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# The Impact of Crowdsourcing on Organisational Practices: The Case of Crowdmapping

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# THE IMPACT OF CROWDSOURCING ON ORGANISATIONAL PRACTICES: THE CASE OF CROWDMAPPING

*Complete Research*

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## Abstract

*In this paper, we investigate the possible impact of crowdsourcing on organisational practices. We answer the research question of whether and to what extent the practices of crowdmapping impact humanitarian organisations. To answer this question, we examine a crowdmapping initiative during a natural disaster. The data collection is based on forty interviews with different actors including crowd-mappers, humanitarian organisations, government specialists and technology providers. Concepts from structuration theory are applied to conceptualise and make sense of the data. The findings reveal the process of change that took place in the practices of a humanitarian organisation. They also show that these changes recursively impacted the practices of crowdmapping. We then argue that there is a duality of change between the micro-practices of crowdmapping and the macro-practices of a humanitarian organisation. The implications of the study on research and practice are then discussed.*

*Keywords: Crowdsourcing, crowdmapping, disaster management, structuration theory, OpenStreetMap (OSM).*

## 1 Introduction

The phenomenon of crowdsourcing has emerged in the last few years, building on the advancements in digital infrastructures and social computing, and specifically web 2.0 technologies. Authors argue that the proliferation of online crowdsourcing platforms has made it more accessible and simpler for individuals to become involved in different types of crowdsourced initiatives (Boudreau and Lakhani, 2013; Brabham, 2013). Furthermore, they argue that the transformational capabilities of these technologies make it possible to access the intellectual property of the masses (Oestreicher-Singer and Zalmanson, 2013; Tilson et al., 2010; Yoo, 2010; Yoo et al., 2012). Crowdsourcing is characterised by having a large number of volunteers who participate in an online activity. In their extensive review of the different definitions of crowdsourcing that have appeared in the literature, Estellés-Arolas and González-Ladrón-de-Guevara (2012), presented a comprehensive definition of crowdsourcing. They stated that crowdsourcing is “*a type of participative online activity in which an individual, an institution, a non-profit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task*” (Estellés-Arolas and González-Ladrón-de-Guevara, 2012, p. 197).

Crowdsourcing “*has seen its wide applications in practice and is yet to receive intense attention from the scholars*” (Zhao and Zhu, 2014, p. 417). The related literature emphasises that the expansion of

crowdsourcing capabilities could have important implications for solving the most enigmatic problems that face society (Boudreau and Lakhani, 2013; Brabham, 2008a; Majchrzak and Malhotra, 2013). These claims are based on observations and reflections on instances in which crowdsourcing is believed to have made a difference. Nevertheless, there is little understanding of the kind of difference crowdsourcing could possibly make, and of how and why these differences could be realised. It is not clear how and why this micro-level capability could have a significant organisational and/or societal impact. An in-depth understanding of the outcomes and changes that can be realised through crowdsourced initiatives is needed to better understand their transformational properties and how organisations could benefit from them (Pedersen et al., 2013; Tarrell et al., 2013). There has also been a call within the IS literature for the discipline to broaden its horizons and focus on societal issues (Majchrzak et al., 2012). Further arguments have been made for the literature to expand its agenda to understand whether ICTs are making the world a better place (Walsham, 2012). To this end, this study questions whether and to what extent the practices of crowdmapping impact humanitarian organisations. A case study of crowdmapping during a natural disaster is examined. Structuration theory is applied as a theoretical lens and ‘sensitising device’, as elucidated by Klein and Myers (1999), through which the impact of crowdmapping may be understood and explained.

The remainder of the paper is as follows. The second section presents a brief literature review of crowdsourcing with a particular focus on crowdmapping. The third section reviews the concepts adopted from structuration theory. The fourth section presents the research methods, whilst the fifth presents the case description. The sixth section presents the analysis, whilst the seventh, besides further discussing it, also presents the conclusion and contributions of the study.

## **2 Literature Review**

This section presents a brief literature review of the disaster management, crowdsourcing and crowdmapping literatures that informed this study.

### **2.1 Disaster Management**

The disaster management literature acknowledges that disasters go through four main phases; mitigation, preparedness, response, and recovery (Neal, 1997). Various actors are involved during these different stages, including a large number of temporary workers and volunteers in both official and unofficial capacities, government and humanitarian organisations, national and international NGO’s, local and national communities, private organisations, the media, political parties, the general public and the victims (Ainuddin and Routray, 2012; Ha, 2012; Mallick et al., 2005; Shaw, 2006; Sutton et al., 2008). Mallick et al. (2005) emphasised the importance of disaster preparedness and stated that effective disaster management relies on the participation of various actors. The role of technology is traditionally highlighted as an enabler for effective communication between the different actors at the different stages of disaster management. However, rapid technological advancements and their use are understood to be providing more opportunities for the rapid broadcasting of disaster events, situational awareness, and involvement of the public in response efforts (Majchrzak and More, 2011; Sutton et al., 2008).

### **2.2 Crowdmapping as a Case of Crowdsourcing**

The IS literature concerning crowdsourcing is very much in its nascent stages. The existing literature tends to focus on areas such as conceptualisation, systems and application (Zhao and Zhu, 2014). Conceptualisation is the area in which there is a focus on better understanding exactly what crowdsourcing is and how it differs from similar concepts (Brabham, 2008a, 2008d; Howe, 2006, 2008). Systems research looks at the structures and components of crowdsourcing systems (Doan et al., 2011; Kazman and Chen, 2009; Kittur et al., 2011). Application research examines how crowdsourcing is applied in different circumstances and for different purposes (Brabham, 2008a, 2008d, 2009). Although some IS crowdsourcing studies are theoretically driven, they lack in their use of social theory. This study argues

that, because crowdsourcing is a social phenomenon, it would be better understood through a social theoretical foundation. In particular, the literature lacks focus on the outcomes or changes that are realised through crowdsourcing (Pedersen et al., 2013).

Crowdmapping has been defined in many different ways; this study adopts the following definition of crowdmapping as *“the aggregation of crowd-generated inputs such as text messages and social media feeds with geographic data to provide real-time, interactive information on events such as wars, humanitarian crises, crime, elections, or natural disasters (the results are sometimes referred to as crisis maps)”* (Quaintance, 2014). The 2010 Haiti earthquake is one of the first examples of a disaster that involved crowdmapping and crowdsourcing in general. Yates and Paquette (2011) undertook participative action research during the 2010 Haiti earthquake and found that social media technologies held great promise for assisting public participation in disaster management. Also, Starbird and Palen (2011) conducted an analysis of the use of social media during the same natural disaster and found that Haiti’s condition of being an underdeveloped nation with a serious lack of available mapping data meant that humanitarian organisations could not develop a good understanding of where assistance should have been delivered. After Haiti, the potential of crowdsourced online mapping emerged as a potential avenue of interaction and representation of disaster areas (Zook et al., 2012). In essence, literature on crowdmapping is emerging, albeit being mostly descriptive in nature and lacking in-depth analysis and theoretical conceptualisation.

### 3 Theoretical Foundation

This study adopts concepts from structuration theory as the theoretical lens through which the impact of crowdmapping will be traced and understood. Structuration theory addresses and explains change, and therefore lends itself well to exploring the problem at hand. It was developed by Anthony Giddens and has been applied to many fields, including IS (Jones and Karsten, 2008; Walsham and Han, 1991, 1993) and organisational studies (Barley, 1986, 1990; Barley and Tolbert, 1997). Despite Giddens stating that structuration theory should be used as a ‘sensitising device’, Turner (1986), argued that the theory offers many detailed and comprehensive insights into the dynamics and properties of social action and interaction for it to be considered merely a ‘sensitising device’. Although the IS discipline has developed various adaptations of the theory, Jones and Karsten (2008), argued that few of these have shown a close relationship with Giddens original formulation of structuration theory. For example, Adaptive Structuration Theory (AST), which has had an important and significant influence on overall structural IS research, has been argued by authors including Jones (1999) and Pozzebon and Pinsonneault (2001) to be significantly diverging from structuration theory’s original position. This is because AST holds the view that structure can be embodied within technology, whereas Giddens vehemently argued against materiality embodying structure (DeSanctis and Poole, 1994; Giddens, 1984). The sections that follow briefly present the concepts of duality of structure and modalities of structuration, therefore highlighting this study’s application of the theory in its more original sense.

#### 3.1 Duality of Structure

Structuration theory maintains that social life cannot be explained by either micro-level activities or macro-level forces. Agency and structure are in a recursive relationship that could reproduce or change them. It argues that agency and structure are mutually constituted. Structure is not independent of agency and agency is not independent of structure, as social agents draw upon structures when they act, which, at the same time, serves as a basis to produce or reproduce them. This recursive relationship is referred to as the duality of structure. Duality of structure is then *“the essentially recursive character of social life: the structural properties of social systems are both the medium and outcome of the practices that constitute those systems”* (Giddens, 1982, pp. 36-37).

Giddens defines structure as *“rules and resources, recursively implicated in the reproduction of social systems. Structure exists only as memory traces, the organic basis of human knowledgeability, and as*

*instantiated in action*” (Giddens, 1984, p. 377). Social practices are situated contextually and temporally and can only exist in and through human action, or ‘instantiated in action’. Social structures condition social practices by providing the contextual rules and resources that allow social agents to make sense of their actions and of others. Social systems exhibit structural properties that are produced, reproduced and transformed through the interaction of social agents. As structures are not enacted in a vacuum, structures call on the structural properties that were enacted by prior social action, which could be the action of a social agent or those of others. It is in this manner that the structural properties that were established by previous social action come to shape social interaction, which then reproduces the structural properties afresh; *“agents also reproduce the conditions that make such actions possible”* (Giddens, 1984, p. 26). Giddens differentiates between the rules of social life and formulated rules, with the former referring to the generalised techniques or procedures that are applied during the production or reproduction of social practices, and the latter referring to the rules of bureaucracy or of a game, that are interpretations of the rules rather than the official rules. Rules cannot be conceived without resources, since it is the latter that provide the means by which transformative rules are assimilated into social practices. Resources serve the purpose of changing or transforming social outcomes and are the facilities that social agents possess and can use to their advantage to influence or manipulate courses of interaction with others, potentially ultimately transforming social outcomes. The resources that Giddens refers to are of two types; allocative and authoritative. Allocative resources stem from the control of material products or aspects of the material world, whilst authoritative resources are derived from social agent activity coordination and command over other social agents. An important aspect of Giddens’s understanding of structure that has attracted criticism by other authors, including Sewell Jr (1992), is the view that structure is virtual, that it exists only in memory traces. Giddens argues that materiality has no structure and that it is only through human interaction that structures are enacted (Giddens, 1979, 1982, 1984).

### 3.2 Modalities of Structuration

Giddens identifies and explains the workings of three dimensions of structure that emerge from the properties of social action. Giddens states that this manner of separation of structure is purely for analytical purposes, as the three dimensions are intricately linked in social systems or societies (Giddens, 1979, 1984). The modalities of structuration are represented in figure 1.

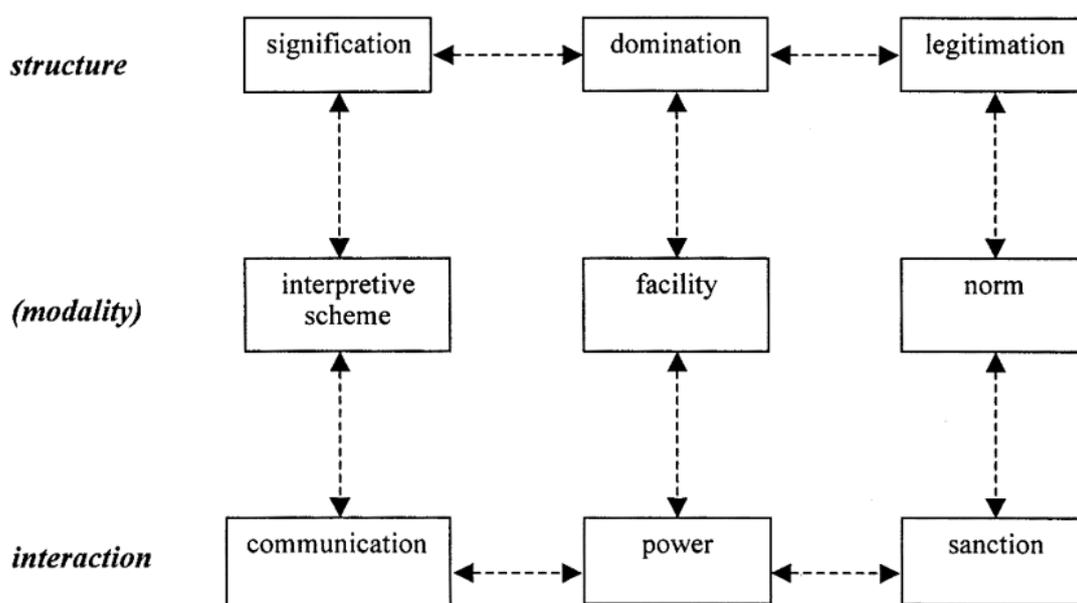


Figure 1. Duality of structure dimensions model (Giddens, 1984, p. 29).

The three dimensions of structure are signification, domination and legitimation, whilst the three types of human agency or interaction are communication, power and sanction. Between these, Giddens presents the modalities of structuration as interpretive schemes, facilities and norms. The modalities of structuration are constituted by the actions of social agents, and are enabled or constrained through structural properties. The mediation of the modalities of structure is a critical element of structuration theory. Structures of signification are produced through communication and enable social agents to communicate. The structure of signification is mediated by interpretive schemes, as social agents, through communication, use interpretive schemes or stocks of knowledge to make sense of their actions and of the actions of others. This produces or reproduces structures of signification or structures of meaning. When social agents draw upon interpretive schemes or stocks of knowledge in their ongoing interaction with society, these form “*the core of mutual knowledge whereby an accountable universe of meaning is sustained through and in processes of interaction*” (Giddens, 1979, p. 83). Moving onto structures of domination that are of transformative capacity, social agents use power in their interactions by drawing upon resources that, as mentioned, can be material or human, to produce or reproduce structures of domination or structures of power. If certain social agents possess resources that are needed by others, then this can act as a source of power that enacts structures of domination; therefore, these structures are used to influence the conduct of other social agents. Finally, social agents sanction their actions by drawing upon the norms or standards of morality of the social system or society to produce or reproduce structures of legitimation (Craib, 2011; Giddens, 1976, 1979, 1984).

#### **4 Research Methods**

This study adopts a qualitative interpretive approach. This approach allows for the in-depth exploration of social and cultural phenomena (Myers, 2012). Interpretive research attempts to understand phenomena through the eyes of the participants. This study adopts a case study approach in order to develop rich insight (Walsham, 1995; Walsham and Han, 1993). The adopted case study is that of crowdmapping during Typhoon Haiyan, which will be detailed in the fifth section. The data collection is comprised of voice and video interviews, and of document, newspaper and media review. Forty voice and video interviews were conducted in addition to email communication with nine other participants. Documents and online resources were reviewed, including agency reports, news items, television interviews and video recordings. The forty voice interviews were conducted with various actors, including the Humanitarian OpenStreetMap (HOT) Haiyan activators, OpenStreetMap (OSM) contributors (crowdmappers) and various humanitarian organisations that operated on the ground during Haiyan, including the American Red Cross, UN OCHA, MapAction, the Canadian Armed Forces – Disaster Assistance Response Team (DART) and specialists from the Philippines Government – National Economic and Development Authority (NEDA). Further interviews were conducted with relevant actors from DigitalGlobe and Mapbox. The voice interviews were conducted between 02/08/14 and 29/10/14, and ranged between 30 to 90 minutes; they were recorded and transcribed verbatim. Interviews were semi-structured, as this provided greater flexibility. Guidelines were followed to ensure thick description whilst increasing the credibility and richness of the gathered data (Myers and Newman, 2007; Schultze and Avital, 2011; Walsham, 1995). The questions asked revolved around four main topic areas; mapping practices, technological interaction, satellite imagery and the impact of crowdmapping. The interview was the main chosen method because it has been argued to be the primary data source for interpretive case studies (Walsham, 1995).

In terms of data analysis, this study follows the structuration theory methodological guidance of Pozzebon and Pinsonneault (2005), namely, ‘narrative’ and ‘temporal bracketing’ for dealing with the duality of structure and the interaction between macro and micro. Narrative is where empirical data is structured in a systematic manner in terms of detailing a chronology of all phases. Analytically, it is used to understand the sequences of different phases. Temporal bracketing is the breaking down of events into the effects of action. Similarly, scholars such as Barley and Tolbert (1997) have elucidated

the breaking down of data in successive periods to understand how the actions in one period lead to changes in the successive, when applying the duality of structure.

## 5 Case Description

The case study is crowdmapping during a powerful tropical cyclone, namely Typhoon Haiyan, which struck the Philippines between the 6<sup>th</sup> and 9<sup>th</sup> of November 2013. Haiyan resulted in 6,201 fatalities, 28,626 injuries and 1,785 missing persons in 591 municipalities and 57 cities (NDRRMC, 2014). The humanitarian organisation detailed in the case description and analysis will be kept anonymous and therefore named Humanitarian Organisation One.

OpenStreetMap (OSM) was a prominent crowdmapping tool that was engaged with in response to Haiyan. OSM is a collaborative and collective initiative that allows users to edit maps of the world. The OSM Haiyan crowdmapping system was activated by the Humanitarian OpenStreetMap Team (HOT), on the 7<sup>th</sup> of November 2013, around 24 hours before Haiyan made landfall in the Philippines. HOT acts as the bridge or link between the OSM community and traditional humanitarian organisations. The system was activated to initially focus on mapping Tacloban City, which an early analysis had predicted would sustain the greatest damage. This estimate was based on HOT Activator Andrew Buck's research from media sources, including a weather blog. An email was then sent out by Andrew to the HOT mailing list, calling the OSM contributors to participate in the mapping activity. By the end of the activation, the mapping efforts went beyond Tacloban City, to cover the majority of the affected areas. Throughout the activation, Andrew was assisted by Maning Sambale, Vice President of OSM Philippines, and Pierre Beland, a board member at HOT, amongst others. This was done in coordination with the American Red Cross, which worked closely with HOT during the activation, as it was working on the ground and continually advising HOT of what areas needed to be mapped. The activated crowdmapping system detailed a map of Tacloban City and other affected regions, broken down into small areas. The tasks were coordinated by HOT; humanitarian organisations would pass mapping requirements on to HOT, which would then list these online to be actioned by the OSM contributor community. The tasking manager allowed HOT to define the areas that needed to be mapped by the contributors. The contributors would select a task or randomly be given one and then pick the desired tool to edit (JOSM, iD or Potlatch), using satellite imagery that was provided by HOT. The tasking manager also allowed more experienced contributors to undertake validation tasks in which they would validate or invalidate the contributions made by others. The three editors suited the different mapping abilities of the contributors; where iD and Potlatch are browser based editors more suitable for beginners, JOSM is a desktop application that requires the contributor to download and configure various plugins. For the most part, Bing imagery was used to develop pre-disaster maps, whilst imagery provided by DigitalGlobe was used to develop post-disaster maps (OpenStreetMap, 2013). There was a delay of around seven to ten days in DigitalGlobe releasing the imagery and, because of this, some contributors and HOT members started an online petition seeking the quicker release of imagery for a longer period of time. Additional imagery from UAVs/drones was also made available, but this was limited and satellite imagery was most commonly used by HOT. Instructions on how to successfully complete the task were included in the tasking manager. Examples of tasks from Haiyan included tracing isolated buildings and road networks, with the mapping of entire cities helping to build up detailed basemaps. Furthermore, numerous mapathons were held across the world to encourage and train new contributors in mapping practices. Figure 2 shows the 'before and after' maps of Tacloban City to demonstrate the work of the OSM contributors in developing a richly detailed crowdmap.

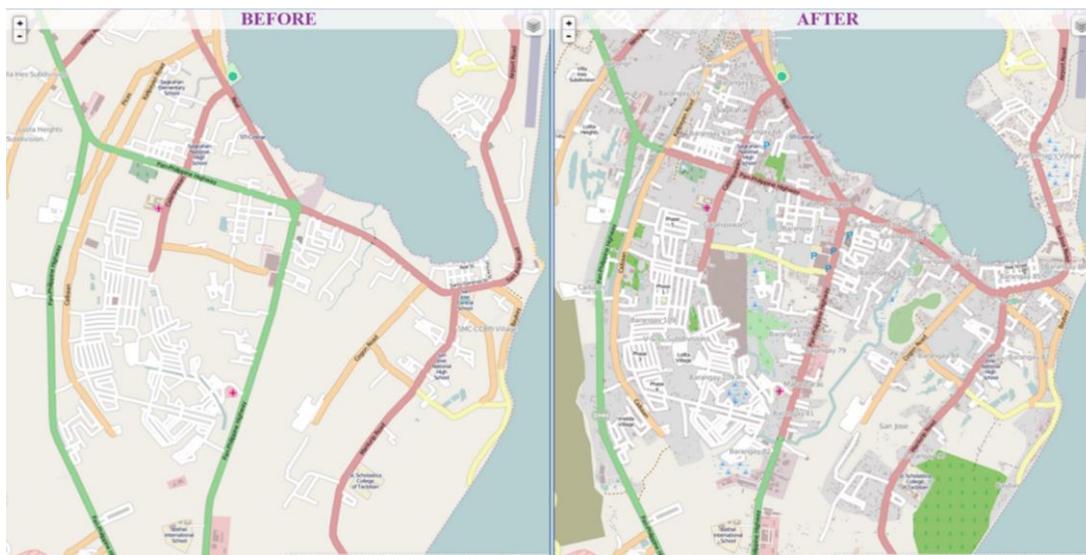


Figure 2. OSM before and after the crowdsourcing initiative (Hern, 2013).

Humanitarian Organisation One used the maps for distribution and navigational purposes. These included the distribution of non-food items, such as tents, tarps, jerry cans and blankets, as well as cash distributions and the setting up of water distribution and sanitation areas. It also used them for non-logistical purposes, such as marking boundaries and adding population estimates to the OSM base layer map. The aftermath of Haiyan saw the development of the imagery coordination tool/group, which allows for greater coordination and collaboration between the actors involved in imagery procurement. Specific requests can be made by HOT, which can now define any specific area and request imagery for it. Imagery providers will then see this and appropriately supply the requested imagery or provide details as to when it will be available. Humanitarian Organisation One has also realised that its technological capabilities have to be improved in order to fully capitalise on crowdsourcing capabilities. Technologies are being developed to improve the real-time crowdmap distribution process and to make it less bandwidth intensive. Furthermore, measures have been taken by Humanitarian Organisation One to improve the technological capabilities of HOT, namely the tasking manager. Improvements have been made to task allocation in terms of non-square task support and to cater for different skill levels. Other changes have been made to enhance the overall user-interface and user-experience. By the end of the OSM Haiyan effort, there were around 1,679 contributors from 82 countries, and 4.7 million changes had been made to the relevant maps.

## 6 Analysis

This section shows that the impact of crowdmapping is not a straightforward cause and effect, but rather a process of structuration. It reveals that crowdmapping impacts humanitarian organisations while being also impacted by them, in a dual relationship. It also shows the structuration process through which the micro-practices of crowdmapping are impacting and being impacted by the humanitarian organisations' resources and rules. They are linked via the modalities of structuration (interpretive schemes, facilities and norms) where the structuring process takes place over time.

### 6.1 Micro-Practices

The OSM contributors drew upon interpretive schemes through past experience, mapathons, technological properties, or any training that had been undertaken. It was these existing structures of signification that provided the contributors with meaning related to what they were doing and guided their mapping practices. Micro-practices included collaboration and coordination, negotiation, quality control, not-knowing, eagerness-to-know, and training.

The OSM crowdmap that was developed during the Haiyan response was, in essence, a collaboration and coordination of actors, objects and events that combined and culminated into the development of a crowdsourced map. The actors included contributors, satellite imagery providers, humanitarian organisations and government specialists. Collaboration and coordination was required amongst these actors to enable them to translate this into effective action. Different technologies had to be engaged with and different fast developing events had to be dealt with. Furthermore, there were various levels of hierarchy and bureaucracy that had to be tackled, especially in the acquisition of post-disaster satellite imagery. To overcome this, considerable discussions took place aimed at having the imagery released to the OSM contributors. The communication between Humanitarian Organisation One, members of HOT and imagery providers was important in obtaining the imagery, despite the bureaucratic red-tape and legal issues that had to be dealt with. A GIS Analyst at Humanitarian Organisation One highlighted the complexity of this process, stating that *“it’s just that everyone has big bureaucracies and so sometimes it takes a little bit of effort to get the bureaucracy moving and to make sure that you are ticking the boxes so that they can have the information they need so that they can take it to the next level, so they can get it approved”*. Structures of domination had to be tackled because of the satellite imagery providers holding the resources that were needed by other actors. With over 1,600 contributors, a lack of effective quality control could have seriously compromised the quality of the crowdmaps; this would have been even more crucial in the context of crowdmaps being used for disaster management. Data verification processes were carried out by the more experienced contributors, who would check map edits against the instructions of the task laid out in the tasking manager. If any problems were found with the edits, an experienced contributor would fix it, or mark it as needing to be redone. If no problems were found, it would be marked as verified. A GIS Analyst at Humanitarian Organisation One stated that *“the HOT team do have a validation process... they have people that do the initial data collection or digitisation and then they have more experienced volunteers who come in and do validation, so we pretty much rely on what they do”*. The mapping rules were mainly articulated, both tacitly and explicitly, through the tasking manager. If such rules were not followed, the contributors would be sanctioned and their edits would be changed or altered accordingly.

Inadequacies were demonstrated in the interpretive schemes of contributors with regards to three main issues. The more experienced contributors who were undertaking quality control were unaware as to how accurate the edits had to be; e.g., if a building was not mapped on its exact location, the contributors would speculate with regard to how small the error should be to be acceptable. Furthermore, the contributors were not clear regarding the mapping of the specific local context using the satellite imagery. A large number of the contributors were not based in the Philippines; therefore, they had difficulty, for example, in understanding what represented a building in the satellite imagery. Also, a large number of contributors were unaware as to how the maps were being used on the ground by the different humanitarian organisations. Leading on from not-knowing, a large number of the contributors conveyed that they wanted to know more about how the crowdmaps were being used on the ground. Despite HOT sending out emails with regard to this, the contributors still expressed a need for more in-depth information on the subject, as this would serve to further motivate and re-energise them. An OSM contributor stated that *“I read a couple of articles about it, but I’m still kind of not sure. I hope right it was having some effect, I would like to have more information on this, but I think generally the use is to coordinate”*. More information on how the maps were being used would have given the contributors access to enhanced interpretive schemes or stocks of knowledge. As the Haiyan activation saw a large influx of contributors compared with previous activations, appropriate training had to be provided. This was done mainly through mapathons that were organised in many different countries, including Germany, the UK, Spain and the USA. This meant that, through communication with those running/organising the mapathon, the contributors were able to draw upon structures of signification through interpretive schemes, to learn and enhance their contributions. The number of mapathons that took place enabled more people to draw upon these structures of signification. After attending a mapathon and when asked what was expected of her, an OSM contributor stated that it was *“to mark buildings and roads, to make sure you*

didn't miss buildings but also to make sure you didn't mark things as buildings that weren't actually buildings; so, trying to be accurate".

## 6.2 From Micro-Practices to Macro-Change

Figure 3 highlights the duality of structure in crowdsourcing, in the case of crowdmapping during Typhoon Haiyan.

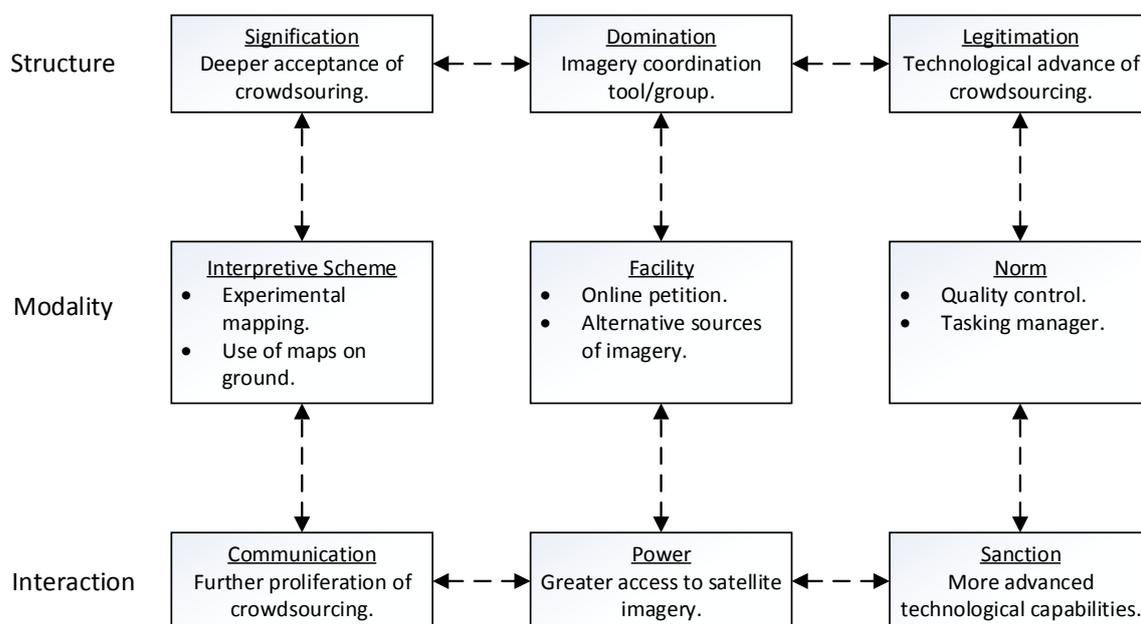


Figure 3. Duality of Structure in Crowdmapping.

### 6.2.1 From Communication to Signification

The OSM Haiyan crowdmapping initiative saw the evolvement of structures of signification amongst humanitarian organisations towards a deeper acceptance of crowdsourced data. The modalities of experimental crowdmapping and the use of OSM crowdmaps on the ground explain these evolving structures of signification.

For Humanitarian Organisation One, it would be fair to say that these new structures of signification did not entirely emerge from the Haiyan response, as there was already some shared understanding of the benefits of crowdsourced data. Further to learning from the Haiti response, amongst others, Humanitarian Organisation One had previously done some experimental mapping in Africa; a GIS Analyst stated that “we were blown away by how completely and thoroughly we were able to map a city that was basically just a blank spot on the map beforehand and that gave us a lot of confidence that, wow, this is something that is really transformative”. Therefore, heading into the Haiyan response, Humanitarian Organisation One already had some idea as to how crowdsourced data could be beneficial. Nevertheless, the manner in which the crowdmaps were used for logistical and non-logistical purposes on the ground during Haiyan brought about a change in shared interpretive schemes among a wider audience within Humanitarian Organisation One. This was key because structures of signification are particularly important for change, as the seeds of change can be seen in new interpretive schemes. Examples of disaster management practices from the ground that helped develop and evolve these significations revolved around an overall improved aid response, mainly for distribution (food, non-food and cash) and navigational purposes. To understand the importance of having up-to-date maps, it is imperative to understand the dynamics of Humanitarian Organisation One distributions during Haiyan; these would, on average, involve four to five trucks and ten to fifteen volunteers with a target population ranging anywhere between a few hundred to a few thousand. Had the different distribution sites not been navigated to using

up-to-date maps, a lot of time would potentially have been wasted, not to mention the delay in the distribution of the items. This could, on occasion, have been fatal, as these distributions would often target entire communities with basic survival items. Highlighting how the crowdmaps were used for navigational purposes, a GIS Analyst for Humanitarian Organisation One stated that *“one of our folks that was deployed said that they were trying to go to this place like several hours away from where the base camp was, and there local driver was like no you can't get there, the roads don't exist, but they had OSM on their tablet and they routed it on OSM, and they literally put it on the dashboard and the driver begrudgingly followed the instructions on the tablet and drove them to exactly where they wanted to go and they were able to see people and talk to people that no one had talked to at all, because nobody knew the roads were there”*.

The evolvement of interpretive schemes and the further proliferation of crowdsourcing was explicated by a GIS Analyst, who stated that *“I don't think we have to sell it anymore, it's already sold. We did have to sell it, we had to convince people why it is valuable but we don't have to do that anymore, it's proved itself. Now crowdmapping is just part of what we do, it's just sort of anticipated and expected that we incorporate this into our projects and our disaster response”*. This highlights how structures of signification have evolved in Humanitarian Organisation One.

### **6.2.2 From Power to Domination**

The OSM Haiyan crowdmapping initiative saw structures of domination that were ultimately changed through the development of an imagery coordination tool/group. The modalities of online petition and alternative sources of imagery facilitated the changing of these structures of domination.

Initially, structures of domination were established, in the OSM Haiyan response, through DigitalGlobe possessing the allocative resources which were required by OSM contributors to develop post-disaster crowdmaps. This is not to say that DigitalGlobe exercised power in a negative manner, but simply that, because they held the resources that were needed by other actors, they held a position of domination over the development of the OSM crowdmaps. The delay in obtaining the satellite imagery can be attributed to a number of reasons. First of all, Haiyan being a typhoon meant that obtaining clear post-disaster imagery was challenging as in the immediate aftermath of a typhoon, weather conditions can remain cloudy and rainy. Another factor that contributed to the delay was the sheer number of actors, such as the US State Department, HIU and Mapbox, that were involved in the discussions between HOT and DigitalGlobe. This meant that obtaining the imagery was not a very streamlined process. The delays, coupled with an unclear release timetable, caused some members of HOT to protest or contest these structures of domination through an online petition, seeking a ‘quicker release of imagery’ for a ‘longer period of time’. The ‘longer period of time’ request came following a misunderstanding by which it was assumed that the satellite imagery would only remain available for 30 days, after which it would be withdrawn. The actual reality was that any number of requests for imagery could be made within a 30 day period, but the imagery could be kept as long as needed. A HOT Activator advised that this misunderstanding was one of the reasons that had fuelled the petition, which, in a general sense, was not well received by the imagery providers and even by a large part of HOT. Despite the petition, a large element of HOT was aware of the legal complications and of the bureaucratic red-tape surrounding the release of imagery; imagery providers had to operate within their own commercial and legal frameworks. These differences of opinion in HOT regarding the petition, by which some people supported it while others did not, importantly demonstrated the diversity of thought that exists within open-source communities. Furthermore, alternative sources of imagery were explored, including UAVs/drones, but these remain underexplored and cannot be thought of as being a replacement for satellite imagery. Nevertheless, this exploration did lead to the greater realisation that more work needed to be done on all fronts when procuring imagery.

It was accepted by all that there were issues and delays in obtaining imagery and that the imagery procurement process was something that needed to be improved and streamlined. A GIS Analyst for Hu-

humanitarian Organisation One stated that “we realised that with all the different organisations now involved in these sort of situations, there needs to be a coordination tool and that’s where the coordination tool came about”. Reflecting on this, there has since been a development that has attempted to deal with these structures of domination, with all actors, including DigitalGlobe, showing willingness to do so. Whilst the imagery will still be held by the providers, the procedures have been vastly improved to help overcome the issues that were faced, resulting in greater access. This development has aptly been named the imagery coordination tool or group, and it has developed stronger direct links not only between HOT and satellite imagery providers, but also with humanitarian organisations such as Humanitarian Organisation One. Not only has this tool/group streamlined the entire process, it also means that duplicate efforts are not undertaken by imagery providers. The tool/group is not specifically a threat to the structures of domination per se; rather, it is a way to work around them. Until more providers decide to share their satellite imagery, the true democratisation of imagery will not become prevalent. This is an internal tool that was developed in the aftermath of Haiyan, and it has been working very effectively in current HOT activations, including the response to the Ebola crisis. A GIS Analyst for Humanitarian Organisation One stated that “it has proven wildly successful, for Ebola for example. We talked about it in I think maybe February or March and we use it a lot”. A further example of its success was highlighted by Kate Chapman, HOT Director, who stated that “it’s been a lot more effective to coordinate things between everyone. We were able to get certain imagery at no cost through the imagery coordination group... We were able to get it free and actually probably in a timelier manner than going through a purchasing process”.

### 6.2.3 From Sanction to Legitimation

Moving on from structures of signification and domination, which can be seen to have initiated change, there has been an evolution of structures of legitimation within certain humanitarian organisations since Haiyan. This is specifically highlighted by internal technological advances. The modalities which assisted in bringing about this legitimation of crowdsourcing revolved around the effectiveness and accuracy with which the OSM crowdmaps were used, and the technologies which normalised this effectiveness and accuracy, namely quality control and the tasking manager.

Therefore, through the acceptance of crowdsourcing, new norms are being established within humanitarian organisations with regard to crowdsourced data. A GIS Analyst stated that Humanitarian Organisation One no longer questions crowdsourced data in terms of validity or even quality; rather, the questions have now shifted to how crowdsourced data can be best incorporated into practices and their capabilities be maximised. In a demonstration of these new structures of legitimation relating to crowdsourcing, Humanitarian Organisation One have realised that they need to further develop their own technological capabilities to be able to support the real-time evolving nature of crowdsourced data. Currently, they are aware of how to put offline OSM crowdmaps into the hands of their field responders, but this does not allow for the continuous real-time updating of maps on the devices that these field responders take to the field. While the pushing of updated maps is possible, the current technological capabilities only allow this to be done by sending large and whole updated files, rather than just the map updates that have been made. This may not seem like a big issue, but, in the context of a disaster situation, sending a 2GB file is just not possible due to limited internet connectivity, amongst other contextual reasons. The technological target of Humanitarian Organisation One is to make the sending of updates a non-bandwidth-intensive task, as articulated by a GIS Analyst; “the mapping technology has come to a place where now we can see the outlines of how that would work, we just need to sit down and knuckle down and do it. We are kind of excited to work that out because I think that it will be a really major advance”. This engagement with crowdsourcing shows its legitimation within Humanitarian Organisation One and how it has shifted from being slightly sceptical to being more embracing.

This technological change may not have fully been implemented yet, but it is being actively worked upon. The mere fact of an institution like Humanitarian Organisation One having accepted that OSM

crowdmaps and crowdsourcing in general are a way forward represents a change in legitimation in regards to crowdsourcing. The Haiyan response proved to be a major point at which the legitimation structures began to change, resulting in greater technological capabilities with regard to crowdsourcing; *“so we are going to major donors now and asking them to support projects where we heavily leverage OSM and where we develop tools for OSM. To go to a major donor, you need your senior managers to sign off on that; so having that kind of commitment from them is huge and has allowed us to think bigger”* (GIS Analyst, Humanitarian Organisation One).

### 6.3 From Institutional Legitimation to Micro-Change

The institutional legitimation of crowdmapping within Humanitarian Organisation One has contributed to micro-change in the micro-practices of the OSM contributors. This has been demonstrated through the post-Haiyan further development of the HOT tasking manager, in which Humanitarian Organisation One played an active role. Highlighting some of the limitations and subsequent improvements, including the ability to prioritise tasks according to urgency, a GIS Analyst at Humanitarian Organisation One stated that *“we couldn’t prioritise tasks; now, when you have tasks on there, you can have high, urgent, medium. What we found was sort of that, whatever task was on top, tasks would just get dropped on it sequentially and people would just take... so there wasn’t like a clear system for assigning things, and also, even within a task, even, for example, for Tacloban tasks, I wanted the inner city mapped first, but people were nibbling at the edges”*.

The most recent version of the tasking manager is a complete re-write and includes new features, including supporting non-square tasks, whereas it was previously limited to simple grid squares. This means that cities can be divided into neighbourhoods, which makes for a more detailed and natural mapping experience. Further improvements include user-interface and user-experience enhancements, such as layout changes, easier contribution workflows, anonymous access, performance, translations and arbitrary polygons support. Since these new changes have been implemented, it has become more responsive to individual details. Further improvements include the ability to assign tasks, by which tasks can be locked with passwords and assigned to contributors according to their skill level; this ensures quality of data, as the more complex tasks can be assigned to the more experienced mappers. Importantly, this has made the mapping experience more worthwhile for contributors, as they are not overwhelmed with tasks that might be too complex for them or, in fact, even too easy for them, not challenging them at all. This feature ensures that the quality of data is not compromised whilst also helping to improve the mapping experience for contributors. Overall, the resulting changes to the tasking manager, such as the ability to add comments, have been well received; *“I really like the new feature that you add a comment that everybody can see after you locked and unlocked a task, and I don’t remember that this was there during the Typhoon, and I think that’s a very, very important thing because, for some tasks, you cannot do anything because you have heavy cloud coverage and it is still marked not done... I think that is a very good improvement of the tasking manager”* (OSM Contributor).

## 7 Discussion and Conclusion

This study explored the research question of whether and to what extent the practices of crowdmapping impact humanitarian organisations. To answer this question, we examined a crowdmapping initiative during a natural disaster. Through the extensive collection of data from various actors and the application of concepts from structuration theory, the analysis revealed a number of changes in structures of signification, domination and legitimation. Specifically, the paper articulates that there is a duality of change between the micro-practices of crowd-mappers and the macro-practices of a humanitarian organisation. The various micro-practices (collaboration and coordination, negotiation, quality control, not-knowing, eagerness-to-know, and training) that brought about change in the practices of the humanitarian organisation are explained (disaster management practices, imagery procurement through imagery coordination tool/group and internal technological advances). Consequently, the recursive changes implemented by the humanitarian organisation (the re-development of the tasking manager) that impacted

the practices of the crowd-mappers are elucidated (new crowd-mapping practices); therefore representing a duality of change. This analysis shows that it is not sufficient to simply look at impact and change as a one-way process, ignoring the existence of well-established institutions. Impact and change in crowd-mapping need to be considered as a duality, in that established humanitarian organisations can impact the action of crowd-mappers and the action of crowd-mappers can impact humanitarian organisations.

This study contributes to the literature on crowdsourcing in IS, which, as stated in the literature review, is very much in its nascent stages (Zhao and Zhu, 2014). Specifically, it details a more in-depth understanding of the outcomes of a crowdsourcing initiative and of the changes that can be realised (Pedersen et al., 2013; Tarrell et al., 2013). It adds to and extends, for example, the following literature: Bao et al. (2011), who examined the effectiveness of crowdsourcing systems to be able to generate and evaluate solutions; Bonabeau (2009), who argued that crowdsourcing systems are better suited for idea generation rather than idea evaluation; Moon and Sproull (2008), who examined the role played by the feedback of a crowdsourcing system in sustaining high-quality contributions from the crowd; Savage (2012), who explicated how crowdsourcing can help generate ideas to solve problems; and Zhai et al. (2012), who examined a crowdsourcing system's ability to perform specific tasks. This study extends this body of literature by theoretically exploring the impact, outcome and changes of a crowdsourcing initiative through contributor micro-practices. It presents the novel finding of the duality of change in crowdsourcing. This is an important contribution, as scholars have noted that theorists cannot fully explain the positive performance of crowdsourcing systems (Bonabeau, 2009). In essence, this paper allows for a better understanding of a phenomenon that has been argued in the literature to be playing an ever-increasing role in society (Brabham, 2013; Howe, 2006). Furthermore, expanding on the literature concerning social media and crowdsourcing in disaster management, it resonates with scholars, including Gao et al. (2011), Majchrzak and More (2011) and Velez and Zlateva (2011) who sought to better understand the role played by social media and crowdsourcing in disaster management. The Haiti earthquake was one of the first cases in which crowdsourcing and crowd-mapping were researched by scholars, including Gao et al. (2011), Goolsby (2010), Heinzelman and Waters (2010) and Sutton et al. (2008), but the literature has not really moved on since then. This paper is aimed at not only encouraging scholars to further research the phenomenon of crowdsourcing, but also at motivating scholars to explore the use of social media and crowdsourcing in the context of disaster management and humanitarian organisations. In terms of contributions to practice, the importance for organisations to reinvest in crowdsourcing systems from which they have benefitted is identified. Furthermore, the importance of close collaboration and coordination between actors is detailed. This ensures the maximisation of crowdsourcing capabilities because efforts are more focussed and are based upon continually evolving systems.

Additionally, this study responds to recent calls for IS research to examine the role of IS outside the traditional commercial organisation (Chiasson and Davidson, 2005; Yoo, 2010). It does so by examining a humanitarian non-profit organisation. In a recent paper, Walsham (2012) argued that the IS literature needs to expand its agenda to understand whether we are making the world a better place with ICTs. Also, in a recent MISQ call for papers regarding ICTs and societal challenges, it is argued that the IS discipline needs to broaden its horizons and focus on societal issues. Specifically, the call was for IS research to explore "*how ICT-enabled platforms help NGOs complete social missions*" (Majchrzak et al., 2012, p. 2). This paper makes an attempt to answer these calls through the exploration of the impact of crowdsourcing in the context of a natural disaster where crowd-mapping 'made a difference'. Crowdsourcing provided a humanitarian organisation with capabilities that allowed it to more efficiently respond in assessing the damaged areas and allocating resources to relief efforts, which had an impact on the ground. Through the exploration of a humanitarian organisation, it answers this call to better understand the societal impacts of ICTs. In conclusion, this paper applies structuration theory to examine the impact of an ICT-enabled crowd-mapping platform that was used extensively by a humanitarian organisation to complete its social mission of relief and recovery, and it also makes an attempt to further encourage the IS crowdsourcing body of literature to go beyond the traditional commercial organisation.

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