Malasakit 1.0: A Participatory Online Platform for Crowdsourcing Disaster Risk Reduction Strategies in the Philippines

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***Abstract*—We describe Malasakit 1.0 (meaning "sincere care" in Filipino), a customizable participatory assessment platform that collects and streamlines quantitative and qualitative analyses and insights of disaster risk reduction (DRR) strategies. While supervised classification approaches offer opportunity to understand qualitative textual suggestions, those methods break down in areas like the Philippines, home to hundreds of dialects and regional language nuances in varying socioeconomic contexts. Instead, Malasakit uses dimensionality reduction and peer-to-peer evaluation on qualitative textual suggestions to identify locally appropriate DRR strategies. We present results from 12 field tests conducted in eight distinct geographic locations in the Philippines. 998 participants provided 7,157 evaluations on flood and typhoon preparedness and 2,481 peer-to-peer ratings on 896 textual suggestions for how local government could improve DRR strategies. Results suggest that female participants are more confident than males in their community's ability to recover from a major typhoon. High-rated textual suggestions focus on issuing immediate early warnings and cleaning drainages to reduce flooding. Malasakit can be accessed at tiny.cc/malasakit.**

***Keywords*—collaborative filtering, development assessment, participatory assessment, principal component analysis**

I. Introduction

More than 98 million people are affected by natural disasters each year, and developing countries often lack effective disaster risk reduction (DRR) strategies, resulting in higher mortality rates and long-term negative socioeconomic consequences [1, 2]. Many existing government-initiated DRR strategies take a top-down approach, treating local communities as passive recipients rather than active collaborators in data collection and interpretation for DRR planning and response. However, recent studies suggest that collaboratively engaging affected communities in the design and implementation of DRR strategies can increase efficacy [3-7]. To engage local communities in the evaluation and design of DRR strategies, we build on our previous work by expanding the capabilities of our Development Collaborative Assessment and Feedback Engine (DevCAFE) platform for soliciting input from local populations on the effectiveness of development interventions [8]. In this paper we describe the design and implementation of version 1.0 of the Malasakit platform (meaning "sincere care" in Filipino) to enable participatory evaluation of DRR strategies and results from 12 field tests in the Philippines, the second most at-risk country for disasters worldwide [9].

Fig. 1. The Malasakit platform was applied to enable collaborative evaluation of disaster risk reduction strategies in the Philippines. 998 participants contributed responses in 12 field tests.

While supervised classification approaches can provide insight into qualitative textual suggestions, those methods can be ineffective in areas like the Philippines, where there are hundreds of dialects and regional language nuances in varying socioeconomic contexts. Instead, Malasakit applies dimensionality reduction to identify features (i.e., combinations of responses), peer-to-peer "collaborative filtering" to discern locally relevant DRR strategies, and graphical user interfaces to reveal emerging patterns in the field.

To evaluate this initial version, we present results from 12 field tests across eight distinct locations in the Philippines (see Table 1). 998 participants provided 7,157 evaluations on flood preparedness and 2,481 peer-to-peer ratings on 896 submitted textual suggestions for how their barangay (i.e., local government unit) could help communities effectively implement DRR strategies.

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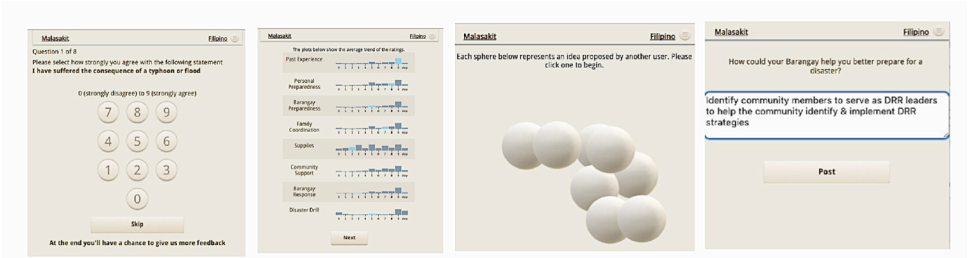

(1) Issues & Demographics (2) Collaborative Idea Evaluation

Fig. 2. Screenshots of the Malasakit platform. Participants first provide quantitative responses on key issues on a scale of 0 "Strongly Disagree" to 9 "Strongly Agree." Participants can then see how their response differs from the responses of all other participants. Finally, participants enter an open-ended discussion where they can evaluate other participants' suggestions and provide their own suggestion.

II. Related Work

Applications of digital data collection tools for humanitarian evaluation and disaster risk management have been well studied [10, 11, 12]. The most comprehensive is the Open Data Kit (ODK), an Android-based platform that can collect text, voice, image, and sensor data; is resilient to intermittent network connectivity; and features a variety of data export formats. Built on ODK, the Harvard Humanitarian Initiative's KoBo Toolbox collects quantitative and qualitative survey data and analyzes quantitative data in real-time [13]. Dimagi's CommCare platform can be distributed over smartphones and feature phones to collect text, image, video, and other data from development practitioners in the field. CommCare can analyze data in real-time and present results back to participants to inform development interventions [14,15]. Alternatives to online data collection include interactive voice response surveys, such as ODK Voice, and SMS-based data collection through platforms such as FrontlineSMS and RapidSMS. FrontlineSMS is an open-source platform that enables communities with limited internet connectivity to answer simple survey forms through text messaging. Alternatively, RapidSMS, built with Python and Django, can collect more structured data on a larger scale.

Participatory action research (PAR) engages participants in active collaboration in the research process, empowering them to contribute to question formation, problem identification, interpretation of results, and formation of solutions [16]. PAR's bottom-up approach is particularly useful for development interventions and DRR strategies. While many of the features of ODK, CommCare, and Malasakit overlap, we optimize our software to prioritize collaborative participant-driven problem exploration and issue discovery. Participants not only contribute data, but also receive feedback and collaboratively evaluate responses provided by others.

Malasakit builds on our previous work on Opinion Space and DevCAFE projects. Results from Opinion Space showed that presenting participant textual suggestions in a 2D visualization increased engagement [17]. DevCAFE, piloted in Uganda to enable collaborative evaluation of effectiveness of development interventions [8] and in Mexico to identify priority policy issues [18], was found to provide researchers with scalable quantitative and qualitative analysis. We have also studied best practices for online civic engagement [19], social influence bias mitigation [20], and ongoing course evaluations for large courses [21].

III. Malasakit 1.0 Platform

A. Overview

Malasakit 1.0 is a customizable, multilingual, and participatory digital data collection platform that collects and integrates quantitative assessment, qualitative feedback, and peer-to-peer collaborative filtering of quantitative and qualitative textual data relevant to DRR strategies (see tiny.cc/malasakit). For version 1.0, the platform was redesigned with new content and implemented as a cross-platform web application using Django web framework and a SQLite database backend. Malasakit is intended to enable direct insights to emerge from those most affected by DRR strategies. Its user-friendly interface enables participants to visualize where they stand on issues in relation to their peers and allows DRR practitioners to identify insights as they emerge.

Malasakit features two stages (see Figure 2). In the first stage, participants provide their demographics, quantitative feedback on local DRR strategies, and evaluate their own disaster preparedness. Participants are able to see their responses in relation to others as bar graphs. In the second phase, participants provide textual responses to a qualitative, open-ended question and collaboratively evaluate the helpfulness of others' responses.

B. Issue Assessment & Demographic Questions

Participants are encouraged to answer quantitative assessment questions regarding their experience with typhoons/floods and the impact of DRR strategies on their community. Upon completing all assessment and demographic questions, bar graph distributions of responses for each question over all prior participants are displayed. This phase serves two purposes. First, it allows researchers to better understand the diversity of the population being assessed and the effectiveness of interventions. Second, the questions reveal to participants where they stand with respect to others, instantly knowing if they largely agree with the other

participants or if their responses are more extreme than others in the system (see Figure 2).

C. Collaborative Evaluation & Discussion

Malasakit features a visual, interactive interface for collecting peer-to-peer evaluation of qualitative DRR strategies. Malasakit presents a 2D map showing a small sample of DRR strategies to evaluate. Each Malasakit participant is invited to evaluate the helpfulness of at least two of their peers' responses before submitting their own suggestion. Rather than relying solely on the frequency of a particular suggestion to signify helpfulness to the local community, peer-to-peer collaborative filtering can identify novel DRR strategies from the participants themselves. For example, if DRR strategy "A" is submitted by a majority of participants but receives a low average helpful score, it may be a common DRR strategy but most agree will not be effective. On the other hand, if DRR strategy "B" is submitted by a minority of participants but receives a high average helpful score, it may be a novel strategy that the community believes could be more effective and thus worth pursuing.

D. Tools for Statistical Analysis

Malasakit provides researchers with the ability to export quantitative, qualitative, and user activity data in portable file formats, such as CSV, for rapid analysis. Researchers may use this information to quickly analyze emerging insights. In addition, researchers can also search and filter the database through an admin panel, allowing them to interact with the database without requiring direct access.

1) Quantitative Data & Demographics: Malasakit applies PCA to the issue assessment questions to identify "factors" that most differentiate participants. Formally, PCA finds a set of orthogonal linear combinations of observed variables, called principal components. These can be interpreted as latent, or unobserved "factors," composed of the various issues addressed in the assessment questions [22]. In our context, PCA provides a computationally efficient way to explore quantitative data and identify correlations among issues. The PCA factors can then be correlated to textual data or demographic variables, allowing identification of relationships between assessment responses and any given demographic variable.

2) Qualitative Data: Malasakit enables participants to collaboratively assess each other's suggestions, providing researchers insight into top-rated textual suggestions and strategies. Malasakit uses "collaborative filtering" to enable participants to rank each other's textual suggestions. Participants are provided a random sample of eight textual suggestions provided by others and rate the helpfulness on a scale of 0 "Strongly Disagree" to 9 "Strongly Agree."

To select textual suggestions for participants to rate, Malasakit calculates the standard error of the mean rating for each suggestion, then constructs a normalized cumulative probability distribution, from which we sample 8 times without replacement. New suggestions are assigned the max standard error of the mean of [0, 9], 4.5. These suggestions can then be projected onto a 2D plane either through random placement or by using the two principal components identified from the PCA. Each principal component has the highest variance possible while still being orthogonal to the other principal component. In other words, PCA yields the axes that best spread out points in the dataset. Suggestions from participants who responded similarly in the quantitative evaluation section are grouped together on the 2D plane. Since suggestions with larger standard errors will be sampled more often, controversial suggestions with highly varied ratings and new suggestions with few ratings will be sampled more often. This is highly desired since new or controversial suggestions still need more ratings to fully determine their salience and the suggestions that have been consistently rated very high or very low are no longer presented to participants for rating.

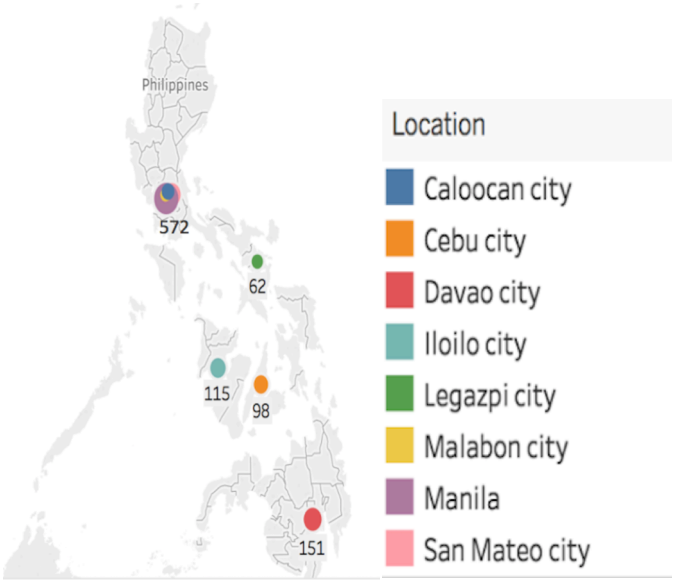

Fig. 3. Location of field test cities and the number of participants in the Philippines.

IV. Case Studies and Results

Malasakit was applied to identify and evaluate the effectiveness of DRR strategies for typhoons and floods in the Philippines. From Dec. 2016 to May 2017, 12 field tests were conducted in eight distinct geographic locations across the Philippines (see Table 1). Each field test was led by a Filipino researcher who guided participants on the goals and structure of Malasakit. Field test locations were chosen according to the community's prior experience with natural disasters and presence of a partnering organization (e.g., local government office, academic institution) to help implement Malasakit. Since Malasakit is built with HTML5, participants were able to access it on mobile phones, tablets, and computers. 998 participants completed Malasakit, providing over 7,157

evaluations on flood preparedness and 2,481 peer-to-peer ratings on 896 submitted suggestions for how local government could help communities better prepare for disasters.

TABLE 1 Malasakit Field Test Locations

Community	Location	Field Test Date	Partner Type	Gender Breakdown (Female, Male)	n
1. Zone 42, Sampaloc	Manila	Dec. 2-3 & 6-7, 2016	Local Government	59%, 41%	71
2. University of San Carlos	Cebu City	Jan. 25-26, 2017	Academic Institution	50%, 50%	98
3. Manila Deaf Community	Manila	Jan. 28, 2017	Community Org	38%, 62%	16
4. National University	Manila	March 13-20, 2017	Academic	44%, 56%	198
5. Barangay Banaba	San Mateo City	March 22 & 24, 2017	Local Gov	62%, 38%	154
6. University of the Immaculate Conception	Davao City	April 21-22 & 25, 2017	Academic	33%, 67%	151
7. Bicol University	Legazpi City	May 24, 2017	Academic	25%, 75%	31
8. Barangay Puro	Legazpi City	May 26, 2017	Local Gov	54 %, 46%	31
9. SM Malls employees	Malabon City	May 28, 2017	Private Sector	33%, 67%	54
10. AMA Computer University	Caloocan City	May 29, 2017	Academic	35%, 65%	79
11. SM Malls employees	Iloilo City	May 30, 2017	Private Sector	64%, 36%	75
12. AMA Computer College	Iloilo City	May 31, 2017	Academic	31%, 69%	40
TOTAL					**998**

Malasakit includes demographic questions (e.g., age, gender), eight quantitative assessment statements, and one open-ended qualitative question. The eight quantitative assessment statements were drafted in collaboration with partner barangay leaders through focus group discussions and refined through consultation with social science experts. Malasakit asked participants to rate the six quantitative assessment statements on a scale from 0-9, representing "Strongly Disagree" to "Strongly Agree":

1. I have suffered the consequence of a typhoon or flood in the past (***Past Experience***)
2. I feel prepared to handle a major typhoon right now (***Personal Preparedness***)
3. The barangay's typhoon Early Warning System is effective (***Early Warning System***)
4. My family has identified a place to meet and ways to communicate in a disaster (***Family Coordination***)
5. I feel like I could count on my immediate neighbors for support when recovering from a major typhoon (***Community Support***)
6. I believe our barangay will help my community repair and rebuild after a major typhoon (***Barangay Response***)

Malasakit also asked participants to assess their own disaster preparedness during this phase:

7. How many days of disaster supplies (e.g., canned food, bottled water, medicine) are immediately available to you in your home? (***Supplies***)
8. How many weeks has it been since you participated in a disaster drill? (***Disaster Drill***)

In addition to the quantitative questions, participants were asked a qualitative question: "How can your barangay help you better prepare for a disaster?"

1) Quantitative Data: 998 participants responded to the 12 field tests conducted across eight distinct geographic locations (see Table 1). Nearly 50% of the participants were between the ages of 18 – 24 as many field tests were conducted at universities. Participants were nearly evenly split between female (47%) and male (53%).

Female participants believed their local typhoon early warning system was more effective (M=6.50, SD=2.73) than male participants (M=5.98, SD=2.97); $t(873)=2.6672$, $p<0.01$. Additionally, female participants (M=6.40, SD=2.45) felt there was stronger community support to recover from a major typhoon than male participants (M=5.79, SD=2.74); $t(873)=3.4667$, $p<0.001$ (see Figure 4).

Strong positive correlations were identified for the following:

- *Early Warning System* and *Barangay Response* (corr=0.50, $p<0.001$). Participants who felt their barangay's typhoon early warning system was effective also felt their barangay would help the community repair and rebuild after a major typhoon.
- *Personal Preparedness* and *Family Coordination* (corr=0.44, $p=<0.001$) Participants who felt prepared to handle a major typhoon had also identified a place for their family to meet and ways to communicate in times of disaster.
- *Community Support* and *Barangay Response* (corr=0.44, $p<0.001$). Participants who gave a high rating for counting on neighbors for support when recovering from a major typhoon also believed their barangay would help their community repair and rebuild after a major typhoon.

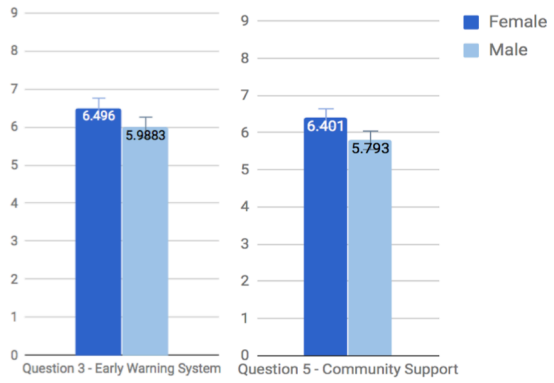

Fig. 4. The average rating by gender for question 3 (Early Warning System) and question 5 (Community Support)

We performed PCA analysis on the scores for the six quantitative questions that measured the participants' personal preparedness and community and barangay support. Below are the results:

TABLE 2 PCA Analysis of Quantitative Questions

	Component 1	Component 2
Past Experience	-0.30	-0.88
Personal Preparedness	-0.40	-0.12
Early Warning System	-0.44	0.17
Family Coordination	-0.43	-0.03
Community Support	-0.41	0.24
Barangay Response	-0.44	0.34

Although there is not much variance in the first component, the second principal component is strongly correlated with decreasing past experience (see Table 2) and can thus be viewed as a measure of the participants' prior experience to typhoons or floods. This component also shows correlation among questions assessing personal and family preparedness from those assessing community and barangay support or response as these factors. If past experience decreases, personal preparedness and family coordination tend to decrease as well while the component increases with increasing community or barangay support and response. The scatter plot (see Figure 5) depicts the projections of the participants split by gender on the first two principal components and highlights that there are no strong gender differences across these two dimensions.

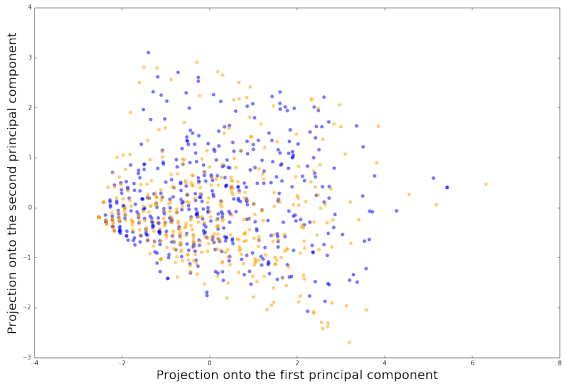

Fig. 5. Female: Orange, Male: Blue. Projection of participants on the first two principal components.

We provide detailed results for three locations with at least two field tests.

Manila: Three field tests were conducted in Manila, totaling 285 participants. Female participants believed they had better support from the community (M=6.71, SD=2.31) compared to males (M=5.76, SD=2.65); t(278)=3.2018, p<0.005. Females were also more likely to believe barangays would help them recover (M=6.88, SD=2.33) in comparison to males (M=6.25, SD=2.65); t(278)=2.1138, p<0.05. Interviews with female participants reveal that they regularly participate in barangay activities, which could indicate they are more aware of the barangay's plans to assist after a disaster.

Strong positive correlations were found between an effective barangay early warning system and barangay response (corr=0.594170, p<0.001), between community support and barangay response (corr=0.475045, p<0.001), and between personal preparedness and family coordination (corr=0.464754, p<0.001). An inverse correlation was identified between age and availability of disaster supplies (corr=-0.208495, p<0.01), indicating that older participants store fewer disaster preparedness supplies than younger participants.

Legazpi City: Two field tests were conducted in Legazpi City, totaling 62 participants. A strong positive correlation was found between community support and barangay response (corr=0.664782, p<0.001), indicating that those who believed their community would provide support in times of disaster also believed their barangay would help the community rebuild after a major typhoon.

Strong positive correlations were found between effectiveness of the barangay early warning system and barangay response (corr=0.461221, p<0.001), between personal preparedness and barangay response (corr=0.495764, p<0.001), and between family coordination and supplies (corr=0.402964, p<0.05), indicating that families that were better coordinated also stored more days of emergency supplies. Strong positive correlations with barangay response could be due to the Albay region's strong DRR strategies, where Legazpi City is located [23].

Iloilo City: Two field tests were completed in Iloilo City, totaling 115 participants. Female participants (M=7.20, SD=1.91) were found to believe they had better support from the community than their male counterparts (M=5.86, SD=2.91); t(93)=2.5913, p<0.01. This finding aligns with our observations in the field that women tend to support each other on tasks (e.g., going to market, doing laundry).

2) Qualitative Data: The field tests collected 2,481 peer-to-peer ratings on 896 submitted textual suggestions for how local barangays could help communities better prepare for a disaster.

*P*articipants rate suggestions on a scale of 0 – 9. We considered the lower bound of the 95 % confidence interval of the sample mean for the ratings for each suggestion to take into account the uncertainty in estimating the population mean rating. We have selected the suggestions with the highest lower bounds and present to you the top five suggestions along with its average helpfulness rating:

1. *"We need to regularly clean canals and monitor garbage collection to reduce likelihood of flooding." (8.58)*

2. *"It would be helpful for the community to be informed beforehand of a coming disaster and to prepare our community for coming flash floods and an evacuation center or area prepared." (8.51)*
3. *"Have early warning to make people ready for the upcoming storm." (8.44)*
4. *"Put up loud sirens that would alert citizens for disasters drills or actual disaster scenarios." (8.44)*
5. "*Have proper drainage, disposal of garbage, and guards round the clock to guard human uses." (8.40)*

The highest-rated textual suggestions reveal a number of important considerations when implementing DRR strategies. The highest-rated suggestions that individuals in the community should take preemptive measures to reduce likelihood of flooding and serve an active role in deploying early warning systems suggests the need for community-driven support in DRR strategies. These point to "bayanihan," a Filipino concept of solidarity—helping one another in times of need without expecting anything in return.

3) Results: Malasakit enabled collection and analysis of quantitative and qualitative data to reveal new insights into effectiveness of DRR strategies. A strong positive correlation was found between likelihood that leaders of the barangay would help their community after a major typhoon and the wider community's likelihood to help. Additionally, those who had planned a place to meet and ways to communicate in a disaster felt more personally prepared to handle a typhoon. Participants provided concrete recommendations, such as cleaning canals to reduce flooding and appointing community members to monitor news and social media to provide early warnings. These recommendations will be communicated to local barangay and community organizations for consideration.

V. Conclusion

Malasakit 1.0 applies a dimensionality reduction model to enable analysis of quantitative data and collaborative, peer-to-peer evaluation to enable analysis of qualitative insights. We evaluated Malasakit across 12 field tests to identify DRR strategies for typhoons and floods in the Philippines. Our results suggest that Malasakit identifies correlations between demographics and quantitative assessment questions as well as qualitative textual suggestions for improved DRR strategies.

In future work, we are exploring incorporating visual- and audio-based interfaces, including voice recognition on quantitative responses. Because of weak internet connectivity during the 12 field tests, some data loss occurred. Thus, we are implementing offline caching of application pages and participant responses with the JavaScript Service Workers and HTML5 LocalStorage APIs to improve reliability. The admin panel will also incorporate features that allow researchers to change the topical focus of the survey, modify question structures and presentation (e.g., short answer, Likert scale), and create detailed data visualizations and reports).

References

[1] United Nations Office for Disaster Risk Reduction (UNISDR). *2015: Disaster in Numbers*, 25 January, 2016. http://www.unisdr.org/files/47804_2015disastertrendsinfographic.pdf

[2] Center for Research on the Epidemiology of Disasters (CRED). *The Human Cost of Natural Disasters: A Global Perspective*. 2015.

[3] United Nations Office for Disaster Risk Reduction [UNISDR]. *What is the International Strategy?* 2017. https://www.unisdr.org/who-we-are/international-strategy-for-disaster-reduction

[4] P. Dongier *et al.,* "Community driven development," World Bank Poverty Reduction Strategy Paper. 2003.

[5] L. Prokopy (2005) "The relationship between participation and project outcomes: Evidence from rural water supply projects in India." *World Development*, vol. 33, no. 11, pp. 1801-1819, Nov. 2005.

[6] A. Dasgupta, A. & V.A. Beard, "Community driven development, collective action and elite capture in Indonesia." *Development and Change*, vol. 38, no. 2, pp. 229-249. Mar. 2007

[7] P. Rogers *et al.,* "Collaboration and communication: Building a research agenda and way of working towards community disaster resilience." *Disaster Prevention and Management*, vol. 25. no.1, pp. 75-90. 2016

[8] B. Nonnecke, *et al.,* "DevCAFE 1.0: A participatory platform for assessing development initiatives in the field." Proceedings of the IEEE Global Humanitarian Tech Conference (GHTC), Seattle, WA. Oct. 2015.

[9] United Nations University: Institute for Environment and Human Security. *Focus: The City as a Risk Area.* 2015.

[10] J. Qadir *et al.,* "Crisis analytics: Big data-driven crisis response." *Journal of International Humanitarian Action*, vol. 1, no. 12, Aug. 2016.

[11] A. Hild Rivera *et al.,* "Information management tools for disaster preparedness and resilience at community level in Central America (El Salvador and Honduras)". United Nations Office for Disaster Risk Reduction. 2015. [online]. Available: http://bit.ly/2sdx6PR

[12] M. Haklay *et al.,* "Crowdsourced geographic information use in government." World Bank Global Facility for Disaster Reduction and Recovery. 2014.

[13] KoBo Toolbox (2014). *About* [online]. Available: http://www.kobotoolbox.org

[14] B. DeRenzi, *et al.,* "Supporting community health workers in India through voice- and web-based feedback." Proceedings of the 2017 CHI Conference on Hujman Factors in Computing Systems (CHI '17), Denver, CO. May 2017.

[15] CommCare (2017). *About* [online]. Available: https://www.commcarehq.org/

[16] W. Whyte. *Participatory Action Research*. Newbury Park, CA: Sage Publications,1991.

[17] F. Siamak *et al.,* "Opinion space: a scalable tool for browsing online comments." Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 1175–1184. ACM, 2010.

[18] M.E. Meneses *et al.,* "Overcoming citizen mistrust and enhancing democratic practices: Results from the e-participation platform 'Mexico Participa.'" Information Technologies and International Development, forthcoming 2017.

[19] M. Nelimarkka *et al.,* "Comparing Three Online Civic Engagement Platforms using the 'Spectrum of Public Participation Framework.'" in *IPP2014: Crowdsourcing for Politics and Policy*., Oxford, UK, 2014.

[20] S. Krishnan *et al.,* "A methodology for learning, analyzing, and mitigating social influence bias in recommender systems." In Proceedings of the 8th ACM Conference on Recommender systems, pp. 137-144. 2014.

[21] M. Zhou *et al.,* "M-CAFE: Managing MOOC student feedback with collaborative filtering." Proceedings of the ACM Learning at Scale Conference (L@S). pp. 309-312. 2015.

[21] Pew Research Center. (2017). *Questionnaire Design* [online]. Available: http://www.pewresearch.org/methodology/u-s-survey-research/questionnaire-design/

[22] L.D. Brown, "Interval estimation for a binomial proportion." *Statistical Science*, vol. 16, no. 2, pp. 101-117. May 2001.

[23] J. Nunez, "Disaster preparedness now a way of life in Albay," Business Mirror, July 2015. [online]. Available: http://www.businessmirror.com.ph/disaster-preparedness-now-a-way-of-life-in-albay/