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The motivations, enablers and barriers for voluntary participation in an online crowdsourcing platform

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ABSTRACT

This paper examines the phenomena of online crowdsourcing from the perspectives of both volunteers and the campaign coordinator of Tomnod – an online mapping project that uses crowdsourcing to identify objects and places in satellite images. A mixed-methods approach was used to study the enablers and barriers to participation, taking into consideration the whole spectrum of volunteers. The results show broad diversity in online volunteers, both in their demographics and the factors affecting their voluntary participation. The majority are older than 50 years and many – particularly the most active volunteers – have disabilities or long term health problems. The personal circumstances of participants are highlighted as a major factor affecting involvement in campaigns. Like many other platforms, altruism is a key motivator, yet many participants are more interested in the quality of their data and the impact it has on the ground. For many participants of online crowdsourcing campaigns, their involvement is strongly linked to the level of contact they have with campaign coordinators, both in the design of the platform and in providing feedback on the impact of their contributions.

1. Introduction

In recent years, crowdsourcing has emerged as a rapidly growing field in research and online content creation (Doan, Ramakrishnan, & Halevy, 2011; Leetaru, Wang, Cao, Padmanabhan, & Shook, 2013). This has been largely facilitated by the development of new technologies, a greater incentive for outreach among researchers, a growing public interest in applied science and the desire to have a positive impact on the world (Cohn, 2008). As a result, many online campaigns which are open to anyone from across the globe have succeeded in attracting large numbers of participants. By engaging a globalised and diverse set of volunteers, many crowdsourcing campaigns have generated much needed 'big data' (Byun, Halpin, & Szeredi, 2015; Sullivan et al. 2014) which is localised and up-to-date (Goodchild, 2010).

To succeed, crowdsourcing campaigns often have to be organized, facilitated, and nurtured (Fischer, 2000, p. 11). Most crowdsourcing campaigns can typically be classed as either 'bottom-up' or 'top-down'. The former are not conceived or planned by scientists, but instead by citizens, and usually involve long-term engagement in local environmental concerns. The latter are organisationally initiated forms of organizing campaigns (Wiggins, 2010; Wiggins and Crowston, 2011). While many highly successful top-down crowdsourcing campaigns have maintained a traditional format of asking amateur volunteers to participate in data gathering protocols, a growing number are trying new methodological approaches to data collection (Liu & Palen, 2010). With the emergence of Web 2.0, novel ideas such as citizen science problem solving games, apps and large-scale online activities have become remarkably popular (Kawrykow et al. 2012). This has opened the door to many exciting and never-before possible research opportunities for individual academics and organisations (Díaz, Granell, Huerta, & Gould, 2012; Kittur, Chi, & Suh, 2008). A significant player in this field is Tomnod – a project owned by Colorado-based satellite company DigitalGlobe that uses crowdsourcing to identify objects and places in satellite images. This capitalises on the unique ability of the human eye to identify ambiguous objects which computer algorithms may struggle with. Tomnod volunteers are given the task of tagging objects of interest to add attributes to an image (e.g. a destroyed house). These tags are collated, processed for consensus and used for a range of targeted campaigns, including assisting in disaster response (Meier, 2013), tracking wildfires (Hansen, 2015) and even searching for the missing Malaysian

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Airlines flight MH370 (Fishwick, 2014). Tomnod differs from many other crowdsourcing platforms in the immediacy of most of its campaigns. These generate geospatial data for use by response teams within hours of satellite imagery becoming available. With participation frequently in the thousands (Tomnod, 2015a), it is clear that Tomnod has attracted the interest of many volunteers. In 2014, when Tomnod's search for the missing Malaysian Airlines flight MH370 attracted over eight million participants (SMH, 2015), it became clear that the breadth of its appeal reached well beyond that of most other crowdsourcing platforms.

Successful crowdsourcing campaigns will typically be both attractive to potential participants and fulfil sufficient data quality standards (Graham et al. 2015). As a result, there is often a trade-off in crowdsourcing research campaigns between maintaining high data quality standards and keeping the platform's design simple, engaging and enjoyable for prospective participants (Crowston & Prestopnik, 2013). While this is challenging, there are many cases where groups of amateur volunteers have contributed data which is of equal or even superior quality to professional sources (Hung, Kalantari, & Rajabifard, 2016; Kuang, Argo, Stoddard, Bray, & Zeng-Treitler, 2015; Silvertown, 2009). In contrast, a number of other studies such as Smith, Liang, James, and Lin (2015), Galloway, Tudor, and Haegen (2006) and Butt, Slade, Thompson, Malhi, and Riutta (2013) have found that the crowdsourced data can be limiting in both its quality and quantity. Hence, more important than pure numbers of participants for most campaigns, is their loyalty, trustworthiness and competence in the field (Li, Tian, Yan, & Li, 2015). Studies which rely on data collected by lay people benefit from explicitly facilitating the continued involvement of participants to both contribute to, and publicise campaigns (Dickinson et al. 2012). Understanding the enablers and barriers for the millions of people who have volunteered on them is a vital step towards developing and building thriving crowdsourcing campaigns (Massung, Coyle, Cater, Jay, & Preist, 2013).

2. Previous research

Online volunteering is a broad term which describes an array of activities from translating important materials to organizing charitable events. It appears to be largely derived from prosocial motivation (Amichai-Hamburger, 2008). Prosocial behaviour refers to "voluntary actions that are intended to help or benefit another individual or group of individuals" (Eisenberg & Mussen, 1989, p. 3). These can be characterised by different types of motivations: altruism, egoism, collectivism, and principlism (Batson, Ahmad, & Tsang, 2002). Altruism aims to increase the welfare of others. Egoism refers to when the ultimate aim is to increase one's own welfare. Collectivism has the goal of improving the welfare of one's own community and principlism aims to uphold one or more moral principles.

Amichai-Hamburger (2008) advocates a model to explain the potential and promise of online volunteering, separating the phenomenon into three separate subdivisions: the personal, the interpersonal, and the group. These centre on motivations, emphasising the importance of E-learning, information accessibility, reframing identity and overcoming disabilities. Further research on online volunteering also emphasise that older volunteers benefit through online volunteering by establishing new connections and increasing social capital (Mukherjee, 2011). However, both these studies do not make any consideration for crowdsourcing activities, many of which rely on attracting and retaining volunteers.

Volunteer motivations for participation in bottom-up crowdsourcing campaigns have been described by Buytaert et al. (2014) as being at the interface of political activism and volunteering. This can help foster a strong sense of community and responsibility. However, with the creation of large-scale online top-down campaigns such as OpenStreetMap in 2004, Zooniverse in 2009 and Tomnod in 2010, many campaigns are becoming enticing to volunteers for different reasons. Amichai-Hamburger (2008) argues that understanding the characteristics behind Internet volunteering from the perspective of the volunteer may enhance the positive potential of the Internet. To date, a large number of studies into the engagement and motivations of citizen observers, including Budhathoki & Haythornthwaite et al. (2013), Haklay, Singleton, and Parker (2008) and Dodge and Kitchin (2013) have used OpenStreetMap[1] as a case study. These largely point to a wish of participants to share their local knowledge, experience community, learn new things and advance their career. To some extent, such findings can be related to broader crowdsourcing phenomena as OpenStreetMap provides a useful example of a well-used and respected crowdsourcing campaign (Dodge & Kitchin, 2013). However, for studies into other forms of crowdsourcing, different motivations have been revealed (Cohn, 2008). As Raddick et al. (2013) outline, the motivations for participation in Galaxy Zoo are radically different to those of OpenStreetMap as the platform caters to a very different user-base. For example, the most frequently cited reason for participating in Galaxy Zoo is a desire to contribute to scientific discovery (Raddick et al., 2013). Evidently, there is no clear consensus on how to get volunteers effectively engaged in crowdsourcing campaigns in general. Yet, achieving loyalty and engagement among volunteers is an essential step towards creating a thriving campaign.

For many crowdsourcing campaigns, particularly in geographical sciences and humanitarian campaigns, there is a need for further research into the motivations and experiences of users (Cashman et al., 2008; Cohn, 2008; Gardiner et al., 2012; Sheppard & Terveen, 2011). This study focuses on addressing this key research gap. Tomnod provides a suitable platform for expanding the research into crowdsourcing as an online volunteering activity as its campaigns are unique and largely altruistic, aiming to help disadvantaged communities. The current literature on crowdsourcing is still nascent and needs mixed-methods research to provide an additional depth of insight into the phenomenon (Brown, 2012; Graham et al. 2015; Raddick et al. 2013). In particular, there is a need to identify the drivers for attracting the large numbers of participants in platforms which are different than Galaxy Zoo and OpenStreetMap.

The overall aim of this study is to address this research gap by investigating the human factors affecting volunteer participation in Tomnod and the application of these to the wider crowdsourcing phenomenon. There were two specific objectives. The first was to: implement a multi-methods approach to investigate the experience of Tomnod participants and their perspectives on the platform's design. The second objective was to identify broader implications for maximising volunteer numbers, ensuring effective data contributions and creating satisfying user general experience with online crowdsourcing platforms.

3. Methods

3.1. Methodological approach

A case study approach is employed, using Tomnod to help build insight and understanding of the human factors affecting volunteer participation of online crowdsourcing campaigns (Onwuegbuzie &

[1] OpenStreetMap is a web crowdsourcing platform available at: https://www.openstreetmap.org.

Leech, 2006; Stake, 1995). Its large user-base helps identify a broad range of factors affecting different participants both in enticing them to the platform and keeping them involved. Given the diversity of its campaigns, examining Tomnod participants (self-labelled 'Nodders') enables a degree of control over, and investigation of campaign preferences in a controlled manner as they are all launched through the same platform.

Both qualitative and quantitative data was collected from multiple sources to enhance its credibility (Patton, 1990; Yin, 2003). This helps generate both representative response rates (Baruch & Holtom, 2008; Baxter & Jack, 2008) and detailed arguments to trace causal mechanisms and complex emotions (Harrits, 2011). Hence, the quantitative phase of the study does not inform or drive the qualitative phase or vice versa (Onwuegbuzie & Leech, 2006; Yeager & Steiger, 2013).

3.2. Data collection and analysis

Three sets of online surveys were undertaken over 14 months, each with a specific purpose (Table 1). Questionnaires were advertised on the Tomnod website blog and sent out by email to reach all registered participants.

A data-driven approach was used to identify themes in the data relating to the research objectives using Nvivo 10 to code the data. Salient themes are exemplified with quotes from the questionnaires, forums and interviews. Particular emphasis is placed on where there was consensus, or clear divergence of opinions. Divergent themes among different demographic groups were also evaluated both qualitatively and using Chi-Square statistics using SPSS 22.

4. Results

4.1. Participant demographics and their influences on motivations

Tomnod has an aging population which is well balanced in gender (Fig. 1). A large number of participants confirm that they are retired while 23% of participants state that they have a disability or a long term heath problem *[Survey C]*. For many participants, this a primary reason for participation:

> *'I am retired so using Tomnod is a better use of my time when I have some free time.' [Survey A, Response 2383]*

> *'This is the perfect site for people to help. Especially the disabled people that want to help in the world but can't leave home. This site allows people to do just that … help in anyway possible!' [Survey A, Response 1873]*

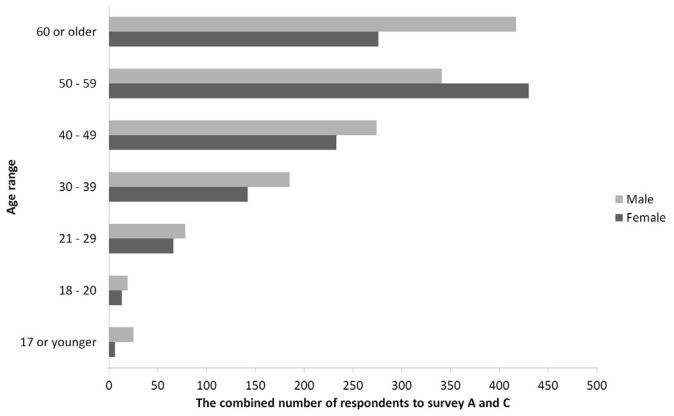

Fig. 1. The combined number of respondents by age range and gender identity [Survey A and C].

In addition, entries on the online forum suggest that this is a common theme amongst many Nodders with one comment on disability leading to a snowball of comments on how participating in online campaigns can be highly rewarding:

> *'I retired after a stroke. Not one to throw in the towel I started looking for ways to help with my limitations.' [Forum, Response 10]*

> *'I fell ill with an auto-immune illness that impacted my mobility and stamina. I still want to contribute to the world, however, and value this opportunity.' [Forum, Response 17]*

People with disabilities are thus clearly highlighted as a niche participant in online crowdsourcing campaigns:

> *'Almost all the crowd are retired. And at least 2 of our top 10, have recently had strokes … our top contributor has tagged over 100,000 locations in just one campaign.' [Interview, Tomnod coordinator]*

Furthermore, comments made by Nodders relating to a wish to help when not working, either through disability or retirement suggests that the personal circumstances of volunteers plays a significant role in affecting their participation on the platform.

For the vast majority of Nodders, the campaigns were based on locations far away from their home location: Nepal, Swaziland, Malaysia etc. despite the largely USA centred user-base. This has a knock on effect on the motivations for participation, with enjoying the exploration forming a key theme in both the surveys and the

Table 1
List of data collection methods, their details and purpose.

Data source	Date(s) undertaken	Number of participants	Purpose
Survey A	August, 2014	2329	Online survey to identify participant demographics plus open ended questions to infer how these affect general perspectives of the platform. This yielded the most response (including ~1000 open ended comments), largely due to the high publicity of Tomnod through its campaign to search for the missing MH370 aircraft.
Survey B	July, 2015	166	Online survey to identify participant motivations, asking volunteers: 'Why do you participate in Tomnod campaigns?'
Survey C	September, 2015	188	Online survey to identify participant demographics plus open ended questions to infer how these affect their relationship with, and behaviour on the platform.
Forum observation	December, 2015	60	Analysis of key quotes from an online forum that was set up by Tomnod in December, 2014. This identified volunteer views on the platform, participant motivations and factors affecting data quality.
Participant interviews	September, 2015	6	Semi-structured interviews with the most active participants on the platform to enable them to expand on their views and establish how the most engaged volunteers compare to the larger population.
Tomnod campaign coordinator interview	September, 2015	1	Semi-structured interview to explore the extent to which the perspectives of Nodders are represented in the design of the platform and its campaigns.

interviews:

'I live near Coco Island … I've never taken a boat out there so I got to see the island. It was fun.' [Nodder interview 6]

'It allows me to see things I would never see or know about.' [Survey B, Response 95]

Hence, for many participants, motivating factors for volunteering and behaviour on the platform are directly linked to their social context. The simplicity and social currency of Tomnod tasks makes them both enticing and straightforward for people who may not typically engage in online content creation.

4.2. General motivations for participation

The feedback from participants, gained from all the data collection protocols, covers a wide range of topics. At least 17% of comments relate directly to participant motivations *[Survey A]*. The majority of motivational comments (59%) aligned with an altruistic theme; however most are vague in who exactly they want to help:

'I do not have much free time that I could use to help others nor money I could donate to others. But being on Tomnod and helping with the campaigns only if it's one or two hours a week let me feel like I do something to help others. That's the least that I can do, offer some of my time.' [Survey A, Response 508]

'To help in searches in the hope it will save lives and provide valuable other information to this country as well as others.' [Survey B, Response 84]

Furthermore, a number of comments explicitly mention the requirement for campaigns to be helping people in urgent need of assistance as a decisive motivating factor:

'Any situation where there is a time sensitive situation and searching is needed.' [Survey A, Response 172]

'I do this for fun but I also do it to help. If it's not going to help no need to waste my time.' [Survey B, Response 97]

'I will always choose first to participate in campaigns that help people who are suffering, no matter whether a particular campaign might be difficult or tedious.' [Forum, Response 168]

These qualities also help Tomnod develop effective campaigns:

'Campaigns with high social currency were shared on social media and helped grow the crowd' [Interview, Tomnod coordinator]

The comments on Nodder motivations for participating in campaigns emphasise how important the cause is to the volunteers. The majority of comments liken mapping on the Tomnod platform to an alternative to charity work:

'Although users volunteer on Tomnod, because of their good hearts, they would also like to document their volunteer activity, much in the same way people do that volunteered for the Red Cross. Many people would like to list volunteer activity on their job applications.' [Survey A, Response 792]

'I can't be on the ground to help Nepal citizens, but I can bear witness to their isolated homes, poverty, and desperation for rescue and assistance.' [Forum, Response 36]

In addition to altruistic themes, a number of more collectivist sentiments were expressed:

'It helps me feel involved in the global community.' [Survey B, Response 1]

'Looking for loved ones' [Survey B, Response 155]

For some, the platform, like many other crowdsourcing campaigns, motivates participation for egoism. A number of survey respondents described tasks as *'an enjoyable experience' and 'a fun and useful pastime' [Survey B, Response 740]*. Words such as '*addicted*', 'interesting' and 'community' have appeared multiple times in all three surveys and the internet forum:

'It's the feeling of being an explorer. I feel like I need to check another row before I can go to bed because there might be something there … Sometimes I spend 8–10 hours a day.' [Interview, Participant 3].

4.3. The participant experience

Participants have diverse preferences of campaign type (Table 2) and views of what qualities a campaign should have (Table 3). 'Helping people and the environment' is the most important feature for all age groups and genders with no significant differences between them. Participants also have strong preferences for other qualities such as 'educational' and 'easy to do'.

The search and rescue campaigns are the most preferred campaign type (Table 2). However, the forum comments largely indicate that while search and rescue campaigns such as the MH370 were '*intriguing*', the natural disasters such as the Nepal campaign were the most '*rewarding*':

'Favourite campaigns would be the anti-poaching, illegal fishing one as there is no sense of urgency to them so can take more time looking around. The ones I get the greatest satisfaction and sense of achievement from are the likes of the Nepal earthquake, the Vanuatu cyclone or the tornado strikes Illinois, then I suppose the more frustrating ones would be the air or sea campaigns when nothing is found.' [Forum, response 1]

This quote emphasises that while Nodder motivations are largely altruistic, 'helping' alone may not be enough to keep all participants engaged. Successful campaigns will benefit from giving participants a sense of satisfaction and achievement on their contribution.

Feedback was a central theme in the open ended survey questions, the interviews and the forum responses. About 23% of comments can be linked directly to aspects of user engagement, with Nodders largely unsatisfied with the level of updates they receive about their contributions and impact on the ground *[Survey A]*. A follow-up on how the data was used and feedback on qualities of data are dominant concerns in all age groups and genders (Table 4). However, perspectives on gamification aspects (leaderboards and awards for the most active nodders) differed with age with under 50s showing significantly more support (chi-sq $p < 0.05$). Educational games and quizzes in comparison were significantly more popular among females under the age of 50 (chi-sq $p < 0.05$).

A number of participants go further, asking for '*something like a certificate of participation or some kind of award' [Survey A, Response 1681]* to be recognised for their work. These comments add to the sentiments expressed on a participant's wish to be more engaged. However, concerns expressed over the gamification of the platform suggest that such actions may cause some to feel ignored:

Table 2
Responses to the question: Which campaign are you most interested in? (Survey A).

Search and rescue	Natural disaster	Environmental plotting	Political unrest	Other
2253	1697	877	618	239

Table 3
Responses to: 'Please tick three of the following qualities of a campaign that you think are most important:' Represented as a percentage of a specified demographic group [Survey C].

	Over 50 female	Over 50 male	Under 50 female	Under 50 male
Fun	8%	13%	10%	16%
Give recognition for contributions	8%	8%	10%	13%
Help people and the environment	33%	32%	33%	32%
Easy to do	18%	16%	20%	13%
Educational	23%	25%	18%	23%
Sociable	10%	6%	8%	4%
Total responses per demographic group	120	234	105	102

Table 4
Responses to question: 'Which features would you would like to see more of?' Represented as a percentage of a specified demographic group [Survey C].

	Over 50 female	Over 50 male	Under 50 female	Under 50 male
Feedback on the quality of my contributions	28%	29%	25%	30%
Educational games and quizzes	1%	3%	8%	4%
Leaderboards and awards for the most active Nodders	3%	4%	10%	12%
Short training exercises to improve my image analysis skills	25%	20%	20%	21%
A follow-up about how the data was used	28%	28%	27%	29%
More engagement with the Tomnod team and DigitalGlobe	16%	15%	11%	4%
Total responses per demographic group	120	234	105	102

'Leaderboards and awards for the most active Nodders. This is good AND bad. It can really backfire. If Person A has 78,000 why should Person C at 18,000 even bother trying?' [Survey C, Response 2]

All comments on current levels of engagement with the campaign managers were negative, with the vast majority of participants referring to how they received no emails or feedback on the quality of their tags. Almost every comment mentioned a desire for more information about the campaigns and updates on new campaigns. A lack of clarity over how their data is used, lack of follow-up information and news on how much they are actually helping are all cited as reasons for becoming less active on the platform. As a result, a number of respondents stated categorically that they would not return. Participants specified that they want to know if they are actually making a difference. One Nodder pointed out that he felt he was *'shouting down a well' [Survey A, Response 584]* while others wrote:

'There was no feedback and it made me feel as though what I was doing wasn't even for real.' [Survey A, Response 2037]

'I enjoy helping. Just wish I understood more about exactly how we are helping.' [Forum, Response 3]

Many point out that they don't have Facebook so they cannot keep up-to-date with latest discussions. As with many topics relating to social media, there is a diverse range of opinions on the matter as not all participants use or like social media. These comments often came from older participants:

'I do not use Facebook. Twitter, etc., and suspect that my efforts are wasted. More communication via your website might help.' [Survey A, Response 330]

Clearly, while using social media to engage participants may be effective for many, it may also isolate those who are not included in the discussions. This is a particular concern given the demographics of the participant base. Limited feedback also has a substantial impact on the most active participants:

'When older/ill/disabled people can't give money, we give ourselves …. we invest our very beings … we need them to give feedback, acknowledgement, recognition to us?... There's a brick wall between us and them' [Interview, Participant 2]

A key feature of most campaigns is an 'agree' score which shows how many participants also tagged the same location. Some of the participants comment that they see this as a sign that they are wasting their time:

'Would help to see how examined my map is. I work hard only to find that 100 other people tagged the same thing. I don't feel helpful.' [Survey A, Response 1002]

'Why did I never hear anything about the results?... Shame on you.' [Survey A, Response 1488]

The diverse community of participants on the platform have varying needs and motivators. Some like to be challenged while others prefer easier tasks with greater guidance:

'Yes (more campaigns at the same time are better). The variety is really important. Our brains can only take so much monotony.' [Interview, Participant 2]

'I'm retraining my brain since my stroke. Tomnod helps with that as it's repetitive. It's healing my brain.' [Interview, Participant 1]

Tomnod will typically have at least three campaigns running at any given time to provide participants with a range of activities to take part in. This directly enhances the experience of volunteers:

'It helps sometimes switch back and forth between campaigns.' [Interview, Participant 6]

Given the number of comments relating to feedback, it is clear that this is an area which is highly important to the participants. The online forum has become popular with many hundreds of posts (Tomnod, 2015b) while 54% of respondents said it helped them stay interested in the campaigns [Survey C]:

'When you have a comradery and you get responses, you are showing them that you have worth. As people become familiar with it, you make it more personal and intimate. The forum adds the human link that is needed to keep interest growing …. For example, someone can say "hey, look at this", then others will say "here's what Wikipedia says it is … oh that's really cool". This makes a better foundation for Tomnod as people feel more loyal.' [Interview, Participant 1]

'We need to communicate how each specific campaign is going to be used' [Interview, Tomnod coordinator]

Technical issues comprise 8% of comments *[Survey A]* and are frequently cited as reasons for not returning to the platform. Hence, the functionality and aesthetics of the website also play a key role in determining its popularity. This has a direct effect on the level of participation as design issues (e.g. image quality) are the most cited reason for ending a session. In comparison, males under the age of 50 were significantly less concerned by technical issues, citing time constraints as the main reason for ending a session (chi-sq $p < 0.05$).

The majority of the survey comments on the platform's design suggested that participants wanted greater control over how they use it. In particular, most comments illustrated people's desire to have a transparent platform:

'Need link maps to google maps or other to know where I am looking at.' [Survey A, Response 1619]

'It would be nice to see what other volunteers are doing. This would give a feel of cooperation.' [Interview, Participant 4]

Campaigns seem too focused on US interests … you should have a vote from a list of possible campaigns. [Survey A, Participant 124]

In order to tackle this, the participant's experience has become the focus of the platform's design:

'We tried not letting people navigating freely and oh man, people didn't like that because half the fun is being able to explore that map … even if it meant we weren't getting better quality results faster.' [Interview, Tomnod coordinator]

The results highlight that volunteers have strong feelings about how the platform should be designed. A prevalent theme in their comments is a desire for the platform to be as transparent as possible. Participants want to have control over where they are tagging and the ability to discuss their observations with each other. Letting these volunteers contribute to the design of the platform by listening to their feedback evidently plays a critical role in keeping them engaged.

4.4. Factors affecting quality of contributed data

Both the clarity of the satellite imagery and the training given to participants are highlighted as areas which can affect volunteer contributions (Tables 4 and 5). For some images, e.g. Fig. 2, volunteers struggled to tag certain targets:

'The main difficulty I'm finding in this campaign is that the built up commercial/residential areas are cast in so much shadow this time of year it's hard to make out anything one the ground let alone flood water.' [Forum, Response 46]

At least 10% of comments referred to a concern about the accuracy of their contributions with 84% of respondents requesting more information on the accuracy of their tagging [Survey A]. Many want further training on how to identify objects with examples and guides on what to tag and what not to tag:

'Both myself and no doubt legions of others kept mistaking and reporting waves as possible remnants of the lost Malaysian jet liner.' [Survey A, Response 427]

'A little more education for novices. That would help us make better tags.' [Survey A, Response 1008]

Since Survey A was conducted, the Tomnod platform has been improved to include training for participants. However, despite these improvements both quantitative results (Table 4) and qualitative comments suggest that increased training remains central to participant motivations and willingness to volunteer:

'Their taking time to educate us is going to be their trade-off for taking free labour.' [Interview, Participant 2]

In particular, for the older participants, opportunities to practise are likely to significantly increase the quality of the data they generate:

'There was a learning curve … My brain did not have the capacity to process what I was doing (the first time). The next time, I was able to work far quicker. You become more effective as you go.' [Interview, Participant 1]

In addition to the level of training given to volunteers, the simplicity of tasks can also feed directly into better quality results:

'When we ask the crowd to do one task at a time, they do a much better job because they can focus … in the past we used to have eight different tag types: a fallen tree, a block road, a damaged house, a destroyed house, water damage, flooding. It was difficult sometimes to distinguish between those different tag types, so we found that by simplifying the tag types and not having any more than three or four per campaign.' [Interview, Tomnod coordinator].

In order to quality check the data, the Tomnod team use a '*CrowdRank algorithm*' to triangulate the data and determine which tags had the most consensus across volunteers. An increased consensus of tags then feeds into each volunteer's reputation. The higher their reputation, the greater weight Tomnod gives to their data. Improvements to the CrowdRank algorithm and the training given to volunteers have had a knock on effect on data quality:

'We have definitely seen an improvement in the quality of the tags, as well as how quickly we can finish a campaign. In the past, we needed to get a minimum of 10 people looking at every map tile and

Table 5
Responses to question: 'What are the three most common reasons for ending a session' Represented as a percentage of a specified demographic group [Survey C].

	Over 50 female	Over 50 male	Under 50 female	Under 50 male
I lost interest	9%	8%	10%	14%
I was happy with my session and plan to have another one soon	12%	15%	17%	18%
Poor image quality	20%	20%	16%	13%
Technical issues	18%	12%	18%	11%
I was short of time	15%	16%	16%	24%
I did not understand the task	3%	2%	2%	4%
The load time was too slow	13%	16%	14%	11%
Other	11%	11%	7%	5%
Total responses per demographic group	120	225	105	111

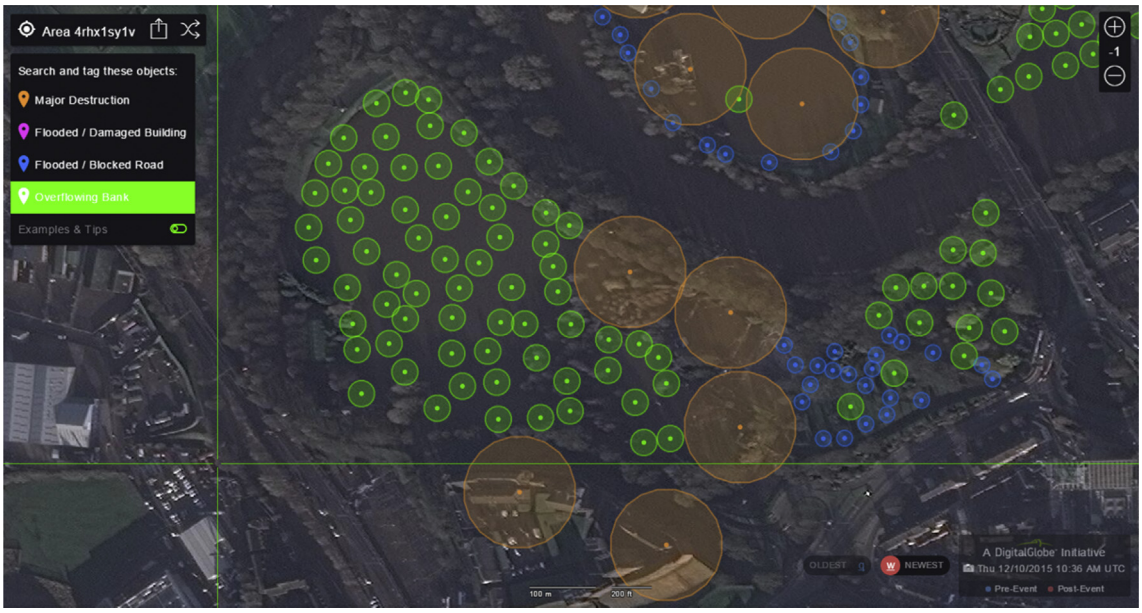

Fig. 2. User interface on Tomnod England Flooding campaign.

voting on a polygon, and now we're getting high confidence results after 3–5 people have looked at the image …. Once we have this confidence, we stop sending people there … This is incredible in urgent situations such as natural disasters.' [Interview, Tomnod coordinator].

The CrowdRank algorithm allows Tomnod to maximise the value of contributions from volunteers. Yet, the strong support for increased training (Table 4) and concerns about data quality in specific campaigns e.g. MH370 airliner search emphasises the value that guidance can have for many volunteers.

5. Discussion

This study uses a mixed-method approach to examine the phenomena of online crowdsourcing from the perspectives of both volunteers and the campaign coordinator of Tomnod. The use of Tomnod as a case study enables an exploration of many core themes on crowdsourcing as a wider phenomenon and helps build on the current literature on the human factors affecting volunteer participation.

The motivations and behaviour of volunteers on online crowdsourcing campaigns have been strongly linked with their age and gender. Our findings show that like crowdsourcing platforms such as Galaxy Zoo (Raddick et al. 2013) and many online volunteering websites (Mukherjee, 2011) the most active Tomnod participants are mostly over 50. This finding contrasts with Brabham (2008) who argues the most productive individuals in the crowd are young and likely to be under the age of 25. Younger groups are also the most active in contemporary content creation phenomena such as blogging (Lenhart, Horrigan, & Fallows, 2004; Lenhart & Madden, 2005). The balanced gender ratio in Tomnod is in stark contrast to some of the most popular crowdsourcing platforms such as Galaxy Zoo and Citizen Sky which are dominated by males – 82% and 78% respectively – (Price, 2011; Raddick et al. 2013). This suggests that the appeal of different campaigns varies with demographic groups. The results of this study help explain what may drive some of these variations.

By aiming to tackle geographical and humanitarian challenges across the globe, Tomnod attracts volunteers who may not typically be able to volunteer outdoors and in the field. Consequently, many general observations in the literature about the characteristics of crowdsourcing campaigns in developing and developed countries do not appear to fit Tomnod. For example, Gura (2013) argues that the objectives of crowdsourcing science campaigns in developed countries largely focus on increasing awareness and scientific literacy. In contrast, campaign goals in developing regions mostly relate to the enhancement of community well-being such as poverty alleviation. Yet for Tomnod volunteers, while many key altruistic motivators such as helping people and the environment are important to all demographic groups, other motivations vary

significantly between participants. Tomnod appeals particularly to those who are retired, disabled or suffer from a long term health issues. Among these participants, the dominant motivations are to undertake tasks comparable to charity work with their free time from the convenience of their home. For many participants, particularly those with health problems such as recovering from strokes, the simplicity and humanitarian nature of tasks makes them both enticing and rewarding. For some, they may even help in promoting positive health outcomes – a finding which is prevalent in research into more specialised cognitive games (Whitlock, McLaughlin, & Allaire, 2012). This emphasises the need to update Amichai-Hamburger's (2008) model of online volunteering to take consideration of prosocial online crowdsourcing campaigns such as Tomnod. These have formed an increasing share of online voluntary activities since the date of the publication. In particular, a greater emphasis on both the enablers and barriers to participation are needed to help improve the design of online voluntary crowdsourcing platforms.

Platform features such as gamification, quizzes and podcasts are frequently cited as key enablers for many crowdsourcing campaigns (Reed, Raddick, Lardner, & Carney, 2013). Gamification in the form of leaderboards of the most active participants can be seen in other large crowdsourcing campaigns such as Biotracker and FreshWater Watch (Bowser et al. 2013; FWW, 2016). This study emphasises that despite being more popular amongst many younger participants, gamification may detract from the user experience of others. However, even for younger participants, a feeling of cooperation as opposed to competition is far more important. This strengthens arguments made in Eveleigh et al. (2013) that leaderboards can discourage some participants. In addition, Tomnod volunteers are more interested in the quality of their data and the impact it has on the ground. Volunteers are also highly motivated by the ability to explore the world through an online portal and want to influence the way they do so. Hence, our study reinforces the argument that campaigns that do not allow participants to have a fun, engaging and interesting experience risk losing popularity (Graham et al. 2015). While volunteers may be drawn to the platform with altruistic intentions, their continued participation is also related to egoism and collectivism.

Tomnod serves as a great example of a crowdsourcing platform that is able to extract both a large number and high quality of results from a global volunteer population. By keeping numerous campaigns active at all times, Tomnod has enabled some participants to dedicate unprecedented amounts of time towards relatively simple tasks that suit their individual preferences. These steps can help crowdsourcing platforms hold on to a diverse set of volunteers. This can play a significant role in improving collective intelligence gathering (Woolley, Chabris, & Pentland, 2010), although a diverse crowd will vary in what they want from the platform (Bonney et al., 2014; Budhathoki & Haythornthwaite, 2013).

Both the number and content of comments relating to engagement emphasise that it is one of the most important issues concerning Nodders. Blogs, forums, polls and training exercises are all cited as key enablers for volunteers. Likewise, a lack of communication and non-dissemination of outputs is a major disincentive to continued participant involvement. Many other studies have also highlighted the importance of communication with participants (Rotman et al., 2012). However, it is clear from the responses in this survey, that for many, limited engagement between volunteers and campaign organisers discourages users from returning to the platform. Evidently, by largely providing prosocial campaigns that aim to directly help in emergency situations and environmental conservation, the platform is held up to a high level of scrutiny by volunteers who expect tangible, well communicated outputs.

This research shows that crowdsourcing campaigns will benefit from increased interaction between coordinators and volunteers, both in providing feedback and in the design of the platform. Enabling citizens to communicate with each other can play a significant role in improving satisfaction (Newman et al. 2010) and participation (Brabham, 2010). This study highlights the importance of the forum in generating a sense of collectivism and breaking down barriers between volunteers who participate in isolation. Indeed, Srinivasan, Thomas, Jamwal, and Lele (2013) argue that there is a clear need for a more bottom-up approach to the identification of most pertinent campaigns and platform design characteristics. Volunteers should be allowed to contribute to the management of the platform as well as contributing to campaigns. For example, they could introduce democratic aspects such as polls to select campaigns to help keep volunteers engaged and valued.

6. Conclusion

This study has highlighted a number of divergent themes from previous research into the human factors affecting participants of online crowdsourcing platforms. Our results demonstrate that online crowdsourcing campaigns are not always dominated by males and that volunteers have diverse preferences in relation to how the platform should be designed. Differing participant populations and experiences between platforms is evident in the literature (Budhathoki & Haythornthwaite (2013); Dodge and Kitchin, 2013; Haklay et al. 2008; Raddick et al. 2013) – and this study helps shed light on the mechanisms behind some of these different observations. Tomnod can be characterised as a prosocial platform. Although Tomnod volunteer motivations are largely altruistic, many participants are more interested in exploring the world, the quality of their contributed data and the impact it has on the ground. Volunteers expect well-communicated tangible results and a greater degree of communication with those behind the platform. As a result, this study has found that if those who ultimately use the results of volunteered campaigns do not disseminate results, provide feedback and training to participants, a platform risks losing volunteers. This study also provides some managerial insights on how to encourage participation in crowdsourcing.

The main limitation of this study was that it focussed on only one platform. Hence, further research is needed to continue to enrich this line of study by exploring the different roles these factors play for a diverse community of volunteers using alternative crowdsourcing platforms. Research is also needed to consider the role that campaign features – in particular training and democratic aspects – can play in fostering loyalty and improving data quality among participants.

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