



Toward developing a humanitarian crowdsourcing model: Enabling medical and disaster response through digital collaboration

Joyce Anne Quinto^{1,2} · Aldo Gavril Lim¹

¹ College of Development Communication, University of the Philippines Los Baños

² Research Institute for Tropical Medicine

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Abstract

Lately, the humanitarian community has been utilizing crowdsourcing to facilitate medical and disaster response. Grounded in Geiger et al.'s (2011) Crowdsourcing Information Systems (CIS) and Surowiecki's (2004) Wisdom of the Crowds (WC), this study content-analyzed 23 humanitarian crowdsourcing websites to find out how crowdsourcing has enabled medical and disaster response, as evident in global humanitarian movements from 2010 to 2014. Findings revealed that the digital volunteers that generate big data in humanitarian crowdsourcing websites are composed of an independent crowd with diverse opinions and a decentralized demography. The crisis-related inputs they contributed were community-based, infrastructure-based, information-based, and related to future threats. Emerging outputs resulted in three phases: 1) first degree material outputs (e.g., geographic crisis map, and/or text database/resource page); 2) non-material outputs (e.g., planning, strategizing, and operationalization via partner organizations); and 3) second degree material output (e.g., actual medical and disaster response). Results of the analysis suggest that the dynamic process of humanitarian crowdsourcing do not appear to be boxed into the CIS archetypes. Instead, the characteristic of the websites presented a merging of the four archetypes into two: 1) crowd creation and crowd solving; and 2) crowd rating and crowd processing. As an outcome of the study, a humanitarian crowdsourcing model is proposed.

Keywords: crowdsourcing · medical and disaster response · information system · wisdom of the crowds

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Corresponding Author:
Joyce Anne Quinto
jcquinto@up.edu.ph

Introduction

One of the emerging concepts that has attracted the interest of the humanitarian community is the method of “harnessing the potential of a large crowd in generating solutions” (Howe, 2006) to crisis management. This phenomenon is called *crowdsourcing*. Crowdsourcing allows data and information related to medical crisis and disasters to be generated through the collaborative effort of *volunteers* who, in most cases, need not be physically present in the disaster zone (Starbird & Palen, 2011).

Information is a key element needed for an effective medical and disaster response. Due to crowdsourcing’s ability to rapidly generate vast information and to bring individuals to the loop of communication that aids in a large-scale problem-solving effort, it has been operationalized widely for disaster relief operations. Of noteworthy mention is Typhoon Haiyan (November 2013), where thousands of digital volunteers provided geographical information concerning the affected areas, which aided in search-and-rescue and relief operations in the Philippines (Butler, 2013). Another example is the search for the missing Malaysian Airlines MH370 aircraft (March 2014), where the online crowd—through the use of digital satellite images—helped find leads to the wreckage.

With the ongoing dialogue on crowdsourcing as an important function during emergency situations, a systematic perspective on how big data enables medical and disaster relief operations must be given foundation. Related questions that arise include: 1) What kinds of crisis-related information are produced in this method? 2) How are these large quantities of information transformed into an actual humanitarian action? and 3) How is this information being used?

Anchored on Geiger et al.’s (2011) Crowdsourcing Information Systems (CIS) and James Surowiecki’s (2004) *Wisdom of the Crowds* (WC), this study looked into the types of information (inputs) that are crowdsourced during medical and disaster crises, as well as the specific medical and disaster responses (outputs) that have emerged from crowdsourcing, to identify themes that may help elicit more information, as well as options, for a faster and more cost-effective humanitarian operations. Undertaking this analysis would generate a humanitarian crowdsourcing model based on the emerging crowdsourcing archetypes.

Crowdsourcing Information Systems

This study adopted the four models of CIS of Geiger et al. (2011) namely 1) crowd processing systems; 2) crowd rating systems; 3) crowd solving systems; and 4) crowd creation systems. Classifying the sampled crowdsourcing websites into these four archetypes relied on difference and value of contributions.

Difference of contributions (Geiger et. al, 2012) is the uniqueness of each input, which could either be a homogeneous contribution (i.e., crowdsourced information that adheres to predefined specifications and is processed quantitatively) or a heterogeneous contribution (i.e., contributions that are not limited to a single type of information). In Figure 1,

homogeneous contribution is represented by the identical shapes with the same color, while heterogeneous contribution is represented by the diverse shapes in various colors.

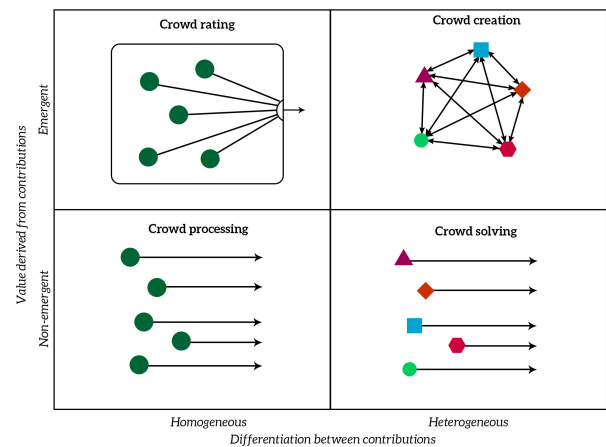


Figure 1. Geiger et al. (2011) sketched a diagram to differentiate the four archetypes based on the combination of *difference* and *value* of contributions.

Value of contributions (Geiger et al., 2012) is determined by the independence of the inputs which could either have an *emergent* value (i.e., contributions that are taken as part of the collection of information), as represented by the interlinked lines and arrows, or a *non-emergent* value (i.e., contributions that are viewed independently and may not necessarily need the entirety of crowdsourced contributions to come up with an outcome), as represented by the parallel lines and arrows in Figure 1.

Crowd processing systems seek homogeneous contributions with non-emergent value. This system collects similar types of contributions directly from the individual, instead of getting the sum or the entirety of the crowd’s inputs. The initiator posts only one type of task, and the crowd submits its ideas and outputs. From a pool of accomplished tasks, only one or a few get/s picked and rewarded by the initiator.

Crowd rating systems, or *crowd voting* (Howe, 2006), require large quantities of homogeneous contributions with emergent value. Identical inputs treated as “votes” are sourced from the crowd. It is the combination of all these votes that matters and results in an effective outcome of the crowdsourcing initiative.

Crowd solving systems seek heterogeneous contributions that have non-emergent value. Initiators introduce a problem, rather than a task, to a crowd of a diverse pool of knowledge, skills, and talents, who then offer different types of solutions. This system aims to get the best-fit solution to a single problem, through different approaches and ideas.

Crowd creation systems also require heterogeneous contributions but seek emergent value. The crowd in this system submits individual contributions that are valued as small parts of a collection of contributions. Each contribution therefore serves as building blocks that comprise the potential outcome of an initiative.

Wisdom of the Crowds

This study is also premised on the WC, which posits that effective outcome of a crowdsourcing initiative can only be achieved if all information that goes into the system comes from a wise crowd. Surowiecki (2004) identified three conditions that will enable a wise crowd, namely: 1) decentralization; 2) diversity of opinion; and 3) independence.

Decentralization refers to the diversity in the demography of the online crowd to allow for a more democratic forming of information.

Meanwhile, *independence* and *diversity of opinion* in an information system is vital to avoid “information cascade” (Easley & Kleinberg, 2010), which states that visibility of everyone’s opinion in a platform could result in an environment where the crowd could influence and imitate each other’s judgments. Social influence and peer pressure could lead to inaccuracy in the average of collected crowdsourced inputs.

Materials and Methods

This study adopted a quantitative content analysis design. Technical communication researchers use content analyses to reveal themes and relationships among different concepts, through comparison of existing contents (Thayer, 2007). This study specifically used web content analysis, as it focused on the content of crowdsourcing web platforms.

Identifying the Coders

Coding was done in two phases. For phase one, four coders were identified based on their knowledge and experience in crowdsourcing. Two coders (including the researcher) were BS Development Communication undergraduate students of the University of the Philippines Los Baños. The third coder was a member of a crowdsourcing website while the fourth coder was a Social Media Producer for Rappler, an internationally recognized crowdsourcing-advocate organization that handles Project Agos (one of the sampled websites). For phase two, four coders from various fields—computer science, engineering, biology, and communication—were tapped. The variety of fields is reflective of *diversity*, one of the WC criteria (Surowiecki, 2004).

Sampling

With the use of online databases, 23 crowdsourcing websites for humanitarianism were purposively sampled. Samples were selected based on these predetermined criteria:

1. Each website must contain recognizable content on a current and/or past crisis regardless of location.
2. Access to crowdsourcing activity page must adhere to any or all of the WC criteria:
 - a. Website is open to all countries and professions (decentralization);
 - b. Website does not provide contents that will preempt ideas of the users (diversity of opinion); and
 - c. Website allows users to work without being influenced by other’s opinions (independence).

3. Homepage of the website must explicitly announce the need for information from the users. Thus, there must be an “open call.”

To ensure reliability of analysis, coders were provided identical databases containing 255 screen shots taken from the sampled websites. The database included all relevant pages/sections, including the activity page, instruction page, about page, blog page, FAQ page, as well as important secondary sources.

Research Instrument

Two sets of codebooks were developed, one for each phase of coding. The first codebook looked into the websites’ input-output instances based on CIS. Meanwhile, the second codebook assessed the websites according to WC criteria.

Data Collection Procedure

For the first phase of coding, all crowdsourcing instances (e.g., type of task, input, and output) were identified using a specific coding scheme, and classified these instances according to their difference and value. Characteristics under difference and value were represented numerically as 0 (absence) and 1 (presence). Data under the variables “type of task,” “input,” and “output,” on the other hand, were coded as string variables in the first round of coding. For reliability analysis, they were then converted to a data file consisting of numeric codes.

For the second phase of coding, another set of independent raters qualitatively evaluated the adherence of the sampled crowdsourcing websites to WC criteria (see Table 1). These observations were then transformed to quantitative data through frequency counts of websites that were observed to employ the given set of characteristics.

Table 1. Guide questions and indicators used to evaluate WC criterion.

Criterion	Guide Question	Indicator
1. Decentralization	- Is the website open to all ages, genders, races, and professions? - Is it accessible by anyone from anywhere in the world?	Presence of sign-up/log-in options should not lead to domination of members with homogeneous characteristics.
2. Diversity of Opinion	- Does the website NOT provide contents that will preempt ideas of the users? - Does the website NOT pose any tendencies for users to “abandon their own information in favor of inferences based on earlier people’s actions?”	Actions and information from other users should not be visible in the main input/ activity page.
3. Independence	- Does the website allow for individual judgments? - Does the website allow users to work without being influenced by other users?	Elements displayed in the activity page should be limited to task-related options.

Intercoder Reliability

To test for internal consistency reliability, Krippendorff's alpha (α) or Kalpha was computed. Quantification of the agreement of the coders was computed using this formula:

$$\alpha = 1 - \frac{D_o}{D_e}$$

...where D_o is the observed disagreement and D_e is the expected disagreement. Kalpha ranges between 0 and 1, and is analyzed as follows:

Poor	K<0
Slight	0 to 0.20
Fair	0.21 to 0.40
Moderate	0.41 to 0.60
Near	0.61 to 0.80
Perfect	0.81 to 1.00

ReCal, an online reliability calculator, was used to countercheck the computation.

Results from the first Kalpha test revealed that four out of the twelve variables achieved only moderate agreement with a Kalpha of <0.55 (See Table 2). Adjustments to the codebook were then made and an additional round of coding for those four variables was conducted until a stronger level of reliability was achieved.

Table 2. Summary of the intercoder reliability tests.

Variable	Intercoder Reliability	
	Test 1	Test 2
WC Criteria		
• <i>Decentralization</i>	1.00	1.00
• <i>Diversity of opinion</i>	0.54	0.85
• <i>Independence</i>	0.46	0.88
Types of task	0.52	0.79
Crowdsourced inputs	0.85	0.88
Medical and disaster responses		
• <i>First degree output</i>	0.52	-
• <i>Geographic Crisis Map</i>	-	0.91
• <i>Text database/ resource page</i>	-	1.00
• <i>Second degree output</i>	0.89	0.89
Difference and value		
• <i>Homogeneous</i>	0.85	0.85
• <i>Heterogeneous</i>	0.85	0.85
• <i>Emergent</i>	1.00	1.00
• <i>Non-emergent</i>	1.00	1.00

Observations of the initial results also suggested that variables for first degree output must be further subdivided into two: 1) geographic crisis map; and 2) text database/ resource page. This resulted to the absence of values in the first degree output row (Table 2), and the addition of two different Kalpha values under this variable in the second run of Kalpha.

After the second run of Kalpha, all of the variables achieved a substantial to near perfect level of reliability with >0.70. Four of these variables achieved a perfect reliability (1.0). This indicates that data produced in this study is statistically significant and can be replicated with the same technique, materials, and samples.

Data Analysis

Correspondence analysis of values coded under difference and value was employed using the XLSTAT software. Data were plotted on an asymmetric graph where, difference and value of contributions (Geiger et al., 2011) served as the x-axis (emergent vs. non-emergent) and y-axis (homogeneous vs. heterogeneous), respectively. Results of this analysis served as the basis in classifying each website into the four crowdsourcing archetypes (Geiger et al., 2011), and in describing the characteristics of each one.

Descriptive data analysis (i.e., frequency and percentage distribution) was done to provide a summary of the collected information.

Results and Discussion

Results are discussed in the following order: 1) website's adherence to WC criteria; 2) types of crowdsourced inputs; 3) medical and disaster responses (outputs); 4) weight of significance of contribution; and 5) classification of humanitarian crowdsourcing websites according to the four CIS archetypes. It then discusses the proposed humanitarian crowdsourcing model based on the themes that surfaced.

Websites' Adherence to WC Criteria

Generally, the digital volunteers of the humanitarian crowdsourcing websites satisfied Surowiecki's (2005) WC criteria.

All websites were accessible by anyone on the web—regardless of age, gender, race, and profession. Majority of the websites (65.22%) allowed users to contribute anonymously without specific conditions. Only eight websites (34.78%) required users to sign up for an account. These suggest that the sampled websites encourage forming a decentralized crowd in humanitarian crowdsourcing systems.

Meanwhile, 21 websites (91.30%) were found to exhibit a system that values "private information," and therefore allows diversity of opinion. Similarly, independence was observed in 21 (91.30%) sampled websites.

However, it is important to mention that the nature of observed crisis information was different from the types of information in other fields. Crisis information in humanitarian crowdsourcing websites largely constituted reports that could not be easily emulated by others, or would not matter if emulated. For instance, re-posting reports on a missing person would not devalue the system, as compared with emulating product opinions in a crowd-solving business-initiated system (which is the basis for crowdsourcing studies such as that of Geiger et al).

Crowdsourced Inputs

The types of crowdsourced information (inputs) generated in a crowdsourcing humanitarian website could be differentiated into: 1) *type of task*; and 2) *type of crisis-related information*.

Type of task. Five types of tasks were identified, namely: 1) text/image data submission; 2) object tagging; 3) text/image sorting; 4) donation/crowdfunding; and 5) text/image mapping (Figure 2).

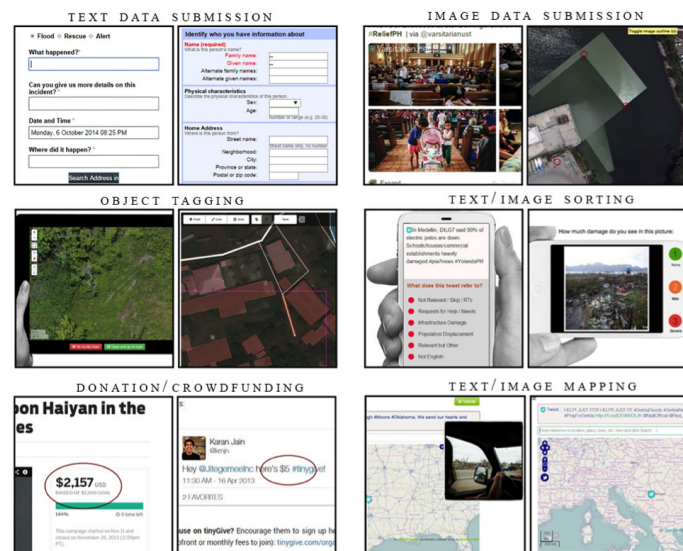


Figure 2. Screen captures of types of task found in the sampled websites.

Text data submission, as observed in 39.13% of the samples, allowed digital volunteers to submit incident reports and details relevant to the current crisis. Observed text data submission websites like Project Agos and Ushahidi provided a text form in the “Report” page, which allowed users to freely contribute crisis-related information, such as flood, rescue, and relief alerts. As the most basic form of crowdsourcing task, text data submission also provided outcomes that lead to operationalization of some of the other types of tasks (i.e., text sorting, text mapping, and crowdfunding). For instance, information collected from social networking sites (SNS) hashtag scheme is further processed and filtered through Micromappers, a text sorting and text mapping web platform. Crowdfunding websites like Indiegogo and TheSparkProject, on the other hand, is powered by individual campaigns created through text data submission.

Image data submission, as observed in the image uploading feature of SNS platforms, such as Twitter and Facebook, allowed the uploading and managing of photos of various scenes of the disaster. This task, which can be closely linked to citizen crisis photography, allowed authorities and responders to analyze current situations in specific locations in real time. In some cases, websites like Mapkitter asked users to either upload their own aerial photographs, or to simply manage and “knit” aerial photographs (uploaded by other users) into an accurate and updated crisis map.

Object tagging, as observed in 21.74% of the sampled websites, posed the virtual act of locating and tagging objects (damaged roads and infrastructure, injured humans, etc.) in a given map or satellite images provided by an external source, such as Google Earth and Digital Globe.

Image sorting, the classification of images according to predefined choices, was observed in 17.39% of the sampled websites. In this type of task, a series of images (provided by an external source, such as Twitter and YouTube) flashed on the screen; users then rated each image as “severe,” “mild,” or “none”, as observed in ImageClicker and VideoClicker apps of Micromappers. In some websites, users are only asked to identify if the image is useful or not, such as the cases of Veri.ly and MapMill.

Text sorting, the least observed employed type of task among sampled websites, entailed the classification of text (usually tweets) according to predefined choices, depending on the situation being solved. The Text Clicker app of Micromappers helped classified tweets relevant to Typhoon Yolanda by asking users to choose from a given set of categories, which included requests for help/needs; infrastructure damage; population displacement; not relevant/skip/RTs; and not English. Categorized tweets from this task are then processed either via a different type task or through an automated system.

Donation/crowdfunding, as observed in 13.04% of the sampled websites, allowed digital volunteers to collectively give financial assistance (often converted to in-kind gifts) via online money transfer systems. It was found that this task always comes after text data submission, where users post an open call for the crowd to send financial inputs.

Text mapping (8.70%) and *image mapping* (8.70%) both required users to identify and enter location of the source of the tweet (TextGeoClicker), and the perceived site where the scene in the images can be possibly found (ImageGeoClicker). Through this, the information coming from the same locations were mapped and analyzed accordingly.

Type of input. There were 17 distinct types of crisis-related information produced in a humanitarian crowdsourcing system. These were further subdivided into four: 1) community-based; 2) infrastructure-based; 3) information-based; and 4) future threats. Table 3 enumerates the specific types of inputs found.

Table 3. Distribution of inputs by category of crowdsourced information.

Category	Input
Community-based	• Relief needs
	• Missing persons
	• Relief operation sites
	• Rescue alerts
	• Emergencies/urgent needs
	• Medical emergency (number of death cases and patients)
	• Population displacement/ community-wide evacuation

Table 3. *Continued...*

Category	Input
Infrastructure-based	• Infrastructure damages (non-passable roads and bridges) • Approximate location of damages and emergencies • Severity of damage • Faulty telecommunication lines
Information-based	• Crucial announcements (Call for volunteers, class suspensions, important hotlines) • Relevance to disaster information • Translation needs • Photographs of crisis geographical locations
Future threats	• Natural hazards (flood reports, weather updates) • Other security threats

Medical and Disaster Response (Outputs)

Analysis showed three phases of transforming crowdsourced crisis information into an actual humanitarian action: (Phase 1) first degree material outputs; (Phase 2) non-material outputs; and (Phase 3) second degree material outputs.

Phase 1. *First degree material outputs* are the immediate results of computer-mediated activities. These were, generally, the visual representations of the summarized crowdsourced information delivered to the responders.

First degree material outputs do not provide direct aid to the affected communities, as there is no intervention from the responders and the authorities at this stage yet. They may come in the form of any or both of the following: 1) geographic crisis map; and 2) text database/resource page (as shown in Figure 3).

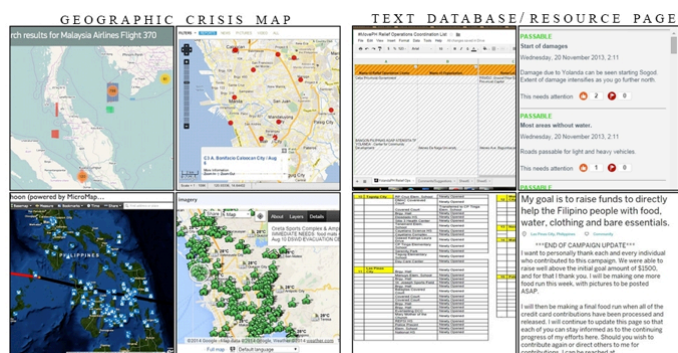


Figure 3. Screen captures of (1) geographic crisis maps and (2) text databases found in the sampled websites.

Phase 2. Humanitarian crowdsourcing platforms also produced *non-material outputs* (e.g. ideation, planning, and strategizing of the partner organizations). Each website has at least one external partner organization—from medical and disaster response groups to national and local government agencies—that directly receives information processed by the website. Some of these partner organizations include: Red Cross International, the World Health Organization, the United States Agency for International Development, the Office for the Coordination of Humanitarian Affairs of

the United Nations, the Federal Emergency Management Agency, Médecins Sans Frontières, and the Cooperative for Assistance and Relief Everywhere. These partner organizations served as the main agents in transforming inputs into non-material outputs, such as: 1) ideation; 2) planning; 3) strategizing; and 4) other intangible outputs significant to transform crowdsourced information into an actual medical and disaster response.

Phase 3. *Second degree material outputs* constitute actual medical and disaster response. These are indirect outputs generated through crowdsourcing websites that lead to a direct impact on an affected community. Observed second degree material outputs include road, bridges, and infrastructure repair; search and rescue operations; power restoration; re-establishment of communication lines; relief operations; financial assistance; evacuation operations; medical assistance; and deployment of volunteers.

Weight of Significance of Contributions

The *weight of significance* of contributions is determined based on difference and value.

Difference of contributions. The type of task posed by a crowdsourcing platform determined the difference of contributions. This is because the type of task, as given in the instruction and activity pages of the website, indicates whether the user is allowed to submit information without restrictions (i.e., heterogeneous), or to just simply choose between/among options (i.e., homogeneous).

A contribution is heterogeneous if the task posed is/are: 1) text/image data submission; and/or 2) donation/crowdfunding. This is because both of these types of tasks seek data that do not need to adhere to a limited type and amount of information.

Meanwhile, a contribution is considered homogeneous if the type of task posed is/are: 1) object tagging; 2) text/image sorting, or 3) text/image mapping, which limits users to a specific type of information.

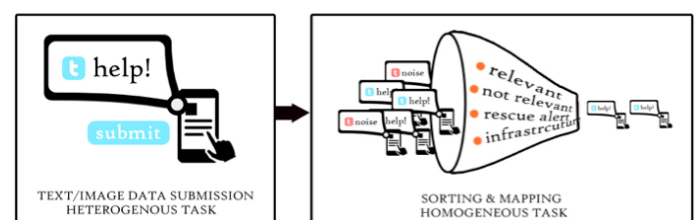


Figure 4. In some cases, homogeneous and heterogeneous tasks co-existed in a single crowdsourcing information system where heterogeneous tasks acted as a strategy to collect “raw” crisis information while homogeneous tasks served as the “filter” mechanism.

Value of contributions. As opposed to the theoretical expectation that a crowdsourcing information system may either have an emergent or non-emergent value, each website possesses **both** emergent and non-emergent values throughout the different phases of a crowdsourcing initiative (Figure 5).

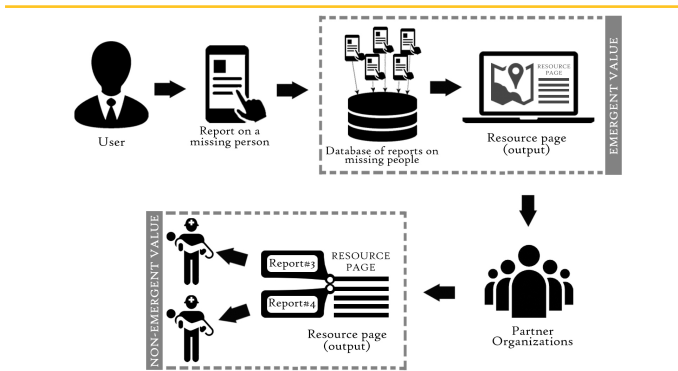


Figure 5. Each input that goes into the system initially has an *emergent* value, as it is taken to be a part of the collection of information and is presented as a *geographic crisis map* and/or a *text database/resource page*. Such information, once received by the responders and the community, loses its *emergent* value and gains *non-emergent* value because, at this point, the reports are processed individually.

CIS Archetypes

Correspondence analysis was used to determine the association between difference and value of the sampled websites in relation to the variables' positions in the perceptual map.

Here, the four quadrants formed by the intersection of the x- (*difference*) and y- (*value*) axes represent *crowd rating* (Quadrant 1), *crowd creation* (Quadrant 2), *crowd solving* (Quadrant 3), and *crowd processing* (Quadrant 4) (see Figure 6). Through this, the emerging CIS archetypes of the humanitarian crowdsourcing websites may be determined.

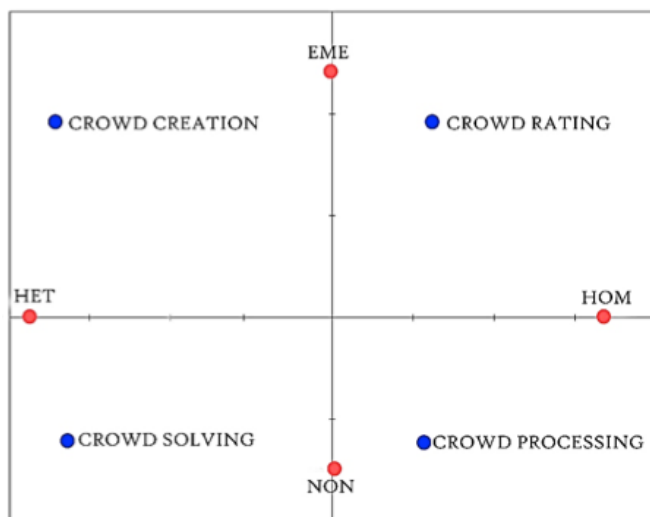


Figure 6. Expected position of CIS archetypes based on value and difference of contributions.

However, results from the correspondence analysis showed a deviation from the expected CIS plot. Since all sampled websites were observed to produce information with both emergent (observed in phase 1 of output) and non-emergent (observed in phase 2 of output) values, the websites formed only two

clusters—across the difference (HET and HOM) axis—instead of four.

Since the clustering of websites landed on the same difference axis, and were only differentiated by type (HET and HOM), the graph presents merging of crowd creation and crowd solving (Quadrants 2 and 3), as well as crowd rating and crowd processing (Quadrants 1 and 4).

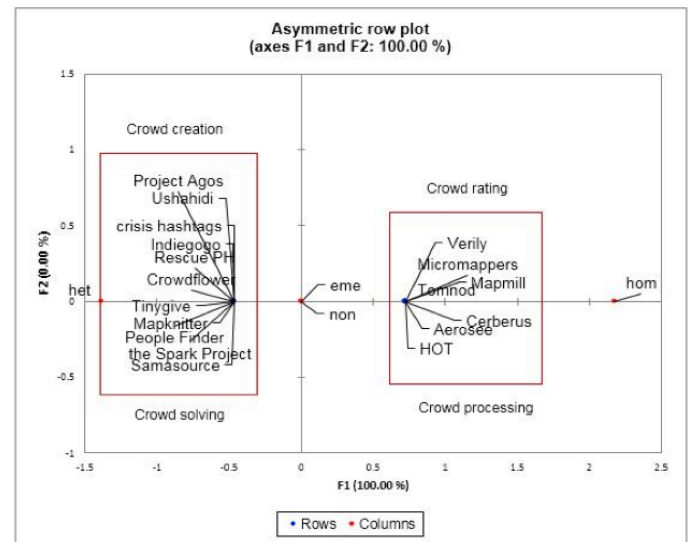


Figure 7. Asymmetric row plot representing the clustering of the websites according to the emerging archetypes.

This merging could be interpreted as the transformation of archetypes from emergent to non-emergent.

From crowd creation to crowd solving archetypes. In general, Quadrants 2 and 3 merged due to the kind of information flow observed on the sampled websites: Crowd creation websites collect heterogeneous contributions and “create” comprehensive databases of texts and maps. These websites then become a crowd solving system as some of the heterogeneous reports are taken among the list and are used to “solve” or respond to a crisis.

From crowd rating to crowd processing archetypes. The merging of Quadrants 1 and 4, on the other hand, could be explained by the phases by which “rates” transform to “processed” information: Crowd rating websites “rate” information according to: 1) relevance and usability (e.g., Micromappers, Mapmill, Verily); or 2) the likelihood of presence of a crisis situation in specific locations (e.g., Tomnod, HOT, Cerberus, aeroSee). These homogeneous “ratings” are then used to produce crisis maps and text databases. As rates turn to filtered information, the websites act as crowd processing systems because they “process” and filter huge amount of raw data.

The dynamic process of humanitarian crowdsourcing does not appear to be boxed into the CIS archetypes. Though the difference and value of contributions were important to determine the characteristics of each system, resulting data did not end up strictly adhering to Geiger et al.,’s (2011) four

CIS archetypes, which arose from analyzing business-oriented websites. Unlike most business crowdsourcing systems where the role of the websites ends online, humanitarian initiatives are expected to conclude with an actual humanitarian response.

Proposed Humanitarian Crowdsourcing Model

Integrating the weightiest findings discussed in this paper, a humanitarian crowdsourcing model (Figure 8) is proposed.

Enabling medical and disaster response through crowdsourcing starts from the aggregated information collected from a wise crowd. Eliciting crisis-related information from a large group of digital volunteers would only be effective if the crowd is composed of individuals with a decentralized demography who willingly contribute their private information and private judgment.

This crowd tosses its information through the different types of tasks posed by humanitarian crowdsourcing websites. The amount and significance of an individual's contribution depend on these tasks, as they limit the kind of input that one can contribute to the system. The types of tasks include: 1) text/image data submission; 2) text/image sorting; 3) text/image mapping; 4) object tagging; and 5) donation/crowdfunding. Through these tasks, crisis-related information is crowdsourced and used to solve real-life crisis situations. The types of information are: 1) community-based; 2) infrastructure-based; 3) information-based; and 4) future threats.

To translate crowdsourced information into actual medical and disaster response, information undergoes processes that result in three types of outputs: 1) first degree material outputs; 2) non-material outputs; and 3) second degree material outputs.

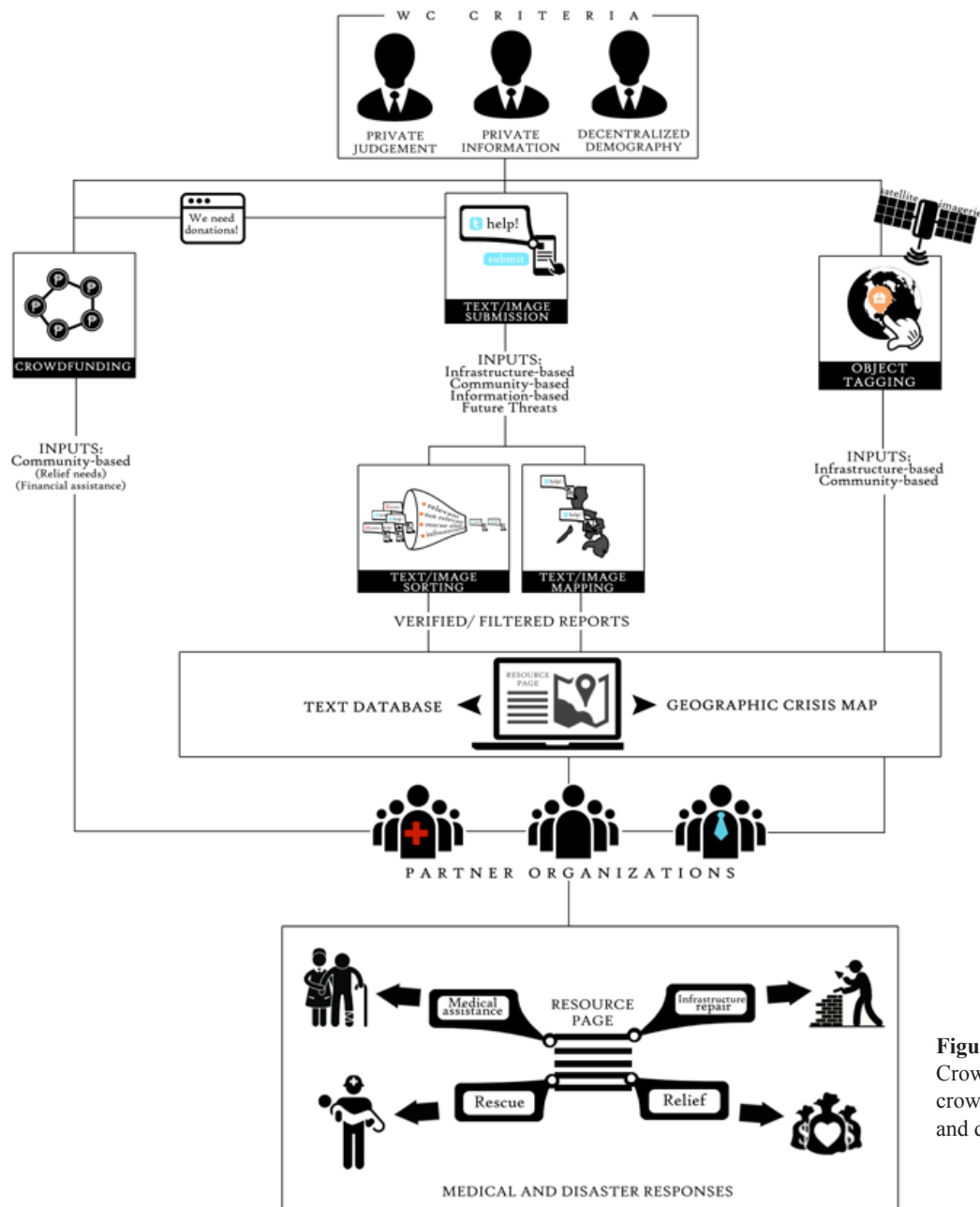


Figure 8. Proposed Humanitarian Crowdsourcing Model illustrating how crowdsourcing platforms enable medical and disaster response.

During the initial phase of transforming information to its desired output, crowdsourced information is presented as a comprehensive geographic crisis map and/or text database/resource page (first degree material output). These outputs are delivered directly to partner organizations (e.g., medical and disaster response groups, local and national authorities, non-government organizations or NGOs), which facilitate the planning, strategizing, and operationalization (non-material output) of the suggested actions.

As the partner organizations act on information that has been crowdsourced, the final phase of humanitarian crowdsourcing is achieved and the actual medical and disaster response (second degree material output) is enacted/delivered to the affected communities.

Conclusion

Enabling medical and disaster response through crowdsourcing consists of integrated elements and processes that co-dependently work as a system.

This study affirms that digital volunteers must be composed of an independent and decentralized crowd with diverse opinions to produce significant outcomes. However, based on content analyzed and results that surfaced, it appears that the nature of the digital volunteers who work for humanitarianism is different from the nature of the online crowd (sometimes paid microworkers) that makes contributions for business purposes (as is the basis of most studies on WC). While Surowiecki's (2005) WC suggests that social influence could lead to emulation of information, some features of a humanitarian crowdsourcing initiative may not necessarily be devaluated if there is repetition of submitted information, especially if it is in the form of raw inputs on critical reports and announcements.

There are two aspects significant in determining the kinds of humanitarian information generated through crowdsourcing: a) type of task; and b) type of crisis-related information. While the types of crisis-related information are more relevant during the actual crisis situation (practical), the types of task prove more useful in describing the nature of the websites (theoretical).

There are two types of material outputs produced in a humanitarian crowdsourcing initiative: a) first degree or the immediate outcomes of a website; and b) second degree or the actual medical and disaster response. A CIS's partner organization enables first degree outputs to be transformed to second degree outputs. This is because it can facilitate non-material outputs (i.e., planning, ideation, and strategizing). Unless the humanitarian crowdsourcing website works with a partner organization, the information crowdsourced on the website would not be acted upon.

The weight of significance of digital volunteers' contributions varies by the difference of the types of tasks and the value they have, to realize actual medical and disaster response. While the homogeneity and heterogeneity of the websites can be easily distinguished through identifying the types of task, this

study concludes that the emergence and non-emergence of the websites must both exist in each humanitarian CIS.

The study's findings conclude that the fundamental dimensions (difference and value of contributions) of Geiger et al.'s (2011) CIS could aid in classifying crowdsourcing systems, but humanitarian crowdsourcing websites did not end up boxed into the four archetypes (i.e., crowd creation, crowd solving, crowd processing, and crowd rating). Instead, humanitarian crowdsourcing websites could be divided based on the types of tasks (e.g., text/image data submission, text/image sorting, text/image mapping, object tagging, and donation/crowdfunding), where homogeneous (filter mechanisms) and heterogeneous (raw inputs) features of the system are given more emphasis.

Recommendation

This study recommends to the humanitarian community and the digital volunteers in the Philippines that they collaborate with web experts in developing a comprehensive humanitarian CIS that would aid in the coordination of various local and national government units, NGOs, local and international humanitarian groups, and digital volunteers during crises. It also recommends to the humanitarian groups, especially to the communication and web experts, to integrate the different types of tasks, types of crisis-related information, and types of outputs in the development of a comprehensive system to optimize the application of crowdsourcing as a method for humanitarian movements in the Philippines. Lastly, this study recommends to further harness the power of social media to attract attention from the public, so that more organizations and individuals would participate and contribute significant information to humanitarian movements in times of disasters.

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