Evaluation of Digital Volunteers using a Design Approach: Preferences and Motivations in Disaster Response

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ABSTRACT

With the growth of social media and crowdsourcing in disaster response, further research is needed on the motivations and contributions of digital volunteers. This study applies a user-centered design approach to understanding how we might make better tools to support digital volunteers. This user-centered design approach involves stated preference elicitation methods through an online survey to understand what digital volunteers want in such tools. Through choice-based conjoint analysis, we contribute to mixed-methods research to gain additional insight into motivations and user preferences for a set of design features that might be incorporated into an online tool specifically for digital volunteers. Initial results show preferences for measures of success that were not monetary, which aligned with directly stated motivations for volunteering. Our findings corroborate with previous research in that feedback to volunteers is very important, as well as being able to measure the impact of their work.

Keywords

Disaster Response, Crowd-sourcing, Digital Volunteer, Social Media, User Design

INTRODUCTION

Emergency and disaster management has been transformed by mobile technologies and social media. Social media is particularly useful for emergency responders to communicate and gather information, meet and manage citizen expectations, increase situational awareness, and leverage citizens as force multipliers (Williams and Phillips, 2014). Previous uses of social media by the affected community and through global digital volunteers through Open Street Maps (OSM) and Twitter have largely been effective (Bjerge et al., 2016). Briony (2018) has made a number of observations about the value of social media for disaster response, particularly in the Caribbean. First, social media has shown potential as an additional channel for disaster response functions and services: Facebook offers preparedness information, WhatsApp has been relied upon for coordination and planning, and Twitter has been used for real-time weather updates to an extent. Second, social media is particularly useful as they are free to access with an internet connection, require little authentication to use, and are available in real-time. Third, the increasing use of social media, especially in small island developing states (SIDS), is important due to islands in the Caribbean featuring compressed spatial scales (local level is similar to national level). Further, the expanded use of social media has led to the growth of resilience and preparedness information online. Finally, as a tool to facilitate hurricane resilience, social media is a priority for SIDS to encourage and enable community engagement (Briony, 2018).

Despite the usefulness of social media, a main challenge is lack of relevancy and clarity of information provided due to the massive volume of available information after events and the fact that much of it can be considered noise (Cobb et al., 2014). There are often tradeoffs between gathering enough information to assess disasters and reducing

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information and channels to be able to respond quickly (Leidner et al., 2009; Zhang et al., 2002). Many involved in disaster management are not always able to distinguish between channels, leading to uncertainty and loss of time (Bjerge et al., 2016). This may be partly due to lack of standardization as there is no customary approach across all actors to evaluate information (Commonwealth Telecommunications Organisation (CTO), 2006; Leidner et al., 2009; Williams and Phillips, 2014; Meissner et al., 2002). There has been growing interest and research on how to leverage the deluge of social media data for disaster management, including online platforms and tools that focus on crowdsourced data (Poblet et al., 2018).

Crowdsourced efforts can be critically important in disaster response, especially as they can be a way to handle big data and reduce the noise in information from social media. Crowd participation can better handle large tasks and data analysis needs through bringing digital volunteers together (Briony, 2018). Digital volunteers are those remotely located to a disaster that contribute either as individuals or within networks or organizations to the response effort (Poblet et al., 2018). They are unaffected individuals using social media and other online tools to assist in disaster response efforts by taking on tasks such as information processing through filtering and mapping crisis-related social media data (Cobb et al., 2014). Social media has become the main tool for digital volunteers, and the use of crowdsourcing platforms has improved volunteers' contributions to disaster management. A main task that digital volunteers conduct is media monitoring, including social media posts, to find new, relevant information and curating it into usable resources (Cobb et al., 2014). Given the value of social media's role in facilitating the efforts of digital volunteers, it is clear that there are substantial opportunities for the creation of online tools to better support their efforts. In this paper, we take a human-centered design approach to these tools that begins by understanding the needs and motivations of digital volunteers.

This study explores two main research questions on digital volunteers in disaster response: what features do they prefer in a digital volunteer platform and what are their main motivations to volunteer in disaster response? We conducted a multi-faceted survey with digital volunteers and potential digital volunteers to (1) assess their preferences for a digital volunteer platform, (2) assess their stated motivations for digitally volunteering in disaster response, and (3) gain insights into the design features of tools for crowdsourcing. Through this study, we hope to identify opportunities to improve the future design of digital volunteer and crowdsourcing tools for disaster response.

RELATED WORK AND RESEARCH GAP

Digital Volunteer Roles

Digital volunteers have become an established feature of crisis events. The main reasons for this include: (1) their motivation to make citizen-reported information usable and (2) access to online tools that allow them to access this information and coordinate their work (Cobb et al., 2014). Digital volunteer communities are one of four roles that crowds take on in crisis management based on distinct skills and expertise. Liu et al. (2014) identified these four roles as: 1) affected populations, 2) diasporas, 3) social networks, and 4) digital volunteer communities. In these roles, disaster-affected populations provide "local, timely, and direct experiential information", diasporas provide unique "socio-cultural tacit knowledge", social networks provide "varied background with unexpected and possible fortuitous experience', and digital volunteers offer their "capabilities in processing and managing crisis data" (Liu et al., 2014). Further, digital volunteers can take on different organizational forms in disaster response.

Empirical research on recent disaster events shows digital volunteer work can take place in four different organizational forms: established, extending, expanding, and emerging (Cobb et al., 2014). The emerging or 'emergent' category is identified by ordinary and local individual citizens that contribute to emergency response through new and informal groups (Sebastian and Bui, 2009). Emergent organizations of remote actors connected through social media are "now a feature of disaster response milieu," as evident through various examples of emerging organization assistance in the Haiti earthquake, Alabama and Joplin tornadoes in 2011, and Hurricane Sandy in New Jersey (Cobb et al., 2014). The expanding category is identified by having an established structure between events, but increased capacity for response during events by activating part time volunteers and bringing in new ones (Cobb et al., 2014). This category includes ongoing digital volunteer organizations that use online tools to provide remote assistance during disaster events, such as Crisis Commons, CrisisMappers, Standby Task Force, and Humanity Road (Cobb et al., 2014). In various organizational forms, digital volunteers have proven as key actors in a disaster response. We focus on the role of digital volunteers as emergent actors by assessing their motivations and incentives.

Digital Volunteer Motivations

Previous studies have surveyed digital volunteers that processed online and social media streams during crisis events and identified important motivations and incentives. A large number of studies have used Open Street Maps as a case study to determine the engagement and motivations of citizens as volunteers and have found participants

want to share their knowledge, experience community, learn new things and advance their career (Baruch et al., 2016). For other platforms, there can be very different motivations such as the desire to contribute to scientific discovery (Baruch et al., 2016). Santos Rocha et al. (2016) review literature on citizen engagement and identified motivations of digital volunteers including: connection to the area, ideology, personal satisfaction, community, humanitarian values, and desire to apply and improve technical knowledge (Santos Rocha et al., 2016). Other important incentives include: encouraging volunteers by giving feedback, recognition, appreciation and gratitude; cultivating sense of ownership and accountability; generating a feeling of inclusivity based on collaborations; and providing training and capacity-building opportunities for volunteers (Santos Rocha et al., 2016). In regards to the effort input of an individual, this is higher when the individual expects that the contribution will yield results (Santos Rocha et al., 2016). Among these incentives, they can influence volunteer's accuracy and task completion differently. Daniel et al. (2018) review crowdsourcing literature and identify that incentives affect the attractiveness of a task in crowdsourcing (Daniel et al., 2018). Incentives can target the extrinsic (reward-driven) or intrinsic (interest-driven) motivations of workers. Increasing extrinsic motivations leads to faster task completion while increasing intrinsic motivations leads to higher quality (Daniel et al., 2018).

Other studies have found motivations can vary based on previous experiences. Cobb et al. (2014) interviewed those who worked remotely to process social media streams as digital volunteers or as emergency response professionals and found a main reason to become a digital volunteer as believing that social media and non-local responders can have an impact during crises. Other reasons they identified included: gain skills for their career, "give back to society because they want to pay it forward and they were impacted," they have extra time on their hands, and they have a personal connection to the area. Among those who used social media in an official capacity, their motivations were to gauge community opinions and misunderstandings so outgoing messages could be tailored to specific needs and they then connected to people doing digital volunteer work (Cobb et al., 2014). This study also found different motivations for continuing as a digital volunteer, especially considering many interviewees described disaster fatigue can occur after responding to an event since continued participation has a significant cost (Cobb et al., 2014). Motivations for sustained membership included: altruism, making an impact, knowledge of definitive impact, formation of identity as a digital volunteer, connecting their work in the crisis space to their self-identity, the personal relationships that volunteers forge with each other, and gain new skills through digital volunteer work that may benefit them in other areas of their lives or in future disaster (and non-disaster) scenarios (Cobb et al., 2014).

Baruch et al. (2016) examine online crowdsourcing from the perspective of volunteers and the campaign coordinator of Tomnod, an online mapping project owned by Digital Globe that uses crowdsourcing to identify objects and places in satellite images (Baruch et al., 2016). Through online surveys, they found participant demographics influence their motivations including being retired or having a disability or long term health problem leading them to use Tomnod as a "better use" of time or "help in anyway possible" (Baruch et al., 2016). They also found a majority of general motivations aligned with an altruistic theme, including explicitly mentioning that they want to help people in urgent need of assistance (Baruch et al., 2016). Further, some saw contributing to Tomnod as an alternative to charity work and other motivating factors included involvement in a global community, looking for people they know, enjoying the task, and taking part in a fun pastime (Baruch et al., 2016). Altruistic motivations may not be enough, but successful campaigns benefit from volunteers having a sense of satisfaction and achievement on their contributions (Baruch et al., 2016).

For crowdsourcing campaigns in humanitarian applications, there is a need for further research into the motivations and preferences of users (Baruch et al., 2016). The current literature need mixed-methods research to provide an additional depth of insight into digital volunteers (Baruch et al., 2016). In particular, there is further research needed on understanding stakeholder needs and values for the development of a platform used by digital volunteers. This study seeks to contribute to this research in order to improve upon sources of information that help meet the needs of those affected by an emergency or disaster.

Design Features and Conjoint Analysis

Using similar methods to identify motivations for participating as a digital volunteer, previous studies have found specified features of a platform or tool that volunteers would prefer. As found in Baruch et al. (2016) through an online survey, the main features that are preferred in a digital volunteer platform include feedback on quality of contributions, follow-up on how data was used, education or training to improve skills, and engagement with formal organizations like Tomnod. Overall, there was a sentiment of a participant's wish to be more engaged, such as by getting a "certificate of participation or some kind of award" (Baruch et al., 2016). Moreover, a majority of participants referred to wanting some sort of feedback and desire for more information on the campaigns, including how data was used (Baruch et al., 2016). A key feature of various digital volunteer platforms is an 'agree' score that shows how many participants also tagged the same location, but this was viewed negatively by some as it reflected how a volunteer may be wasting their time and they would rather prefer to get feedback on their impact or results (Baruch et al., 2016). Other features that volunteers would like included: greater control over data

(i.e. a more transparent platform), links to Google maps, ability to see what other volunteers are doing, ability to discuss observations with others, and a voting system to choose the campaign that is activated (Baruch et al., 2016). Including this study by Baruch et al. (2016), directly stated questions in surveys and open-ended questions in interviews have largely been used to identify preferences for features of crowdsourcing and digital volunteer platforms for humanitarian and disaster response applications. In other work on individual motivations for digital volunteering and design preferences for crowdsourcing platforms, interviews for persona identification and user trials have been used (Yu et al., 2012b; Ludwig et al., 2017). We seek to apply an approach of user-centered design to understand the preferences and motivations of digital volunteers that has been seldom applied in the field of disaster response.

This study applies a user-centered design approach to understand stakeholder perceptions and motivations for being a digital volunteer in disaster response and to determine important features for a platform for digital volunteers. To obtain meaningful and accurate information from users, conjoint analysis is a widely used and cost-efficient tool to capture preferences for products. Conjoint analysis addresses the additive effect of a set of individual variables on consumer preference (Bao et al., 2014). The type of conjoint analysis used in this study is choice based conjoint, which presents participants with several products with different combinations of attributes and asks them to choose which they prefer (Bao et al., 2014). An example of choice based conjoint analysis is in c, where this method was used to identify preferences for product appearance of solar panels. In the humanitarian and disaster response field, there have been few uses of conjoint analysis including identifying preferences for aid delivery plans (Gralla et al., 2014). Although widely used in market research, conjoint analysis has largely not been used in the field of humanitarian and disaster response nor to capture preferences in crowdsourcing platforms. In this study, the preferences of potential and previous digital volunteers for features of a digital volunteer platform were examined using conjoint analysis.

METHODS

User-based Design and Conjoint Analysis

In this study, choice based conjoint analysis is used as the main preference elicitation method. Conjoint is used widely in marketing for understanding the preferences among attributes in a group of people. In a conjoint analysis, several attributes of a product are chosen, and each attribute can be varied at discrete levels. A controlled set of potential configurations is created by experimental design, and each configuration contains a combination of the attributes (Kuhfeld, 2003). After the set is prepared, users are asked to rate, rank, or choose among the product profiles. Choice based conjoint presents several configurations with different combinations of attributes to users and asks them to choose the one they like the most (Kuhfeld, 2010). With the user ratings, utility models can be built and predictions can be made about users' future preferences. Conjoint analysis is used to address the additive effect of a set of individual variables on consumer preference and is widely used in market research to determine user value of different features that make up a product or service (Green, 1974). As conjoint belongs to the category of stated preference eliciting methods, this was supplemented by directed stating preference methods in the online survey we conducted.

Data Collection

This study's first part includes presenting users with an online survey on a digital volunteer platform with varying features and related questions on experience and potential motivations for volunteering in a disaster response. The details of creation of the survey, administration, and participant demography follow.

Attribute Identification

A literature review was conducted to identify features (or attributes) of crowdsourcing platforms (Poblet et al., 2018; Hossain and Kauranen, 2015), including websites (Yu et al., 2012b), public displays (Ludwig et al., 2017), apps (Gu et al., 2017; Morschheuser et al., 2018; Li and Ulaganathan, 2017), among other systems (Ogie et al., 2019; Yu et al., 2012a), as well as to identify motivating factors for digital volunteers (Cobb et al., 2014; Daniel et al., 2018; Baruch et al., 2016; Spatharioti and Cooper, 2017; Santos Rocha et al., 2016). This was supplemented with an analysis of the attributes of major crowdsourcing platforms for digital volunteers, including Tomnod, CrowdSource Rescue, Ushahidi and Open Street Maps (OSM). In this study, analysis of the literature and currently available resources identified five key attributes that are related to the motivations of digital volunteers in a crowdsourcing platform:

1. Volunteer Profile
2. Volunteer Measure of Success Shown on Profile
3. Social Network of Volunteers
4. Feedback to Volunteer

5. Social Media Post of Volunteer Task

In the survey, each attribute was varied on 3-6 levels, which are shown in Table 1. We only considered design features of a crowdsourcing platform that are most directly related to motivating factors for digital volunteers. For the sake of simplicity, we also do not consider any other user interaction or design features than those listed, and hold all other attributes constant.

Attribute	Num. of Levels	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Volunteer Profile	4	Display past experiences in volunteering	Display volunteer's location	Display volunteer's calendar	Display when volunteer is working on task		
Volunteer Measure of Success Shown on Profile	5	Rank among other volunteers	Points earned based on task completed	Money earned from tasks completed	Awards won based on tasks completed	Money earned from donations	
Social Network of Volunteers	4	View volunteers nearby	View volunteers with similar interests	View volunteers working on similar tasks	No Social Network		
Feedback to Volunteer	6	Get verification from formal organization	Earn points for accuracy in the results of tasks	Enter to win reward for highest accuracy in results among group of volunteers	Earn money per task completed	Earn money from donations depending on who sees your profile and tasks completed	Earn money based on accuracy in results of tasks
Social Media Post of Volunteer Task	4	Add to LinkedIn skills or experience	Post on Facebook	Post on Twitter	Post on Instagram		

Table 1. Levels of attributes influencing design features of crowdsourcing platform

Survey Design and Participants

A seven-part survey was designed, with a summary of its structure shown in Table 2. The sequence of different parts of the survey was designed so directly stated questions came after pairwise choice questions to reduce potential bias of preference. Specific questions were introduced as cross checks to see if respondents answered the same questions the same way again. Directly stated questions on motivation and social media use were elicited in Part VI in the survey. The survey was created and distributed using SurveyAnalytics. Informed consents from the participants were obtained at the beginning of the survey. A total of 695 participants took part in the survey. Two criteria were used to screen the data:

1. **Completeness**: Respondent data was assessed based on total completeness of survey. Incomplete questions were identified and rejected.
2. **Quality Control Questions**: Two quality control questions were included to ensure respondents did not thoughtlessly provide answers. The questions were dispersed throughout different parts of the survey and included a fixed question with a simple 'please select continue response' direction. In addition, a question from Part V was reintroduced in Part VII to cross check whether respondents answered in the same way. Respondents that did not pass all quality control questions were rejected.

This led to 389 valid responses for final data analysis. Among the valid data, demographic information of the participants is as following: 269 females, 117 males, age ranging from >18 to 60+, and 371 participants stated they reside in the United States.

Conjoint Data Analysis

A multi-nomial logit model was used to determine the conjoint part-worth values. In this model, $w(a, l)$ is the part-worth value for a particular attribute a and level l and x is an array which is equal to 1 if a specific attribute and level are present and 0 otherwise. Where U_x is the sum of the part-worths for the attributes and levels present in a configuration, this model assumes that for a choice between N configurations, the probability configuration 1 will be chosen is:

$$P_1 = \frac{exp(U_1)}{\sum_{i=1}^{N} exp(U_i)}$$

Following with this model, the choice probability of choosing the c^{th} configuration out of total C configurations in the t^{th} task for the n^{th} respondent is:

$$P_{ntc} = \frac{exp(X_{rtc}.w)}{\sum_{i=1}^{C} exp(X_{rti}.w)}$$

Part I	Introduction: general introduction of study and volunteering for disaster response
Part II	Disaster Experience Level: two questions on experience levels in an area impacted by a disaster or emergency, including if have known someone else with a first-hand experience
Part III	Preference as Volunteer for Platform: five-question pairwise choices questionnaire. Each question asks participants to choose preferred set of features of platform among five other sets of features.
Part IV	Preferece as Donor for Platform: five-question pairwise choices questionnaire. Each question asks participants to choose preferred set of features of platform among three other sets of features.
Part V	Volunteering Experience Level: two questions on experience levels in volunteering and digital volunteering for emergency or disaster situations
Part VI	Directly Stated Preferences: two questions asking motivating factors for volunteering and social media use. Question one asks participants to rank possible motivating factors if they were to volunteer in an emergency or disaster. Question two ask participants to specify level of use of various social media
Part VII	Demography: a questionnaire asking basic demographic information including age range, gender, income level, education, and residential location.

Table 2. Survey Structure

As per the algorithm by SurveyAnalytics (SurveyAnalytics, n.d.), a log-likelihood measure for all responses is used, forming a multi-dimensional non-linear continuous maximization problem. This is solved using a Nelder-Mead Simplex Algorithm to find the part-worth values. Finally, the part-worths are re-scaled so that for any attribute they have a mean of zero and then normalized for graphical representation on a percentage scale of 0 to 100 percent. The relative importance of each attribute was calculated by considering how much difference each attribute could make in the total utility of a product, where the difference is the range in each attribute's utility values. The importance measures are ratio-scaled and relative, study-specific measures. Utility value is calculated by the average of the part-worth values. Part-worths are scaled to an arbitrary additive constant within each attribute and are interval data. The equation used in this study for calculating a relative attribute importance was:

$$RelativeImportanceofAttribute = \frac{(HighestUtilityValue - LowestUtilityValueofattribute)}{\sum UtilityRangeofallattributes}$$

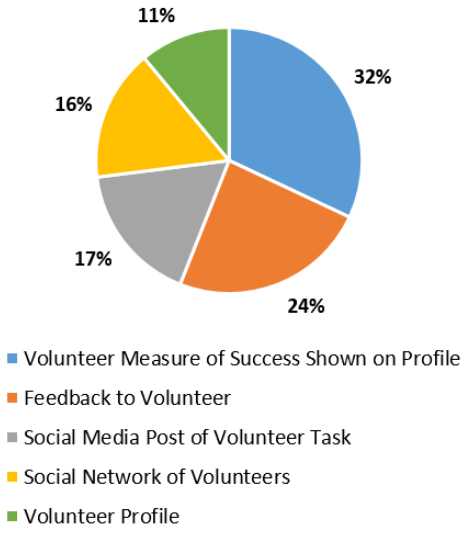


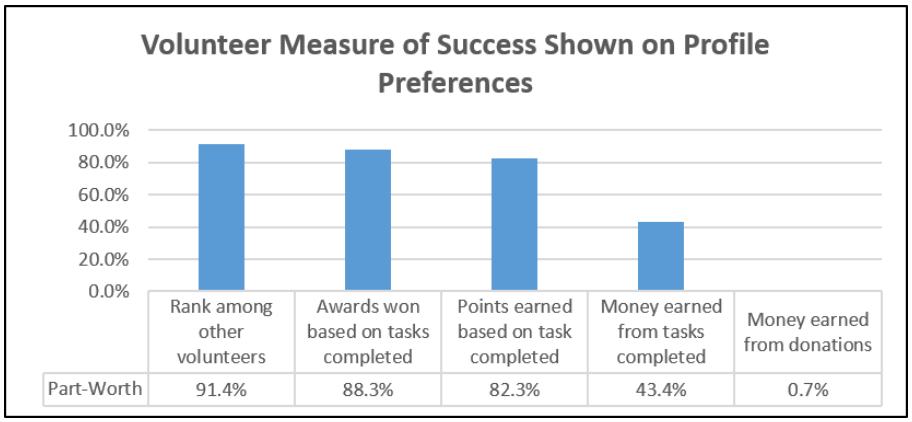
Figure 1. Relative Importance of Attributes

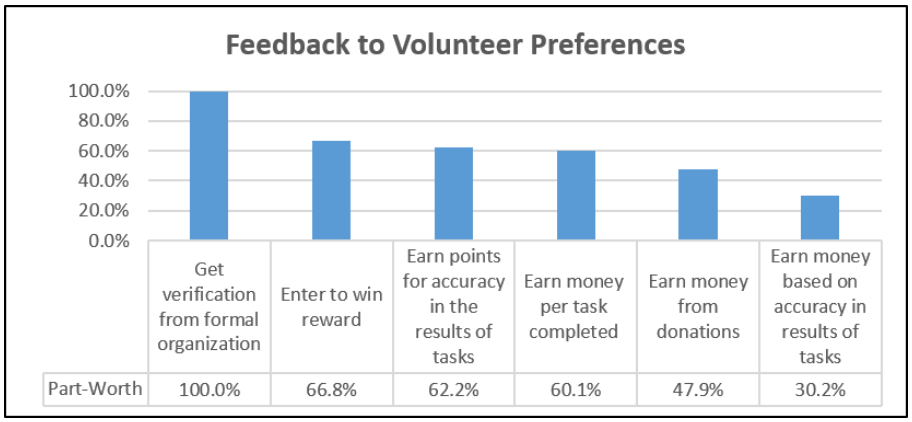
	Best Profile Levels
1.	Display past experiences in volunteering
2.	View volunteers working on similar tasks
3.	Get verification from formal organization
4.	Post on Facebook
5.	Rank among other volunteers

Figure 2. Best Profile

RESULTS

The relative importance of each attribute was calculated by considering how much difference each attribute could make in the total utility of a product. The results shown in Figure 1 are the part-worth utilities of each attribute level, which indicate the preference level of that attribute. The higher the part-worth, the more important the attribute is to the respondent. The *Volunteer Measure of Success* attribute was found as the most important followed by *Feedback to Volunteer*. The results for all attributes are shown in Figures 3 and 4. Among all the possible combinations of attribute levels, the 'best profile' made up of the most important level for each attribute is shown in Figure 2. For the top attribute of the *Volunteer Measure of Success*, the level with the highest utility (or part-worth) was *Rank among other volunteers* at 91.4% and the level with the lowest utility was *Money earned from donations* at 0.7%. For the directly stated question on motivation factors for volunteering in a disaster or emergency, the results are shown in Figure 5. The average rating of motivation factors are shown, based on participants rank ordering each factor from 1-8 (1 being highest). The motivation factor with the highest average rating was *Personal connection to area*, followed by *Give back to society* and *Make an Impact*.





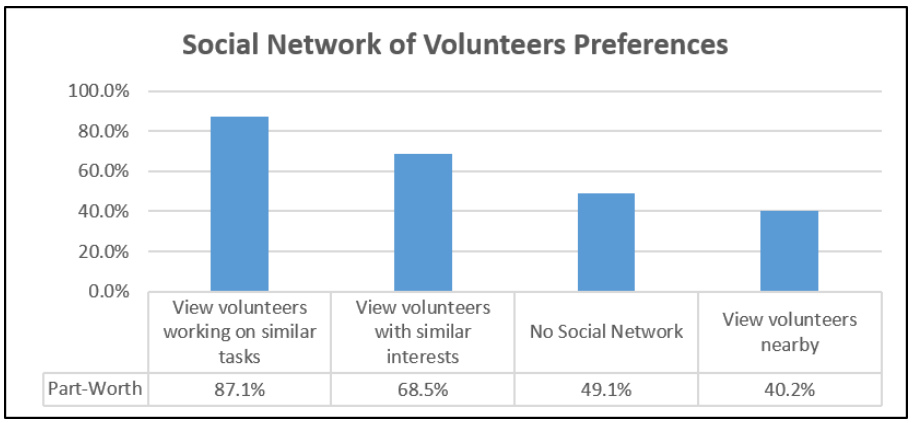


Figure 3. Average Part-Worths of Attributes of Crowdsourcing Platform: Part 1 of 2

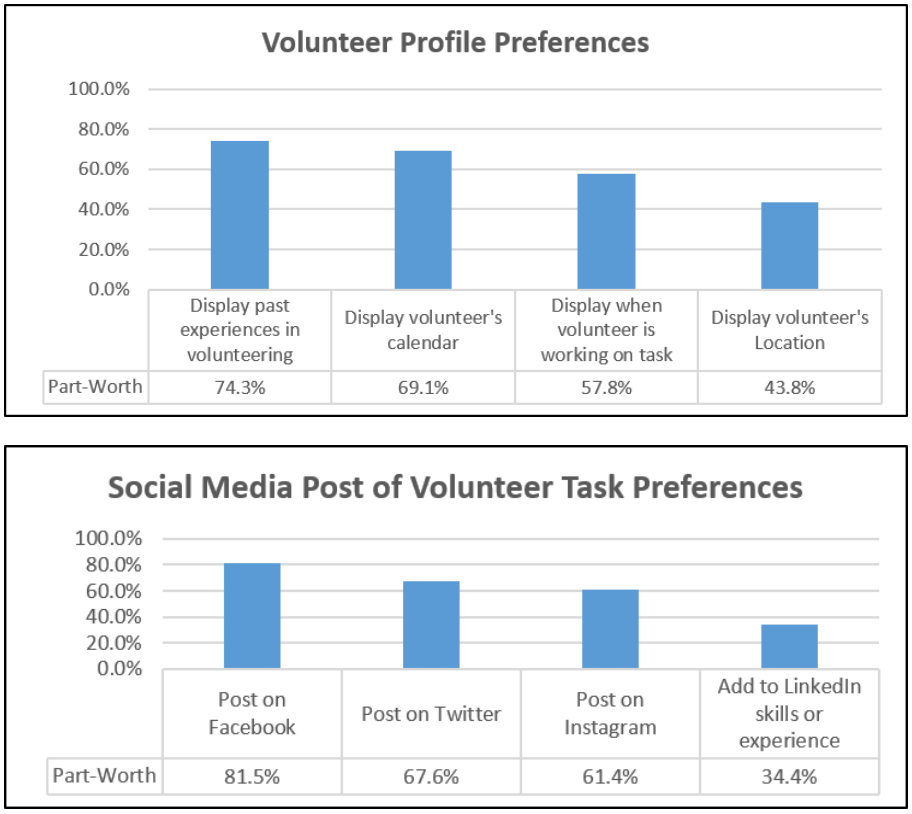


Figure 4. Average Part-Worths of Attributes of Crowdsourcing Platform: Part 2 of 2

Figure 5. Average Rank of Motivation Factors (1 being highest)

DISCUSSION AND CONCLUSION

Digital Volunteer Motivations and Design Preferences

Similar to previous studies on digital volunteer roles and motivations (Cobb et al., 2014; Baruch et al., 2016), important attributes for a crowdsourcing platform were found to be the measure of success of volunteers and the feedback provided to volunteers. Within these two attributes, the least preferred levels were those related to monetary compensation. This aligns with the directly stated results for rating of motivation factors in the survey, which found earning a reward (monetary, prizes, etc) as being rated the lowest. For the remaining three attributes of a crowdsourcing platform, the utility values for the levels within the attributes were less varied, indicating that users did not strongly prefer these certain features of a crowdsourcing platform over others. As the conjoint results

indicate, digital volunteers value understanding their success and would prefer to view this on a digital volunteer platform in the form of a rank among other volunteers or as awards won. Similarly, digital volunteers also value feedback and would prefer to view this on a digital volunteer platform in the form of verification from a formal organization or entering to win a reward. Conjoint analysis elicited such preferences of digital volunteers and revealed the importance of evaluation of a volunteer's performance. The main findings of this paper are that the future design of digital volunteer platforms should consider the importance of measuring volunteer's success and providing feedback to volunteers, particularly in a form that confirms to the volunteer that they have made a useful contribution.

Overall, this study has shown a user-centered approach can be applied to understanding digital volunteers and in the field of disaster response. Moreover, this study contributes to mixed-methods research to gain additional insight into motivations and user preferences for a set of design features that might be incorporated into an online tool specifically for digital volunteers. A limitation of this study includes that the survey used written description of features of a digital volunteer platform rather than visual depictions or examples, which may impact the understanding of respondents and preferences of features. Remaining work still needs to be done in building individual preference models, aggregated preference models, and comparing subgroups. Future work could also include different scenarios for volunteers to select motivating factors, as well as an experimental evaluation of accuracy in a digital volunteer task compared to motivating factors.

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