2009). The purpose of this research is to describe, study and improve a humanitarian organisation's efforts to improve knowledge management and more specifically its knowledge sharing practices on the KMS.

1.1 Research context

Doctors Without Borders (Médecins Sans Frontières, MSF) is a non-governmental organisation (NGO) created in 1971 to deliver emergency medical aid quickly, effectively and impartially (http://www.msf.org). Typical MSF activities include performing surgery, providing health care, carrying out vaccination campaigns and setting up sanitation systems. In 1999, MSF received the Nobel Peace Prize in recognition of its humanitarian and medical work. Despite being a world-leading NGO, MSF's digital transformation had not been totally implemented. Consequently, MSF mandated a knowledge manager to conduct a series of studies of different knowledge management systems (as required by their 2012-2015 Strategic Plan). Internal MSF documents reveal that after internal and external consultations, MSF decided to focus on four key axes which were to increase its field knowledge sharing, to improve its internal (horizontal, vertical and transversal) and external (e.g., with experts and academics) work practice exchange, to reduce existing systems' multiplication and to reduce information overload. More specifically, the newly

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developed KMS should allow simple and rapid on/offline access to and sharing of essential knowledge, facilitate the creation of communities of practice (e.g., a forum for knowledge exchange), implement efficient search process, enable connectivity and increase usability.

To attain these objectives, MSF focused on the level of simplicity and access to the relevant knowledge (independent of the specific format, location or structure) which would give its employees more time to concentrate on their specific tasks. Since these employees might have to leave extremely rapidly to respond to a specific crisis (e.g., earthquake, Ebola outbreak), they need a system that allows them to acquire as much knowledge (e.g., access to specific documents, asking targeted questions on a forum) as quickly as possible before being deployed. However, at that time, the knowledge access was tedious. Employees struggled to find the correct person to contact or the accurate online resources from the dozens of different internal websites. An advisory supervisor from Mozambique noted that there was "nothing on a digital format" when asked about his activities. Moreover, much of the digital knowledge was shared using emails, hence not easily accessible. A fleet manager from South Sudan reported: "I communicate with email with the staff both in the field and on the coordination level". Moreover, interviews with employees reflected that they were willing to use the existing KMS passively, but not to contribute to it actively. They were more motivated to find documents rather than rating them or adding new ones, although their active engagement is key to providing up-to-date, relevant and sometimes even instantaneous (e.g., in a forum) knowledge. This dependence on contributions mirrors past research advocating that active use should be the basis of a well-functioning KMS (e.g., Wu & Wang, 2006). Consequently, the specific research problem addressed in this paper concerns the motivation for sharing knowledge on the KMS of a humanitarian organisation.

1.2 Contributions

We contribute to theory and practice in several ways. Firstly, we contribute to the scant, but important, literature on humanitarian technology (Sandvik, Jumbert, Karlsrud, & Kaufmann, 2014). More specifically, we assess and propose a solution for issues related to knowledge sharing in humanitarian organisations, since the importance of such a contextualization (especially in respect of gamification) was recently pinpointed as a key IS research factor (Te'eni, 2015, 2016). Knowledge sharing is particularly challenging in humanitarian organisations, because they operate in very unique settings with high unpredictability; high risk, short-term, life-saving engagement; a large staff turnover; and poor technological infrastructures (Cardozo et al., 2012; Korff, Balbo, Mills, Heyse, & Wittek, 2015). These factors make it both challenging and crucial for staff to contribute to the knowledge base. To study this specific context, we developed, designed and tested our solution in direct collaboration with MSF. Secondly, we provide new insights into gamification design (i.e., adding game-like features to a KMS, such as levels or points) to foster individuals' contributions. We did so by designing and evaluating (in the field and laboratory) digital artefacts. Despite the growing literature on gamification, the outcomes are not yet clear and many studies lack proper empirical validation (Hamari, Koivisto, & Sarsa, 2014; Seaborn & Fels, 2015). Our research contributes to this literature by taking a multidimensional measurement model to validate gamification features in a KMS context. More specifically, we not only measure attitudes towards our artefacts, but our evaluations also include psychometric measurements, behavioural outcomes and control groups. Thirdly, one of our artefacts addresses the lack of research on ambient objects and their impact on gamification features (Liu, Cui, Wu, & Liu, 2014). These ambient objects are especially useful in a humanitarian organisation context with users performing most of their activities offline. Fourthly, we demonstrate the importance of a psychological underpinning, i.e. the perception of sociometric status gained through feedback. A recent literature review pinpoints status as a fundamental human motive (Anderson, Hildreth, & Howland, 2015). Contrary to other status types which have been extensively studied (e.g., socioeconomic status, Adler et al., 1994; Bradley & Corwyn, 2002; Piff, Stancato, Côté, Mendoza-Denton, & Keltner, 2012), we extend the literature by focusing on one type of status - sociometric status - which is gained through others' respect and admiration (Anderson, John, Keltner, & Kring, 2001; Anderson, Kraus, Galinsky, & Keltner, 2012). To the best of our knowledge, we are the first to develop, implement and measure a system that uses the perception of sociometric status, gamification and their subsequent influences on actual behaviour. Finally, digital transformation's fast pace has led to design science methodologies becoming more important and to IS researchers calling for more proactive design science pieces (Goes, 2014). Since design science methodologies (Peffers, Tuunanen, Rothenberger, & Chatterjee, 2008) allow the solving of practical problems by means of theoretical insight and relevant outcomes, these methodologies are particularly adequate for this research. Design science knowledge outputs can take the form of artefacts such as models, methods, instantiations, constructs and design principles (March & Smith, 1995; Vaishnavi, Kuechler, & Petter, 2017). Our research specifically contributes to three of these outputs: a *model* (an abstract artefact) describing the links between the key constructs (feedback gamification, sociometric status perception, altruism and engagement), a *method* representing a set of steps required to perform a task (the design process) and an *instantiation* realising the abstract artefact in a situated implementation (the humanitarian environment).

2. Research approach

To execute this project, we followed a Design Science Research Methodology (DSRM) (Gregor & Jones, 2007; Hevner, 2007; Hevner, March, Park, & Ram, 2004; Holmström, Ketokivi, & Hameri, 2009; Iivari, 2015; March & Smith, 1995; Peffers et al., 2008; Sein, Henfridsson, Purao, Rossi & Lindgren, 2011; Simon, 1996). The DSRM aims to address an identified research problem by creating and evaluating an artefact. It adopts a proactive approach by creating a technological artefact that impacts people and organisations (Hevner & Chatterjee, 2010). In this article, we, like Reinecke and Bernstein (2013), follow the DSRM process described by Peffers et al. (2008). As shown in Figure 1, the first step of the process investigates the problem (Section 1), whereas the second step defines the objectives of a solution (Section 3). The third step is the design (Section 4) of the artefacts, the fourth implements (Section 5) and the fifth evaluates them (Section 6). The sixth step communicates the results through different channels, such as this article.

We used an artefact design and evaluation approach (Jung, Schneider, & Valacich, 2010). Practice and theory informed the artefacts' design, and the psychological and behavioural outcomes used to measure their impact. Qualitative methods (such as field studies and interviews) as well as quantitative methods (online surveys, laboratory experiments and log data) were used to assess the different outcomes. A multidisciplinary team composed of researchers from information systems, behavioural science, psychology, marketing, development studies, design, computer engineering and humanitarian action conducted this project over the course of a 12-month period. In monthly face-to-face meetings, the research team assessed their progress and decisions. The relevant team leaders held weekly meetings and video conferences.

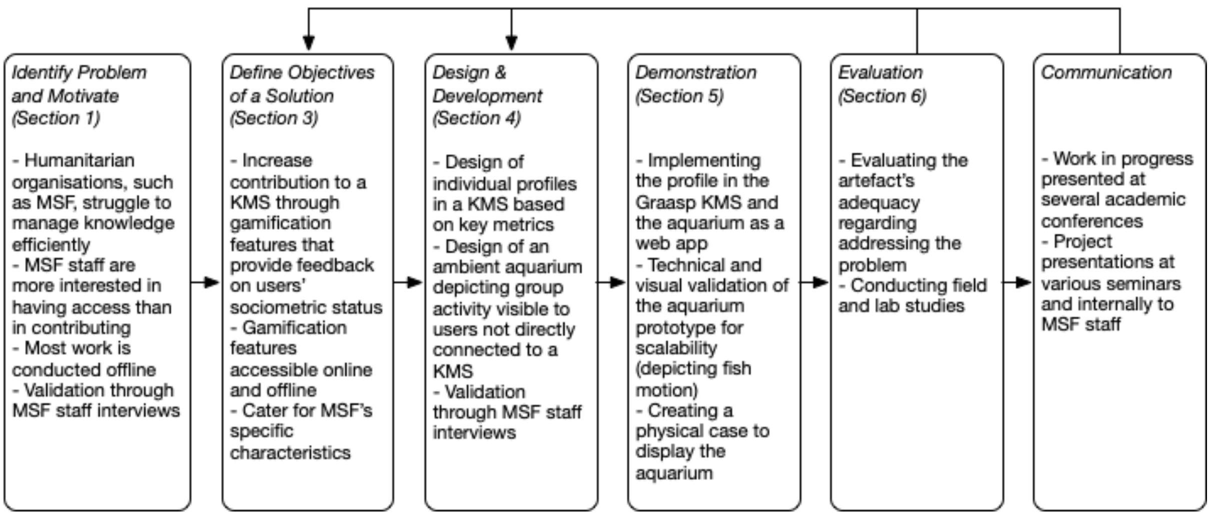

Figure 1. Design Science Research Methodology Process Model (Peffers et al., 2008).

3. Define the objectives of a solution

This section infers objectives of a solution on the basis of the problem's definition and the knowledge of what is possible and feasible. The problem definition clarifies that the overall objectives are to improve humanitarian organisations' knowledge sharing practices on their KMS. In the following, we review the relevant literature streams and state specific objectives based on four hypotheses. We start with an overview of the challenges that knowledge management faces (in and outside humanitarian contexts) and present studies on systems that support knowledge sharing. We subsequently detail the theoretical background underpinning motivations for sharing knowledge. Finally, we discuss the design of systems to trigger motivational levers by means of various gamification features and pinpoint a humanitarian context's specificities.

3.1 Knowledge Management Systems (KMS)

The competitive advantage that any type of organisation gains through efficient knowledge management has been repeatedly demonstrated (Hurley & Hult, 1998; Moorman & Miner, 1998; Ofek & Sarvary, 2001). Researchers have investigated various ways of incentivising and optimising such knowledge management from a variety of different perspectives, ranging from specific features' impact on job performance (Zhang & Venkatesh, 2017), cultural values' effects (Alavi, Kayworth, & Leidner, 2005; Young, Kuo, & Meyers, 2012) to various contingencies' impact (Kim, Mukhopadhyay, & Kraut, 2016; Zhang, 2017). Introducing managerial incentives is one way of managing knowledge (e.g., Gold, Malhotra, & Segars, 2001; Kulkarni, Ravindran, & Freeze, 2006). Another way, and the focus of this research, is to use digital interventions with the help of, for example, a KMS (e.g., Kulkarni et al., 2006; Lee & Choi, 2003). A KMS can range from a simple system to more integrated interventions. In the simplest version, knowledge is seen as a commodity and the IT department as the change agent playing a deterministic role. In the most integrated versions, organisations embrace social media, with IT departments' role therefore no longer being central, but supportive (Cummings, Regeer, Ho, & Zweekhorst, 2013; Ferguson, Mchombu, & Cummings, 2008; van Osch, Steinfield, & Balogh, 2015). According to the McKinsey Global Institute report (Chui et al., 2012), the more integrated interventions (e.g., wikis, ratings and reviews, social networks, discussion forums) have the greatest potential and impact on outcomes (e.g., productivity).

Past literature demonstrates mixed evidence on the impact of a KMS on job performance while the proper ways of designing such systems in order to reap productivity gains are of great importance (Zhang, 2017). The literature has identified the characteristics and the consequences of inefficient knowledge management systems, such as qualified workers wasting time looking for crucial knowledge, essential know-how only being available in a few employees' minds, interferences between various practices, and irrelevant data hindering access to knowledge (de Vasconcelos, Seixas, Lemos, & Kimble, 2006; Huber, 2001). One of the major challenges that organisations face is their employees' motivation for sharing relevant data (Kettinger, Li, Davis, & Kettinger, 2015). Researchers warn that "developing and introducing a state-of-the-art KMS and encouraging employees to use it only to share knowledge will likely be a wasted financial investment because of the low level of knowledge sharing that occurs" (Wang, Noe, & Wang, 2014, p. 1001). To avoid such a situation, organisations must understand that the transfer of organisational knowledge is heavily dependent on social processes (Argote, Ingram, Levine, & Moreland, 2000; Kyriakopoulos & De Ruyter, 2004; Lindkvist, 2005; Watson & Hewett, 2006). Knowledge management is not only about creating and managing knowledge, but also about managing individuals whose work depends on, or is influenced by that knowledge (Alvesson & Kärreman, 2001; Smoliar, 2003). We argue that a properly designed system, specifically through feedback gamification, can maximise individual engagement with a KMS. User engagement is defined as the different activities users perform on the system, such as postings, site visits, document reads and interactions with content (Grinberg, Dow, Adamic, & Naaman, 2016).

3.2 Gamification: Increase engagement with the KMS

Past research has provided general design principles to motivate engagement in a knowledge management system (e.g., Butler & Murphy, 2007; de Vasconcelos et al., 2006; Zhang, 2008). For example, Zhang (2008) suggests that information systems should have motivational affordances - an object's properties that determine whether and how to support one's motivational needs - and proposes several specific design principles. More recent research argues that gamification can foster various motives including intellectual curiosity, self-determination or fun (Blohm & Leimeiseter 2013; Kankanhalli, Tan, & Wei, 2005). In a gamified system, game-like features serve as motivational affordances in non-game systems (Deterding, Dixon, Khaled, & Nacke, 2011; Fitz-Walter, Wyeth, Tjondronegoro, & Johnson, 2014; Mekler, Brühlmann, Tuch, & Opwis, 2017). Typical game-like features include points, leaderboards, achievements/badges, levels, stories/themes, clear goals, mastery, teams, rewards, progress and challenges (Deterding, 2012; Hamari et al., 2014; Seaborn & Fels, 2015).

Despite the increasing interest in gamification, a recent literature review on gamification (Hamari et al., 2014) found that only four (of 24) studies were conducted in an organisational context (e.g., Farzan et al., 2008; Thom, Millen, & DiMicco, 2012). Unfortunately, these gamification studies lack strong experimental validity (Hamari et al., 2014;

Seaborn & Fels, 2015) and the user engagement findings are not conclusive (Fitz-Walter et al., 2014). These studies have small sample sizes, lack proper validated psychometric measurements and controls of the implemented motivational affordances (Hamari et al., 2014; Hamari, 2017). Furthermore, no study used multidimensional measurement models, including motivational affordances, psychological levers, and behavioural outcomes (Hamari et al., 2014). Market research companies' findings have also been mixed, ranging from positive (e.g., wide adoption rates) to negative (e.g., high failure rates) (Baer, 2017; Gartner, 2011, 2012). A few properly designed recent studies have, however, demonstrated gamification's potential positive impact. For example, some studies show that badges (a form of gamification) increase user activity through their shared goals and feedback they provide (Hamari, 2017; Morschheuser, Riar, Hamari, & Maedche, 2017). Feedback has been shown to be a crucial element in the motivation and goal attainment literature (e.g. Ammons, 1956; Becker, 1978; Greller, 1980; Greller & Herold, 1975; Ilgen, Fisher, & Taylor, 1979; Ivancevich & McMahon, 1982). Recent meta-analyses have shown that feedback's effectiveness depends on how and to whom it is communicated (Anseel, Beatty, Shen, Lievens, & Sackett, 2015; Karlin, Zinger, & Ford, 2015). Feedback can influence a variety of concepts, such as specific knowledge, self-efficacy, trust, habit formation and internalise behaviours by providing specific targets (Tarakci, Ateş, Floyd, Ahn, & Wooldridge, 2018; van Houwelingen & van Raaij, 1989; van Raaij & Verhallen, 1983; Wang, Du, & Olsen, 2018). In line with these findings, we argue that one of the consequences of feedback generated through gamification is helping users to better understand and assess their behaviour on a KMS, both of which will have a positive impact on their engagement (see Figure 2 for the Conceptual Model). Stated formally:

H1a: Gamifying user activity feedback within a KMS improves their engagement with it.

There is a variety of ways of displaying gamification features inside a system, for example, through badges or points (e.g., LinkedIn, ResearchGate). Interestingly, since the introduction of connected objects, researchers have investigated how ambient connected objects can provide awareness of online activities (Pousman & Stasko, 2006). Displaying electrical consumption on an artistic digital screen in a kitchen can raise awareness of and incentivise energy saving (Rodgers & Bartram, 2011). In another context with tangible interfaces and gamification, researchers have given asthma patients an Asthma Buddy teddy bear (Gisvold & Aarseth, 2014). This teddy bear, which has an integrated Raspberry Pi, teaches asthmatic children when to take their medication. The bear is synchronised with a mobile application that keeps track of the points that the children collect and motivates them to take their medicine.

We argue that the above objects can be an inspiration for gamification *outside* the KMS. Similar to traditional gamification features (e.g., badges, points), tangible objects can provide direct feedback from online activity. These objects do, however, differ from gamification within a KMS and have unique characteristics. Users do not need to be working on a KMS to receive feedback, because these objects are a constant reminder of online activities occurring, even when the users are not connected to a KMS. Consequently, an individual's (in)activity is constantly visible. For instance, when employees do not contribute to a KMS, they still see their fellow workers' contributions. A recent survey of data visualisations shows that studies of such ambient objects are still scarce (Liu et al., 2014). Nevertheless, the few relevant studies' initial results are promising, indicating that these objects have a real effect on behaviour (e.g., leading to a five to 20 percent decrease in energy consumption), specifically by delivering regular and engaging feedback (Vine, Buys, & Morris, 2013). Ongoing activity's visualisation, which is especially relevant for our research, can be regarded as an example of ambient awareness, which has been shown to be an important antecedent of knowledge acquisition (Leonardi, 2015). In line with these initial findings, we hypothesize that:

H1b: Gamifying user activity feedback *outside* a KMS improves their engagement with it.

3.3 Sociometric status: Feedback in a social environment

When the user activity occurs in a social environment, we argue that the gamification's feedback will influence individuals' perceived social status on the KMS. Social status is broadly defined as a person's position relative to others within a social structure (Brekke, Howarth, & Nyborg, 2003; Cheng, Tracy, & Henrich, 2010). Social status has been studied from a variety of perspectives and is a key motivator of human behaviour (for a review, see Anderson et al., 2015). Recent research has started disentangling different types of social status, for example, socioeconomic status is defined as an individual's standing within society based on criteria such as income and wealth (Anderson et al., 2012). Sociometric status, which is the most relevant for our context, is based on more interpersonal criteria and defined as the amount of respect, influence and prominence a person enjoys (Anderson et al., 2001; Anderson et al., 2012). Researchers have demonstrated sociometric status's impact on individuals' subjective well-being (Anderson et al., 2012), self-esteem, mental and physical health (Anderson et al., 2015), favour exchange, productivity (e.g., Flynn, 2003) and knowledge sharing (Hung, Durcikova, Lai, & Lin, 2011; Suh, Cheung, Ahuja, & Wagner, 2017). Individuals prefer social environments that offer them a higher (vs. lower) sociometric status (Anderson et al., 2015). We argue that in a social environment, the feedback that gamification features provide (e.g., activity visualisation, badges) will help individuals to perceive their sociometric status. Formally stated:

H2a: Gamifying user activity feedback within a KMS helps users identify their perceived sociometric status.

3.3 Altruism: Sharing knowledge in a humanitarian context

Like other organisations (e.g., consulting firms), humanitarian organisations are regarded as knowledge-intensive (de Vasconcelos et al., 2006). However, as mentioned above, humanitarian organisations have specific characteristics, such as having to provide emergency operations in technologically challenging environments with a high staff turnover. Furthermore, humanitarian organisations face the paradox of requiring specialized, but participative, knowledge production involving many stakeholders (de Vasconcelos et al., 2006). Researchers argue that in the context of knowledge management for development (KM4D), a transdisciplinary approach that includes societal issues should be followed (Cummings et al., 2013). This brings us to one of humanitarian workers' distinctive characteristics: their altruistic identity (Korff et al., 2015). In line with past research, we refer to altruism as "the degree to which a person was willing to increase other people's welfare without expecting returns" (Hsu & Lin, 2008, p. 68).

Several researchers have investigated altruism's role in knowledge sharing, but their findings lead to mixed conclusions (e.g., Xu & Li, 2015). In some cases, altruism has been found to influence knowledge sharing positively (e.g., Hsu & Lin, 2008; Kankanhalli, Tan, & Wei, 2005), while other researchers have not found a significant impact of altruism on sharing (e.g., Wasko & Faraj, 2005). Gaining a more fine-grained understanding of the link between knowledge sharing and altruism is therefore crucial. We argue that the extent to which and the specificities of the KMS feedback gamification is an important factor affecting this link. Prior research has shown that feedback is an important trigger for altruistic individuals, because it allows them to see how their actions help (Hung et al., 2011; Smith, Keating, & Stotland, 1989). Consequently, the feedback of one's actions through gamification is particularly important for altruistic individuals. This leads us to our last hypothesis:

H2b: Gamifying user activity feedback increases the engagement of more altruistic individuals.

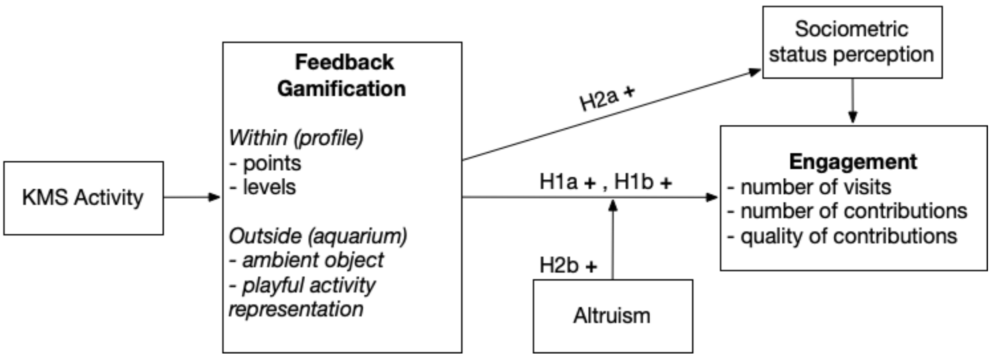

Figure 2. Conceptual model.

4. Design and development

This section presents the artefacts' creation and details the design choices and user validation. More specifically, the objectives were the design of gamification features within and outside the system aimed at providing users with feedback and leveraging their status.

4.1 Designing gamification within a system

We based our design process on five design principles (Zhang, 2008): 1) afford autonomy and the self; 2) afford competence and achievement; 3) afford relatedness; 4) afford leadership and followership; 5) afford affect and emotion.

Based on the literature review and previous iterations with MSF, we started with the idea of adding feedback features, notably about users' sociometric status that would be shown in their personal profiles, which at that stage only comprised a photograph of the user and a short biography. Personalising a profile by means of metrics based on the user activity (e.g., number of posts, time online) and social feedback (e.g., likes, views) is similar to the design principle to *afford autonomy and the self* (principle 1) and *afford competence and achievement* (principle 2). Figure 3.1 shows mock-ups of rating features for comments (arrows up vs. down) and for documents (whether helpful vs unhelpful).

We designed six visual representations of users' contributions to provide a sense of usefulness and their influence on one another (see Table 1 for an overview): Commenter (measures the number and the quality of comments); Influencer (measures others' number of views on the user's content); Contributor (measures the number and the quality of the uploaded resources); Collaborator (measures the number of people with whom the user collaborates); Visitor (measures how often a user is online); and Sharer (measures the amount and the quality of publicly shared content). The quality of these dimensions was measured using sociometric status feedback provided by peers in the form of ratings (e.g., upvotes for comments, number of likes for documents). Besides the six dimensions, we also created an overall score called Graasper (derived from the name of the KMS extended for this project), which groups the six dimensions and provides the users' average performance. These visual representations reflect the fourth principle (*afford leadership and followership*). Figures 3.2 and 3.3 show mock-ups of how the dimensions could be represented.

Table 1. Dimensions of the profile gamification.

Dimension name	**Description**
Commenter	Measures the amount and quality of comments. The quality is measured through the number of upvotes-downvotes per comment.
Influencer	Measures others' number of views of the user's content
Contributor	Measures the number and quality of uploaded resources. The quality is measured by the number of likes per resource.
Collaborator	Measures the number of collaborators (i.e., number of users with whom the user shares a space as editor or owner).
Visitor	Measures how often a user has been online in the previous 30 days.
Sharer	Measures the number and quality of the publicly shared content. The quality is measured by peer reviews (votes for comments, likes of resources).
Graasper	Average of the above dimensions (without decimals)

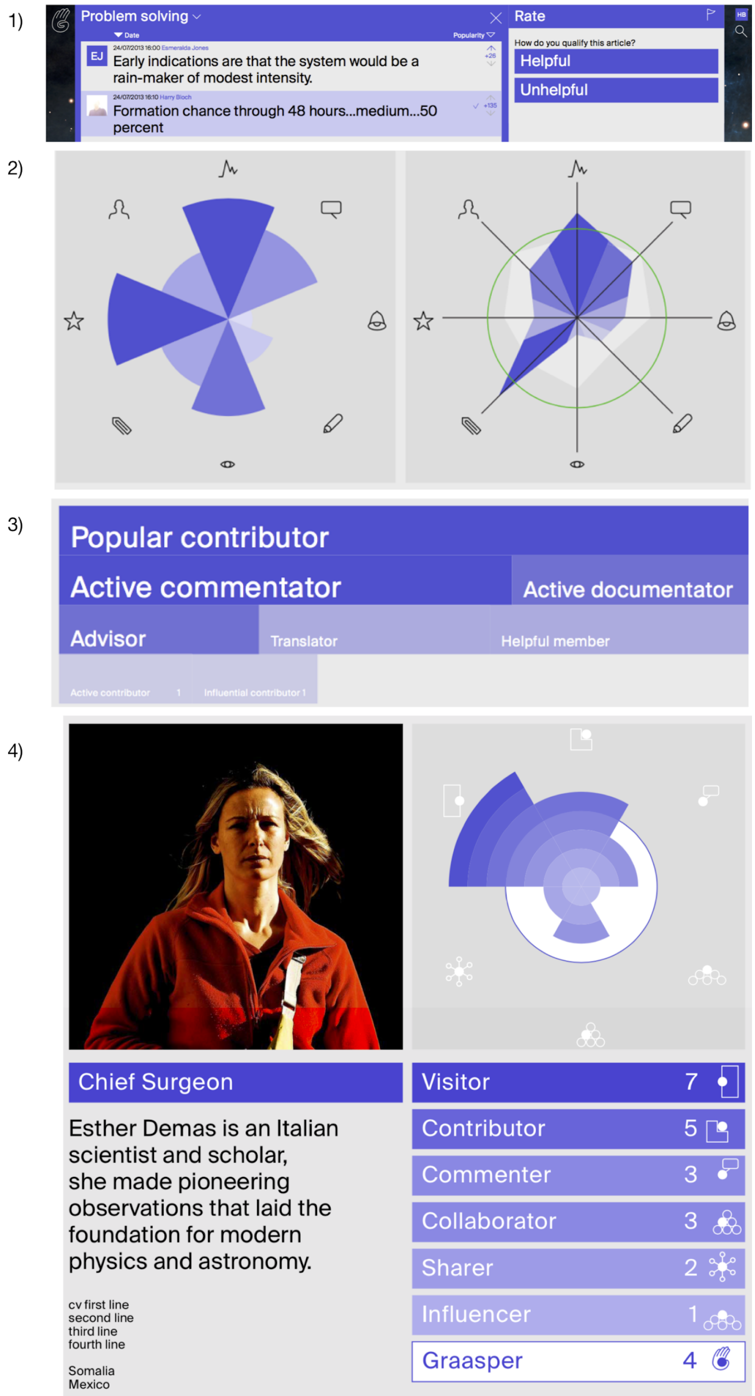

Figure 3: Designs for within-the-system gamification features.

The choice of seven levels (from 1 to 7, 7 being the highest level) was decided with MSF. Each level represents a value relative to others (see the third principle, *afford relatedness*) and not an absolute value. The top level (level 7) is reached by the top 1% of users, level 6 by the next 4% of users, level 5 by the next 20% of users and so on until level 1, which comprises the 5% of users with the lowest score (see Table 2 for the percentile details). Finally, the artefact's design was chosen to respond to the last principle (*afford affect and emotion*). The spiderweb chart creates relatively unique shapes that are associated with users. This structure was intended to create an incentive to complete it and increase engagement. Finally, the design was conceived to avoid negative emotions when users are not performing well. For example, in order to motivate newcomers, the lowest level is level 1 and not 0. Figure 3.4 shows one of the final designs for the user profile; its dimensions are presented separately and in a graph.

Table 2. Mapping between percentiles and the levels of each dimension.

Level (L)	1	2	3	4	5	6	7
Percentile (P)	Bottom 5%	Top 95-75%	Top 75-50%	Top 50-25%	Top 25-5%	Top 5-1%	Top 1%

4.2 Designing outside the system

Ideations of designing gamification features outside the system were much broader in scope. This included ideas about creating connected tangible objects that could be personal (e.g., a stethoscope, a phone case, or a reading lamp) or communal (e.g., an office totem). After several design iterations, an aquarium was chosen, because it is a powerful conveyor of relatedness between users (e.g., fish share a common space, are relatively identical). Moreover, an aquarium fosters a calm relaxing atmosphere (Kidd & Kidd, 1999), but still draws attention. This is particularly important, as the first condition for engagement is the ambient object's visual attractiveness and focus (Pousman & Stasko, 2006). Japanese aquascaping styles (e.g., zen, wabi-sabi) with their minimalist design aimed at inciting a meditative or contemplative mood inspired the aquarium's style. Nevertheless, the different shapes and items still imbue the aquarium with enough complexity to allow the representation of a range of metrics, while the dynamic movements and asymmetries in it draw users' attention. The landscape changes over time, inviting users to stay engaged over a longer period. Since users have to take care of the fish and their environment to keep enjoying the aquarium, it is associated with an aspect of care. The final argument in favour of an aquarium was that it appeared as a culturally neutral object that can be deployed in MSF's various activity regions. Figure 4 shows the aquarium's various design stages. Figure 4.1 shows a preliminary scene design, figure 4.2 early rocks and seaweed designs, figure 4.3 a design iteration for different fish sizes (with the user's Graasper score determining the fish size). Figure 4.4 shows an iteration of the aquarium with fish, rocks and seaweed.

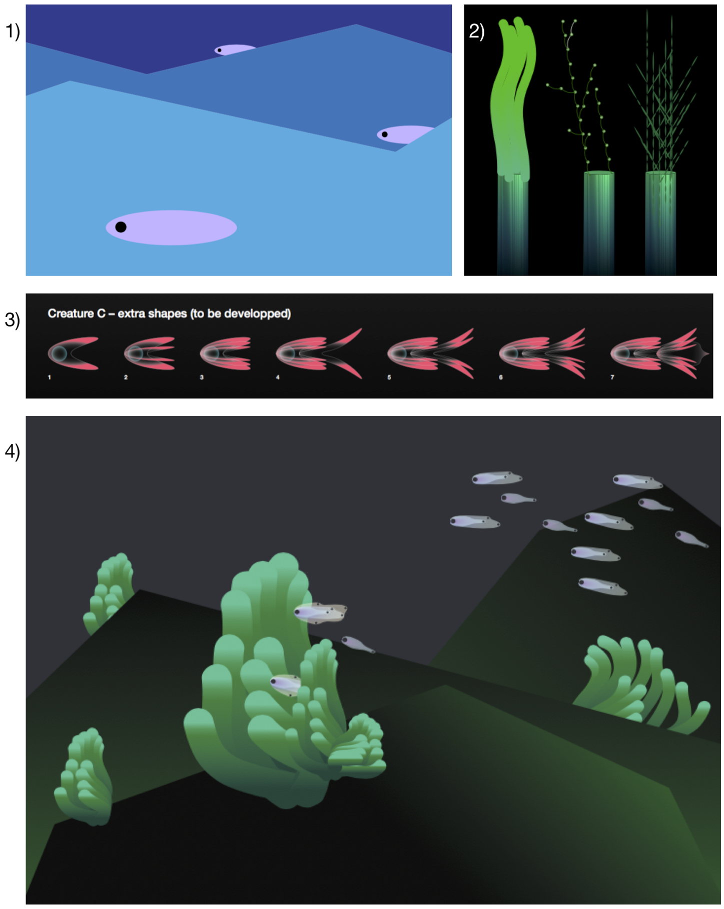

Figure 4. Designs for outside-the-system gamification features.

A virtual aquarium was chosen for convenience in terms of exploitation in the field. An industrial designer created the display as a tangible object that could be placed on a table or hung on a wall, and which would easily fit in the cabin luggage when brought to the field (see Figure 5).

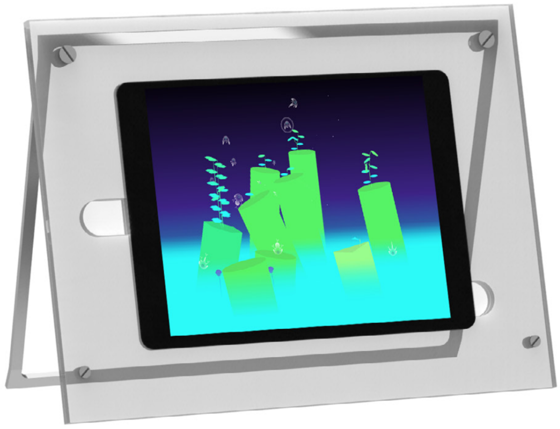

Figure 5: Aquarium shown in the tablet display with specifically designed casing.

Since our digital aquarium's primary purpose is to be displayed in a communal room, such as a shared office, it was designed to reflect the users' activity. The aquarium represents a space (similar to a folder) in the KMS, the fish are user avatars, the rocks are the items and the seaweed represents comments on each of these items. Timely feedback is achieved by updating the aquarium dynamically whenever there is a new comment, document, or user. In general, the fish are anonymous (i.e., there is no constant display of names), but the participants can identify their own fish when they log into their personal profile. The number of fish in one aquarium shows the total number of people working on the same space, while each fish's size represents a user's relative contribution, which facilitates user self-assessment (based on the overall Graasper score).

4.3 Preliminary design feedback

In the early stage of the design phase, we interviewed MSF field staff to evaluate their acceptance of our ideas. We conducted semi-structured interviews with seven individuals (one of whom was female) aged between 30 and 60. The interviewees were from different countries (Cameroon, Nigeria, Niger, Togo, South Sudan, Mozambique, Argentina) and from various backgrounds (e.g., assistant manager, medical leader, pharmacist, IS specialist). The interviewees' attitudes towards gamifying knowledge sharing were generally positive and the idea of an ambient aquarium was well received. A 40-year-old female pharmacist from Togo argued that "mak[ing] [the KMS] a sort of professional toy" was a positive step. A 49-year-old male Nigerian assistant manager stated that "it's going to motivate people; there is an aquarium, here I am, here is my friend. Very good if it exists, it's going to have a lot of success". A 30-year-old male supervisor from Cameroon echoed this comment and thought the aquarium's dynamic part was an advantage, since "being able to create your own fish is interesting, see the others coming close will motivate you to answer to grow. Even when you work, it's captivating". He also pointed out that "there are a lot of people using the machines to play their own little favourite game; so yes, maybe people will come for the game first and then stay for the content. It could be a good factor of motivation". He also argued that the idea of using fish as an ambient visualisation was very good, since "aquariums, even if you don't like fish, attract your eyes, are very attractive". A 60-year-old male Mozambican advisory supervisor found the ambient gamification very appealing, as it could create a team spirit through which "one gets attached to the team and never takes it out of his heart". Nevertheless, there were also negative opinions. The 40-year-old female pharmacist from Togo had some doubts when asked whether the digital aquarium would be useful to motivate people. She said that she could not speak for people in general, "but it does not attract me". A South Sudanese fleet manager thought that adding gamification was unnecessary, as "I don't have time for games, maybe on the weekend at home for leisure". This feedback encouraged us to pursue a gamification approach that leveraged the sense of community (which had already emerged in previous interviews) rather than pure gamification (e.g., displaying leaderboards).

5. Demonstration

In this section, we demonstrate the use of the artefacts to solve instances of the problem. The central component of the KMS, called Graasp, used as a pilot system at MSF, is composed of spaces. As aforementioned, a space can be thought of as a folder where items can be placed and knowledge shared with other members of the space. Figure 6 shows a screenshot of a space in the KMS. Malaria is the name of the space used in the figure. Inside the space, there are several subspaces (i.e., Malaria Treatment, Malaria Monitoring), a file (i.e., Child Malaria.pdf) and a discussion (i.e., Unusual Symptoms). On the right of the figure, there is a list of users who have access to the space.

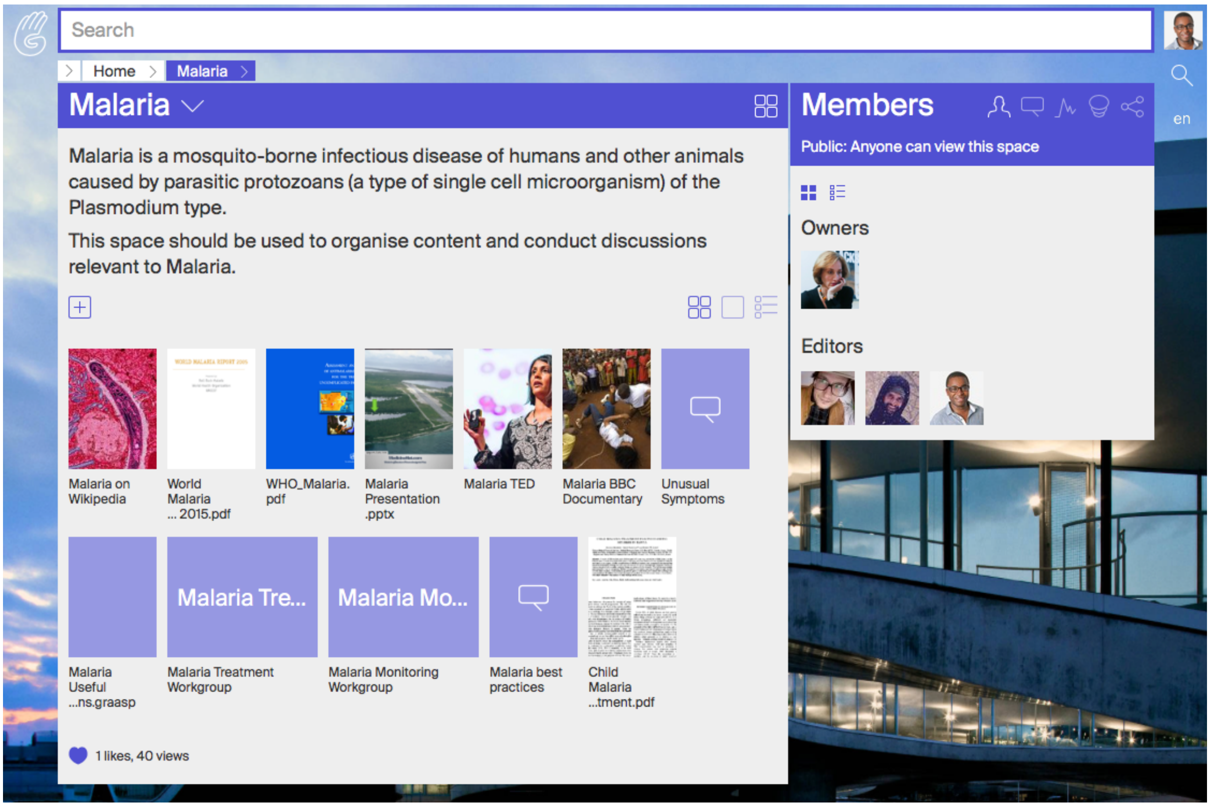

Figure 6: Screenshot of a space in the KMS.

5.1 Gamified profile in the KMS

The implementation phase lasted four months and overlapped with the design phase. Over this time, iterations led to adjustments to the designs, technical limitations, resource constraints and usability concerns. A significant part of the implementation effort was dedicated to setting up the analytics in the back end to ensure that the different metrics were recorded and computed.

5.2 Gamified aquarium in the KMS

The aquarium was implemented on a separate web page that could be directly accessed through the KMS. The MSF workers navigating the KMS could access the aquarium through a dedicated link. A professional media-interaction designer developed the aquarium software. A key development challenge was to capture realistic fish behaviour and plant movements that would scale since MSF missions can range from a few individuals to dozens of participants. We undertook iterations to refine the algorithms in order to validate the requirements. The aquarium link is only accessible to the associated shared space's members, who can decide to display it publicly in a physical place, such as a mission office, or not. We conducted an AttrakDiff survey with 91 users (19-37 years old, mean age 22, 52% female, participants from section 6.3) to obtain feedback on the aquarium's aesthetic aspects. The AttrakDiff survey measures an artefact's attractiveness by means of pragmatic and hedonic factors (Hassenzahl, Burmester, & Koller, 2003). The results in Table 3 show that the aquarium was rated positively on most dimensions. It was considered particularly imaginative, stylish and simple. These results validated our design and implementation choices.

Table 3. Results of the AttrakDiff questionnaire (scales ranging from 1 to 7).

Attractiveness (ATT)	Bad (1)	Good (7)	Mean (SD)	5.22*** (1.22)
	Ugly (1)	Attractive (7)	Mean (SD)	4.82*** (1.50)
Hedonic Quality - Identity (HQ-I)	Unimaginative (1)	Imaginative (7)	Mean (SD)	5.79*** (1.25)
	Dull (1)	Captivating (7)	Mean (SD)	5.16 (1.17)
Hedonic Quality - Stimulation (HQ-S)	Tacky (1)	Stylish (7)	Mean (SD)	5.30*** (1.54)
	Cheap (1)	Premium (7)	Mean (SD)	4.13 (1.28)
Pragmatic Quality (PG)	Unpredictable (1)	Predictable (7)	Mean (SD)	4.00 (1.67)
	Confusing (1)	Clearly structured (7)	Mean (SD)	4.99*** (1.2)
	Complicated (1)	Simple (7)	Mean (SD)	5.71*** (1.33)
	Impractical (1)	Practical (7)	Mean (SD)	4.90*** (1.41)

***p < .001, N=91

6. Evaluation

In the following, we compare the objectives of a solution to actual observed results from the artefact's use. We evaluate whether the designed gamification features support the hypotheses in Section 3 (see Table 4 for an overview of all the results). We also report on the usability evaluation of the gamified aquarium by MSF field staff in Kampala, Uganda.

6.1 Does the gamified profile lead to more engagement with the KMS (H1a)?

To test if gamifying the user profile triggers a behavioural change, we performed a field experiment. The gamified feedback feature (i.e., the visualisation of the profile) was available to half of the users randomly selected over a three-month period. A total of 458 users were active during this period (226 were assigned to the control group and 232 to the treatment group). As engagement variable, we measured the number of visits to the platform (i.e., the number of visits during the previous 30 days).

As expected, there was no significant difference in the two groups' number of visits in the month prior to the experimental manipulation. However, the results of a regression with robust standard errors showed that the profile's introduction positively impacted the number of visits by the individuals in the treatment group (TG) who could see their profile compared to the control group (CG), who could not ($M_{TG} = 5.04$, $SD_{TG} = 5.96$ vs $M_{CG} = 2.63$, $SD_{CG} = 3.69$, b = 1.81, $p = .001$). We ran this analysis by including the number of visits prior to the experimental manipulation as a control variable, since this variable is a predictor of the number of subsequent visits.

To test our findings' robustness, we tested two alternative models. Firstly, we added the interaction between the experimental manipulation and the number of visits. This interaction was not significant (b = .19, p = .26). Secondly, to test for extreme values' impact, we transformed both variables into quantile splits (variables between 1 and 5, splitting the data into quantiles). The regression results remained similar (b = .47, p = .003).

These findings show that adding a gamified profile increases participants' actual engagement in a KMS, thus supporting H1a.

6.2 Does a gamified profile help users identify their perceived sociometric status in a KMS (H2a)?

To understand the link between gamification and the perception of a user's profile, we evaluated how individuals responded to the gamified personal profile, its six dimensions and the total (Graasper) score. Firstly, we were interested in understanding if a profile's total score would be linked to users' perception of their sociometric status. Secondly, we evaluated if individuals understood the profile's various dimensions. Lastly, we were interested in knowing how specific profiles would be perceived (Appendix 1 details the questions that the online respondents were asked).

We conducted a survey with 156 online-recruited individuals (19-65 years old, mean age 32, 42% female). After a short introduction describing the KMS, we randomly presented the profile's different dimensions and the total score to the respondents. A short description (the one used on the actual KMS) was given of each dimension. We then asked the respondents to evaluate (on a scale from 1 = completely disagree to 7 = completely agree, with 4 as the midpoint) a series of statements about each dimension and the total score.

In the second part of the survey, the respondents were exposed to one of four fictitious profiles. The profiles were either presented with a photo of a female or a male (both with the same name and an identical short description; see Figure 3.4 for the female profile) and the score of the profile was either low (i.e., total score of 2) or high (i.e., total score of 6). After exposing the respondents randomly to one of the four profiles, we asked them four questions to determine whether they would evaluate a profile with a high score as someone sharing more with others and with a high level of sociometric status. The last question was whether having this type of personal profile would motivate individuals to contribute to the KMS.

Evaluation of the total sociometric status score. Two statements tapped into the sociometric status that we hoped to create with the total score. The first statement asked whether "A high score on this dimension would indicate that someone is respected by their peers" and the second was whether "A high score on this dimension would indicate that someone is a good member of the community". Both items were statistically higher than the midpoint (M = 5.26, SD = 1.42, $t(155)$ = 11.15, $p < .001$ and M = 5.51, SD = 1.27, $t(155)$ = 14.85, $p < .001$).

Evaluation of the dimensions for understanding. The purpose of these analyses was to determine whether the respondents would understand the different dimensions well. A series of t-tests revealed that all of the dimensions and the total score were rated significantly higher in terms of their understandability than the midpoint of the scale (means ranging from 5.2 to 6.13, all p values < .05).

Perception of a profile. A 2 (gender: male vs. female) x 2 (score: high vs. low) between-subjects ANOVA revealed that only the score had a main effect on perceptions of sharing ($F(1, 152)$ = 123.52, $p < .001$). More precisely, the profiles with a high score were perceived as sharing more (M = 6.42, SD = .85) compared to profiles with low scores (M = 4.38, SD = 1.36, ($t(154)$ = 11.18, $p < .001$). We also asked two questions about the sociometric status of the individual depicted in the profiles (respected by their peers; a good member of the community). The results showed that the score had a main effect on both variables ($F(1, 152)$ = 114.51, $p < .001$; $F(1, 152)$ = 114.82, $p < .001$). More specifically, the profiles with higher scores were perceived as more respected (M = 6.12, SD = .93) and better members of the community (M = 6.31, SD = .86) than profiles with a lower score (respectively M = 4.27, SD = 1.21, $t(154)$ = 10.71, $p < .001$; M = 4.46, SD = 1.25, $t(154)$ = 10.78, $p < .001$).

In a last step, an ANOVA revealed that only the score had a main effect ($F(1,152)$ = 102.95, $p < .001$) on the perceived motivation to contribute to the KMS. More specifically, the respondents indicated that having a profile like the depicted one would be more motivating to contribute to the KMS if the profile had a high score (M =5.95, SD = 1.36) than if its score was low (M = 3.71, SD = 1.40, ($t(154)$ = 10.15, $p < .001$).

These results demonstrate that individuals understand the dimensions and the profiles' total score. Moreover, a profile with a high score (positive feedback), indicating a higher sociometric status (thus supporting H2a), would motivate individuals to contribute to a KMS. Gender had no main effect (the male and female profiles were evaluated similarly) and there was no interaction between the gender and the score.

6.3 Does the gamified aquarium lead to more engagement with a KMS (H1b)?

We performed a lab experiment to test the aquarium's influence on the participants' motivation to contribute. We designed a specific task for this experiment, asking the participants to play the role of a digital humanitarian - a new type of humanitarian actor that social media and crowdsourcing software have allowed to emerge. Digital humanitarians are volunteers who, working from their homes or offices around the world, use geolocation, mapping, data cleaning, translation, and social media to collect and organise data. Their gathered knowledge is put online and made accessible to humanitarian stakeholders. Researchers argue that these humanitarian actors' actions can change the way humanitarian relief is conducted (Meier, 2015), which offers opportunities, but also new challenges (e.g., some volunteers might not fully understand the humanitarian context; Morrow, Mock, Papendieck, & Kocmich, 2011). Nevertheless, there is little research on these groups and their contribution to humanitarian activities (Sandvik et al., 2014).

By means of a university's subject pool, we recruited 184 participants (18-41 years old, mean age 22, 44% female). They were asked to gather online resources (e.g., images, videos, web links, maps, tweets) about Tiburon, a small village in Haiti badly affected by hurricane Matthew. The intention was to support the MSF staff before they were deployed. The participants were instructed to place their gathered resources in a space in the KMS and to provide comments explaining their contributions' relevance. As a final task, the participants had to comment on and rate additional items (all of the participants had to rate the same ones) already in the space. Half of the randomly selected participants were in the "aquarium condition", meaning that a screen displayed the aquarium (the ambient object visualising the activity in the space) next to their working screen. The other half were in the control group with no visualisation. To assess the user engagement, we measured the number of new items the users added. We also monitored the number of comments on the new items, on the items already in the space as well as the number of likes of items already in the space. Furthermore, two experts assessed the quality of the new items that participants had added (r = .78) and the quality of the participants' overall contribution, taking the added new items' quality and quantity into account as well as the quality of the comments on items already posted in the space (r = .60).

We also assessed the participants' altruism, choosing a measure of altruism specifically linked to our context. We questioned the participants in respect of their willingness to spend time on a task linked to a humanitarian action. At the beginning of the experiment, the participants were told that the experiment's last task was optional, but that they would help the researchers by completing it. This optional task consisted of the evaluation of a set of humanitarian NGOs. Each evaluation would take around 45 seconds and the participants had to indicate beforehand how many evaluations they were willing to complete (0-20). The more tasks the participants were willing to complete, the more altruistic they were considered.

To test the hypothesis on whether the aquarium condition leads to more contributions, we ran a multivariate regression with the four measured variables described above (i.e., the number of items, number of comments on new items, number of comments on items already in the space, number of likes of items already in the space). We found that the manipulation had a significant effect on the number of new items ($M_{CG} = 3.02$, $SD_{CG} = 2.65$ vs. $M_{TG} = 4.33$, $SD_{TG} = 2.81$, b = 1.31, $p = .002$) and on the number of comments on the new items ($M_{CG} = 1.94$, $SD_{CG} = 1.98$ vs. $M_{TG} = 3.58$, $SD_{TG} = 2.73$, b = 1.64, $p < .001$), and a marginally significant effect on the number of likes of the items already in the space ($M_{CG} = 1.60$, $SD_{CG} = 1.32$ vs. $M_{TG} = 1.99$, $SD_{TG} = 1.66$, b = .38, $p = .098$). There was no effect on the number of comments on items already in the space ($M_{CG} = 2.90$, $SD_{CG} = 2.30$ vs. $M_{TG} = 2.45$, $SD_{TG} = 2.04$, b = -0.45, $p = .18$). Our manipulation, or the simple fact that there were more items to comment on, could explain the number of comments on the new items. To assess this alternative explanation, we used a structural equation model (mediated regression). In the fully saturated model, the manipulation still predicts the creation of new items (b = 1.31, $p < .01$). The manipulation (b = .79, $p = .01$) and the creation of new items (b = .64, $p < .001$) explain the commenting. Consequently, when the ambient object is present (aquarium condition), individuals tend to create more new items and comment more. It could also be argued that participants in the aquarium condition simply added irrelevant items or comments.

However, the analysis of the quality of the new items that the participants added did not show a statistical difference between the two groups. The quality of the participants' overall contribution even showed a statistically significant improvement in the aquarium condition ($M_{CG} = 2.22$, $SD_{CG} = 0.83$ vs. $M_{TG} = 2.51$, $SD_{TG} = 0.76$, $t(167) = -2.372$, $p = .019$), thus supporting H1b.

6.4 Does feedback gamification lead altruistic individuals to contribute more than others (H2b)?

Finally, we tested if altruism ($M = 14.65$, $SD = 6.49$) influenced the relationship between the manipulation and the creation of new items. We did so by running a moderated regression with robust standard errors and found a significant interaction between altruism and our manipulation (b = .12, $p = .046$), as illustrated in Figure 7. If a regression of altruism is run on the number of new items within each subgroup, altruism's effect is only significant in the aquarium condition, but not in the control condition.

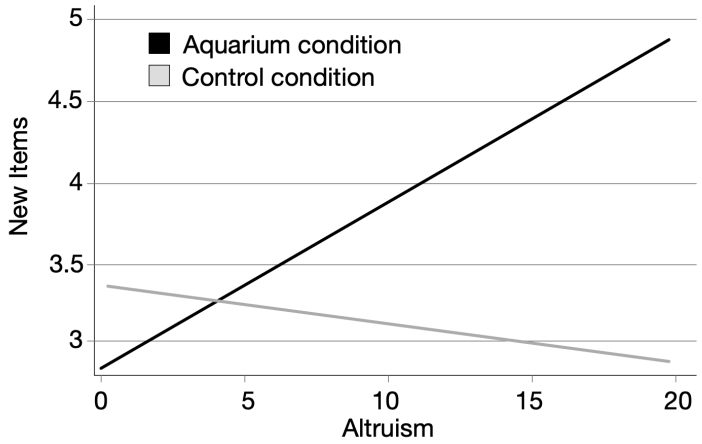

Figure 7: Fitted values in the graph represent the dependent variable: new_items.

In other words, when exposed to feedback gamification outside a KMS (ambient visualisation), altruistic individuals are willing to contribute more, thus supporting H1b.

6.5 How is the gamified aquarium perceived in the field?

We performed a final field study to validate the aquarium's usability and to gather informed insights into its usage in the humanitarian environment. This study was performed at MSF's office in Kampala, Uganda. Two groups of 12 people each participated in the experiment, which was performed during a two-week field training session. The course material for the training sessions was uploaded and made accessible on the KMS. The aquarium shown in the tablet display was set on a table in the classroom without any explanation being added over the duration of the training sessions. In each course, a group of participants inquired about the artefact and the knowledge manager explained its purpose. Some participants played with it casually throughout the week. At the end, we conducted semi-structured interviews with several of the participants to obtain further insights. The semi-structured interviews lasted an hour each and included seven people (one female) between 26 and 42 years old. All of the participants were positive about the aquarium's visual attractiveness. A 42-year-old French logistician described the artefact as "very simple and well designed". A 42-year-old Mozambican logistician thought it was visually appealing "because of the animation". A 32-year-old French female human resources manager commented that it was "beautiful and well designed".

The participants also maintained that the visual appeal led to curiosity, engagement and, eventually, to contribution. A 37-year-old French finance manager argued that the artefact would "attract people to come often" and a 26-year-old driver from Mozambique said that it would make people "stay connected". The logistician from Mozambique found that "the positive aspect is to have a visual alert on potential activities happening in [the KMS spaces] and be attracted to go and see what is happening or reply". A 39-year-old Mozambican geographical information system assistant thought that it "motivates people to react in the spaces" and a 29-year-old Ukrainian head of logistics argued that the artefact had "good animation and [was] attractive to people to contribute". A 42-year-old French logistician thought the negative aspect could be "the addiction" that it could cause. The knowledge manager thought the aquarium was far more useful for visualizing activities in the space "than receiving a mail notification". Interestingly, the participants also suggested improvements to the artefact. For instance, several participants expected the screen to take them directly to the corresponding space if they touched an item. If this were implemented, the aquarium could become an active alternative user interface in the system.

7. Discussion and conclusion

This research is a design science journey based on Peffer et al.'s (2008) DSRM process. More specifically, this project covered the whole DSRM cycle by first investigating the knowledge sharing problem with end users in an authentic setting, by defining objectives of a solution, by designing and implementing artefacts and by evaluating their impact. An interdisciplinary team of researchers was involved in this design science journey with frequent feedback loops and adjustments of the initial ideas.

To increase the user engagement with a KMS, a gamified artefact was created and deployed via a personal profile. This profile allowed users to receive feedback on their activity and to assess their sociometric status. We conducted an online survey to test the users' understanding and the effectiveness of this artefact. In addition, we undertook a controlled field study over a three-month period, exposing half of the KMS's users to this gamified profile. Our results, summarized in Table 4, show that the profiles communicated the intended feedback and led to an increased engagement with the KMS. We also investigated whether adding feedback gamification outside a KMS by using an ambient artistic object (a virtual aquarium) would engage users further. After a first positive response to the ambient object in a controlled experiment, we used it in a field study, which confirmed its positive impact.

From a theoretical perspective, this research contributes to the literature in several ways. In terms of DSRM, our article is a direct response to the recent call for additional design science studies in the IS literature (Goes, 2014). Following Peffers et al. (2008), we adopted an agile approach by evaluating and validating each step of the process and not just the designed artefact. Even though agile approaches are sometimes still a fashion trend (Cram & Newell, 2016), they are, with regard to software development (e.g., SCRUM) and product innovation (e.g., Lean Startup), becoming standard practice in many companies. Contrary to past design science research, which has often overlooked the importance of aesthetics in its processes (Baskerville, Kaul, & Storey, 2018), our design science journey strongly emphasises appealing aesthetics. We included professional graphical, industrial and media interaction designers throughout the entire DSRM cycle. By doing so, our artefacts provided not only truthful and useful feedback, but also created an emotional connection with users. The current knowledge management literature lacks a deep understanding of how to encourage users to share more. This research provides insights into how knowledge sharing can benefit from well-designed artefacts. Helping other users is a key motivational factor and gamification can be used to cater for this need. Our research uses control groups and multidimensional metrics previously lacking in gamification studies. To the best of our knowledge, we are therefore the first to develop, implement and measure the impact of feedback gamification on users' perception of their sociometric status and behaviour. Our artefacts were specifically developed to reflect sociometric status, which depends on an individual's activities and on others' response (measured by digital feedback, such as likes and upvotes).

Altruism is an important aspect of humanitarian action; we therefore evaluated its effect on knowledge sharing and its interaction with gamification. We found that feedback gamification has a significant positive effect on altruistic individuals' contributions, but, in the control condition, there is no difference between more altruistic and less-altruistic individuals in terms of their contributions. This finding diverges from previous research observing a positive association between altruism and contribution (Kankanhalli et al., 2005; Hsu & Lin, 2008), but is, however, similar to the work of Xu and Li (2015) and of Wasko and Faraj (2005). Our results showed that altruism per se is not sufficient to foster contributions. In this respect, we argue that feedback, notably on users' sociometric status, could be one of the factors explaining past research's mixed results. Altruistic contributors need, in some or other way, to see the impact of their work, which is in line with Hung et al. (2011, p. 423), who argue that "[a]ppropriate feedback would allow people to understand that sharing their knowledge helps others". Since gamification can include some aspects of extrinsic rewards, this finding is important, because extrinsic organisational rewards can undermine altruism (Zhao, Detlor, & Connelly, 2016). The results are particularly encouraging in a work environment like that of MSF, in which altruism is an important part of its staff identity.

From a practical perspective, our close collaboration with MSF allowed us to investigate a crucial and understudied side of knowledge management. We produced research output that stakeholders on the ground not only informed and validated, but that has practical applications for MSF and other humanitarian agencies. By doing so, we have improved the efficiency of the high impact work that humanitarian organisations undertake.

Future research should aim to verify our results and address our study's limitations. Even though we included various groups in our research (e.g., MSF staff, students, online panels), our fieldwork is inherently linked to MSF's specific situation. Other humanitarian organisations (e.g., in other contexts with alternative organisational structures, norms and incentives) could react differently to gamification features. Furthermore, design choices, no matter how informed by theory or iterative feedback, result in a defined set of solutions covering only parts of the design space, which is an inherent limitation of the design science approach. Future research should explore other parts of this design space to find alternative solutions. Other research avenues could, however, build on the knowledge gained in this study and explore gamification's negative effect. For instance, in certain situational contexts and in respect of users with certain personality traits, gamification could cause addiction and anti-social behaviour (Blackwell, Leaman, Tramposch, Osborne, & Liss, 2017). Finally, some of our respondents suggested that the ambient object should be investigated in greater detail to become a potential tool for accessing documents and posting comments. The gamification feature could therefore become the entry point to an actual system and not the other way around.

Table 4. Overview of the research results

Research Goal	Methods	Findings
Test H1a. Gamifying user activity feedback within a KMS improves their engagement with it.	**Experimental design.** A/B testing on actual platform users. Half assigned to the treatment group. DV: Number of visits to the KMS as measure of user engagement. Control variable: Number of visits before. N (%Female) =458 (n/a) Age range (mean): n/a	The results of a regression with robust standard errors show that the introduction of the profile positively impacted the number of visits for the individuals in the treatment group (M_{TG} = 5.04, SD_{TG} = 5.96) compared to the control group (M_{CG} = 2.63, SD_{CG} = 3.69, b = 1.81, $t(331) = 3.28$, $p = .001$). Note that users who did not click on their profiles were removed from the analysis. Model: $F(2,331) = 38.85$, $p = .001$, $R^2 = .24$ **H1a supported**
Test H2a. Gamifying user activity feedback within a KMS helps users identify their perceived sociometric status.	**Quantitative online surveys.** Survey with online respondents. The survey exposed participants to different gamified profiles and enquired about understanding and perceptions. DV: Perceptions of sociometric status Other DV: Perceptions of motivation to contribute to the KMS N (%Female) =156 (42%) Age range (mean): 19-65 (32)	The profiles with higher scores were perceived as being more respected (M = 6.12, SD = .93) and being better members of the community (M = 6.31, SD = .86) than the profiles with lower scores (M = 4.27, SD = 1.21, $t(154) = 10.71$, $p < .001$; M = 4.46, SD = 1.25, $t(154) = 10.78$, $p < .001$). Model "respected by peers": $F(1, 152) = 114.51$, $p<.001$, $R^2 = .43$; Model "better member of community": $F(1, 152) = 114.82$, $p<.001$, $R^2 = .43$ **H2a supported** An ANOVA showed that a profile with a high score (positive feedback) was perceived as more motivating to contribute (M = 5.95, SD = 1.36) than a profile with a low scores (M = 3.71, SD = 1.40, $t(154) = 10.15$, $p < .001$). Model: $F(1, 152) = 102.95$, $p<.001$, $R^2 = .41$
Test H1b. Gamifying user activity feedback outside a KMS improves their engagement with it.	**Experimental lab study.** Half the participants were assigned to a treatment group (TG) and exposed to the gamification condition and half of the participants were in the control group (CG). DV: Number of new items added as a measure of user engagement Additional DVs: Number of comments added on new items, Number of likes on items already in the space, Number of comments on items already in the space. N (%Female) =184 (44%) Age range (mean): 18-41 (22)	Number of new items is higher in the TG (M_{TG} = 4.33, SD_{TG} = 2.81) than in the CG (M_{CG} = 3.02, SD_{CG} = 2.65, b = 1.31, $t(167) = 3.13$, $p = .002$) Model: $F(2, 167) = 9.77$, $R^2 = .06$, $p = .002$ **H1b supported** Number of comments on new items is higher in the TG (M_{TG} = 3.58, SD_{TG} = 2.73) than in the CG (M_{CG} = 1.94, SD_{CG} = 1.98, b = 1.64, $t(167) = 4.47$, $p <$ .001) Model: $F(2, 167) = 19.95$, $p < .001$, $R^2 = .10$ Number of likes on items already in space is marginally higher in the TG (M_{TG} = 1.99, SD_{TG} = 1.66) than in the CG (M_{CG} = 1.60, SD_{CG} = 1.32, b = .38, $t(167) = 1.67$, $p = .098$) Model: $F(2, 167) = 2.77$, $p = .098$, $R^2 = .01$ No effect on number of comments on items already in space (M_{CG} = 2.90, SD_{CG} = 2.30 vs. M_{TG} = 2.45, SD_{TG} = 2.04, b = -.45, $t(167) = -1.34$, $p = .18$) Model: $F(2, 167) = 1.80$, $p = .18$, $R^2 = .01$
Test H2b. Gamifying user activity feedback increases the engagement of more altruistic individuals.		A moderated regression found no main effect of altruism (b = -.02, $t(165) = -.53$, $p = .59$), nor gamification (b = -.49, $t(165) = -.51$, $p = .61$). However, we found a significant interaction between altruism and gamification (b = .12, $t(165) = 2.01$, $p = .046$). If we run a regression of altruism on the number of new items within each subgroup, the effect of altruism is only significant in the gamification condition, but not in the control condition. Model: $F(3, 165) = 4.66$, $p = .0037$, $R^2 = .08$ **H2b supported**

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Appendix 1

The following questions were asked in the online survey in respect of each of the 6 dimensions and the total score (Collaborator, Visitor, Sharer, Contributor, Commenter, Influencer, Graasper) on a scale from 1 = completely disagree to 7 = completely agree, with 4 as the midpoint:

Concerning the [name of the dimension] dimension above, you would say that: “This dimension is understandable”, “This dimension is useful to motivate people to contribute”, “I would like to have a good score on this dimension”, “A high score on this dimension would indicate that someone is respected by their peers”, “A high score on this dimension would indicate that someone is a good member of the community”.

The following questions were asked in the online survey in respect of each profile (male vs. female / high vs. low score) on a scale from 1 = completely disagree to 7 = completely agree, with 4 as the midpoint. Note that Cameron Paterson was the name chosen for the profile: “I believe that Cameron Peterson is respected by peers”, “I believe that Cameron Peterson is a good member of the community”, “Cameron Peterson is the kind of colleague to share knowledge with others”, “Having a profile like Cameron Peterson would motivate me to contribute to the platform”.