Increasing Efficiency of Humanitarian Organizations with Volunteer Driven Information Products

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Abstract

Emerging technologies provide new opportunities to humanitarian organizations for enhancing their response to crisis situations. Since the 2010 Haiti Earthquake, online volunteer communities have been activated to gather data and generate information products to improve humanitarian organizations' situational awareness and decision making. However, how and to what extent these information products influence the operations and organizational routines of the humanitarian organizations is a matter of considerable debate.

In this paper we introduce an evaluation method to determine the impact of these new opportunities. Built on existing evaluation design principles for information systems, the resulting framework is used to identify the relevant impact factors in creating and using volunteer driven information products. Our results show that, despite the high response time and technical expertise, the organizational performance impact is inhibited by the limited embedding of volunteer driven information products in the organization. Using the presented evaluation tool the impact of other deployments can be determined and improved in a similar manner.

1 Introduction

Emerging and re-emerging technologies, driven by the ever more connected world and new approaches to collecting and processing data, provide new opportunities for humanitarian responders to enhance their response to crisis situations. A combination of technical developments, institutional changes, and emerging modes of communication are all facilitating a paradigm shift in possible response options. In addition, the accelerating increase in data available online yields new possibilities for information products and systems [1].

With the rise of volunteer-driven information systems, products and services such as the Digital Humanitarian Network (DHN), decision makers and crisis responders have a new set of tools to aid them in their responses. These systems, products and volunteer communities have been deployed across the world, including Libya, Haiti, Samoa, and even New York City, and post-action reviews emphasize their potential to significantly influence the ways organizations respond to crises [2-4]. Since at least 2004 with the founding of MapAction, volunteer initiatives have been discovering new contributions to information management and emergency response, and recent innovations have increased the number of uses to which these groups can be put.

However, while these new technologies and organizational strategies could change disaster management and humanitarianism as we know it, there are few commonly accepted metrics for evaluating the outcomes of individual projects or long-term impacts. Developing an evaluation framework that is designed to assess and understand the impact of volunteer initiatives would help responders as well as the volunteers improve on their efforts, and advocate their importance to humanitarian response efforts.

1.1 Approach

Based on data collected from literature reviews, interviews, and proof-of-concept testing, we inductively determine the principles and guidelines that should be followed and addressed by an impact evaluation framework. First our literature review explores the design principles of existing evaluation frameworks in general and for information systems and information products in particular.

In addition to the review of existing academic work, a series of interviews helps us understand which specific metrics, qualities, and benchmarks we should include in our evaluation framework. We target two broad groups of people in our interviews. The first group are representatives of digital volunteer communities and initiatives; for example the founders of those organizations or members of their respective leadership committees. In the second group we will focus on decision-makers from the humanitarian response agencies; the people who are

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program leads, and/or are directing the allocation of human, financial, and aid resources. In their decisions these people rely on information products provided from both internal and external sources.

The interviews with these groups are oriented toward understanding how impacts and outcomes are currently assessed by the organizations. Questions probe what has been effective, the impacts and outcomes that have resulted from utilizing information products, systems and services from volunteer entities, either in a positive or negative sense. Particular attention goes towards the dominant *metrics*, *outcomes*, and *characteristics* that would be identified as relevant. These results are used to identify connections and contrasts between the existing work for evaluation frameworks and the interviewees' responses.

Next, our review of existing literature combined with the outcomes of the interviews results in a prototype evaluation framework. We test this concept in a post-deployment review of selected cases. This entails asking individuals from the emergency management and digital humanitarian communities involved in previous deployments to apply the evaluation framework to the specific deployment they were involved in. Finally post-survey follow-up interviews are used to verify and discuss the results.

The objective of the research presented in this paper is to design and demonstrate an evaluation framework prototype, highlighting aspects that worked well, as well as those aspects that did not. In addition our research intends to use the results from the framework application to identify factors that contribute towards a more efficient operation. In particular we investigate the following questions:

Q1: How has impact been evaluated by humanitarian organizations and the responding volunteer entities. Specifically, how can the appropriate metrics and characteristics be incorporated in an impact evaluation framework?

Q2: What factors in the process of generating and employing volunteer driven information products relate to the organizational performance and drive the success of collaboration with volunteer communities?

2 Background

2.1 Evaluation frameworks

Various evaluation frameworks exist, however these frameworks are employed post-deployment and have a broad scope. There is a lack of studies that focus on evaluating information systems and products provided by volunteers and their impact on humanitarian response. Harvard Humanitarian Initiative's report "Disaster Relief 2.0" [1], while not an evaluation study, investigated digital technologies' role during disasters; it discussed challenges in information sharing and suggested a framework for future learning and collaboration. The Ushahidi Haiti Project Evaluation was an evaluation of the Ushahidi Haiti Project (UHP) [5] and the consultant team used the Organization for Economic Cooperation and Development (OECD) criteria, surveys and interviews. The study highlighted the relevance of real-time geo-referenced information, but the evaluation was unable to fully determine the impact on affected populations. In these evaluations there were design, methodological and logistical challenges in the evaluation that limited the team's ability to successfully determine impact.

These studies show that volunteer communities have made considerable contributions to the efficiency of information gathering, processing and dispersal, within the context of situational awareness. However, it is difficult to determine the exact impact volunteer entities have made and how this impact could be improved, as there currently is no practical and shared way for these organizations to reflect, evaluate and understand their effects on decision makers and their organizations. Humanitarian practitioners and volunteer communities are asking for better ways to understand the impacts of these initiatives [6]. Current evaluation methods in the volunteer and traditional humanitarian communities are generally retrospective, limited to after-action reviews and summary reports often produced months after the crisis. In contrast, the volunteer communities often adapt in real time, sometimes making major changes in a single day. An established and focused evaluation framework will help volunteer and humanitarian organizations analyze the impact of their activities and initiatives.

2.2 Evaluation principles and elements

To design an impact evaluation framework`, we look at the design elements of existing frameworks for information systems and products. In particular we look to different applications and objectives.

Looking to the objective of an evaluation, we can distinguish summative and formative evaluation objectives [7, 8]. *Summative evaluation* aims to determine to what extend certain objectives have been accomplished. *Formative evaluation* [9] has a stronger focus on the assessing the processes and is used to rate or determine the effectiveness of the involved processes. In the summative approach the

focus is more on whether or not certain (pre-determined) objectives have been achieved, the formative approach assesses the efficiency of the process used to reach those objectives.

Similar to these general evaluation approaches, in the context of information system and product evaluation two general views can be taken, each with its own focus. In the *goal-centered* view the performance of information systems is evaluated using the objectives set for either the system itself or the organizational units using the system [10]. These objectives are used to develop measures to assess to what extend the objectives have been achieved. In the system-resource view, rather than objectives, the viability of resource is considered to be a measure for effectiveness. Measured resources can be human (participation), technological (service levels) or financial (return on investment). The system-resource view considers that a system may fulfill other functions then the pre-determined, official or formalized objectives.

In both views the scope of the evaluation is not limited to the technical aspects of a system. The indented objectives when developing and implementing systems are rarely defined as a pure technical (IT) specifications; however these can or should be a sub-objective.

2.3 System performance indicators

In general, the primary objective of any system is to improve the ability of the organization to accomplish its strategic objectives. Evaluation methods rely on the definition of these objectives to determine how well the system is performing [11-13]. To accurately evaluate the performance of a (information system) these objectives have to be an accurate representation for the various dimensions that influence the performance. For both introduced perspectives various levels of performance indicators exist that can be used to evaluate the system performance. These levels aid in defining a set of representative indicators for the system performance.

The *system-resource* perspective considers the efficiency with which the system is provided to the user. In other words, the extent to which the provisioning of a system is optimized [14]. The indicators for this perspective can be classified in four measurement levels: *systems*, *resource consumption*, *capability* and *investments* [15-17]. The *goal centered* perspective considers the contribution of the systems to the organizational objectives. In other words, the extent to which a system is enabling the organization to achieve its goals. The objectives for this perspective can be categorized in three levels: *information & support*, *process & user performance* and *organizational performance [16, 18]*.

To accurately describe the impact of a system, the performance has to be considered in light of both the efficiency with which the system has been developed and the change in the effectiveness. For example, if a system increases the organizational performance but requires a significant amount of resources to be developed, the overall impact may not be optimal.

3 Impact evaluation framework design

Taking the described evaluation design principles into account, developing an evaluation framework includes (1) the definition of the system objectives, (2) determining the scope i.e. the levels considered, (3) selecting representative performance indicators and (4) developing appropriate measures. Using these elements, we look at specific requirements of the evaluation framework for collaborations between volunteer entities and the responding traditional humanitarian organizations. We especially focus on the specific performance indicators and the corresponding measures used to assess the impact of information products.

Semi-structured interviews are used to discuss each of the evaluation framework elements listed. During the interviews participants are asked to consider recent deployments and decision making processes involving information products provided by volunteer communities. The objective of these interviews is to ascertain the connection between the described evaluation framework constructs listed in the previous sections and the utilization thereof in the context of humanitarian responses. In particular the interviews focus on the translation of the general levels introduced in the previous section to the information products provided by volunteer entities.

To develop the impact evaluation we conducted 15 interviews with practitioners from both the humanitarian organizations that have employed volunteer-driven information products (8 interviews) and members of volunteer initiatives involved in creating such information products (7 interviews).

3.1 Evaluation objective

From the interviews we establish that the need for an impact evaluation method is based on three objectives: (1) demonstrate the effectiveness of the volunteer initiatives aiding in securing resources and advocate their work [19], (2) determine the most effective way to include the volunteer initiatives and (3) provide feedback to both the initiatives and the organizations to improve future or on-going

collaborations. Once a collaboration with a volunteer initiatives has been established it is important to know how efficient and effective the joint effort is and how this can be improved [20, 21]. This will allow the involved organizations, both operational and coordinating, to adjust their efforts in order to maximize the impact of the action undertaken by the volunteer initiatives [22].

3.2 Scope of evaluation

Next we consider the scope of the evaluation. This scope is determined by examining the overall process, from the activation of an online volunteer community to the decision making process. Information products provided by volunteer communities reach the humanitarian decision makers in several ways. Decision makers can request the support of volunteer initiatives either directly or through a coordinating body, such as the DHN, as demonstrated in the Libya crisis map [23]. Volunteer communities also generate information products without a specific request. For example the Ushahidi deployment to monitor the violence during the Kenya elections [8]. In both cases information products are generated by the volunteers and transferred to the humanitarian responders.

Based on the conducted interviews a generalized process flow can be drafted, as shown in Figure 1. In this generalized process flow several important exchange points are indicated. Since the focus of this research is on the impact the information generation efforts have, these exchange points play an important role. Consider a supply chain where the output from one stage forms the input for the next: impact is then determined by the influence the work in one stage has on the success of the next [24]. The final exchange point in this information supply chain is the transfer of information products from the volunteer initiative to the decision makers, illustrated in Figure 1 as the transfer from C to D. This exchange is the main focus of this research as it determines the impact of the supplied information products on the decision making process and organizational efficiency.

3.3 Performance indicators

Both sides of this exchange point have their own distinct dimensions for determining the impact of the information products. Considering the theoretical base of impact evaluation introduced earlier, this exchange can be described in terms of the *system-resource view,* focused on the provisioning of the information products, and the *goal centered view,* focused on the use of the information products.

The different levels for each view introduced correspond to the steps described in the process. The initial stages, depicted in quadrant ***A***, of this process focus on the project definition, corresponds to *level 0* of the *system resource* perspective of information system development as depicted in Table 1. The allocation of the resources (quadrant ***B***) corresponds to *level 1* and the capability of the resources used to *level 2.* Finally the level the team invests in their knowledge and other resources can be considered part of *level 3*.

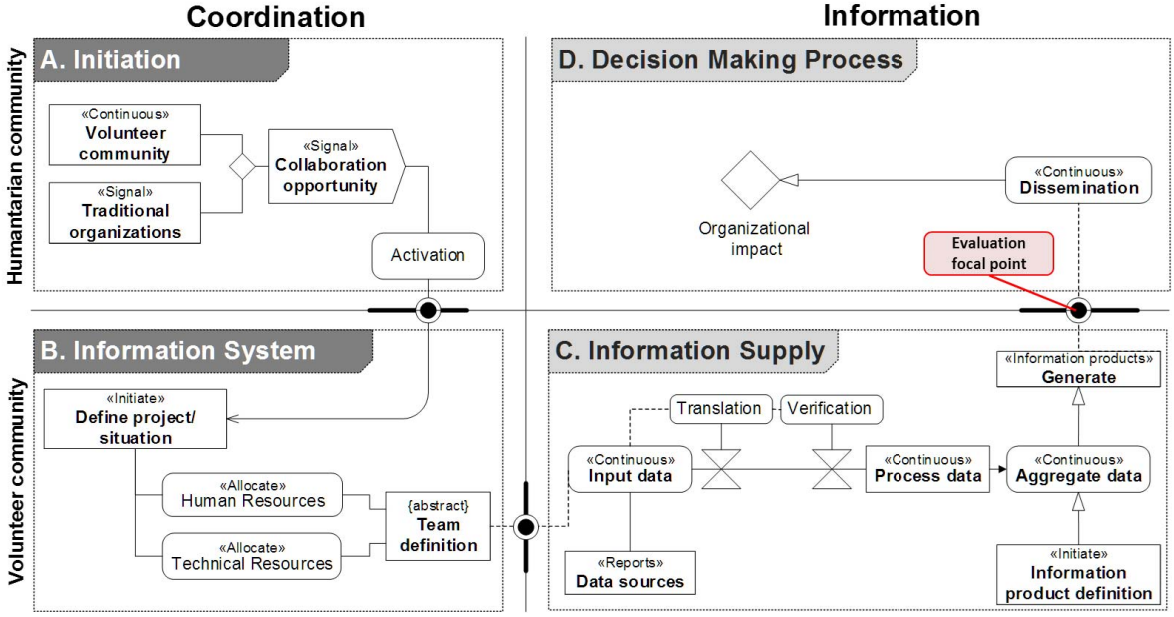

Figure 1 Coordination, activation and information product delivery process

Table 1. System resource-view indicator levels

Level	*Description*	*Application*	*Quadrant*
0	*Requirements definition*	Received request project definition	A/B
1	*Resource allocation*	Team composition, tech. resources	C
2	*Resource capabilities*	Generation of information products	C/D
3	*Resources investments*	Knowledge and technical investment	

The use and effect of these products corresponds with the *goal centered* perspective, illustrated in Table 2. Providing information and support on developed tools to humanitarian organizations, corresponds with *level 1*. Increasing the effectiveness of the decision makers and processes using the supplied products can be classified as *level 2*. The overall effectiveness of the decisions and the effectiveness of the response can be considered *level 3*. In the scope of this research we consider the impact of the delivered products on the decision makers and the decision making process, reflected by *level 2*. The provided information itself and the included support are inherent to this.

Table 2. Goal centered-view indicator levels

Level	*Description*	*Application*	*Quadrant*
1	*Information & Support*	Information products quality and provisioning	C/D
2	*Process & user performance*	Organizational and operational efficiency	D
3	*Organizational performance*	Impact on crisis response	

Next we select the levels from each perspective that correspond with the defined scope in the previous section. This results in 2 performance indicator-levels for each perspective, illustrated in Figure 2. From the system resource perspective these levels are *1: Use of resources needed* and *level 2: Resources capability*. From the goal centered perspective these performance indicators levels are: *1: Information & Support* and *2: Process & user performance.*

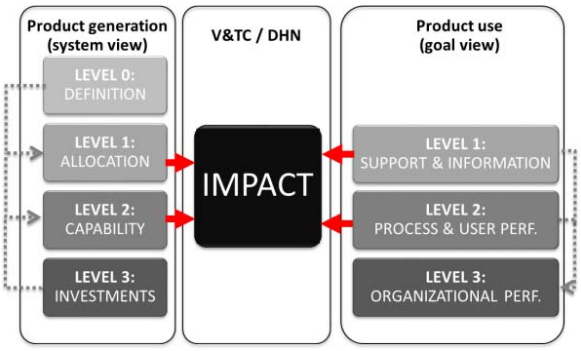

Figure 2 Performance indicators levels and impact

3.4 Indicators and measures

Next specific indicators and their corresponding measures are defined for the previously introduced indicator levels.

We first look at existing frameworks providing indicators used in the industry. Indicators, used to assess system resource perspective -the efficiency of provisioning the information products and systems- can be derived from the *Post Installation Review* evaluation method [18]. The indicators in this method match closely with the *Level 1: Resource allocation* (team composition and resources). Additionally the *MIS Personnel Productivity evaluation* [25] provides potential indicators that can be used to describe *Level 2: Resource capability* (generation of information products). The indicators of the goal centered view - the usage of the information products- can be divided into two sets in this research. The first set is concerned with the efficient use of the information products, which includes the quality of the provided information products and the underlying systems to provision them. The second set of indicators considers the impact the information products have on the performance of the individual users and their tasks [14, 26].

During the interviews participants were asked to interpret the presented information system and product indicators and translate these to the context of humanitarian operations. To aid in this interpretation, we asked participants to first describe a recent case involving information products provided by online volunteers. Next we asked the participants to describe how the presented indicators would be defined in that specific situation. Finally these results were generalized and consolidated to create a listing of the indicators to be used in the intended evaluation framework. Table 3 provides an overview of the used indicators in the design of the evaluation framework applied to the DHN situation.

4 Evaluation framework application

4.1 Setup

To conduct the impact analysis, two surveys were designed based on the derived indicators introduced in the previous section. The first survey focuses on the system resource perspective and the information product provisioning efforts. This survey is intended for the suppliers of the information products and systems – in this scenario the digital volunteer communities. The second survey focuses on the goal centered perspective and the use of the supplied

Table 3. Applied information products provisioning and usage indicators

Provisioning performance indicators			
Lvl	*Indicator*	*Measure*	*Applied measure*
1. Resources allocation	*System development*	Facilities allocation	Availability of required (tech.) facilities
		Schedule compliance	Time required to setup required systems
		Requirements definition	The clarity of requested products
	Operational resources	Data collection	Time/effort required to analyze data
		System maintenance	Time/effort required to maintain system
		Training support	Efforts for user assistance.
2. Resource capabilities	*Team capacity*	Productivity rate	Level of DHN deployment
		Required man-hours	The total amount of hours used
	Operational capability	Throughput	Products delivered, users served
		Utilization rate	Hours to product ratio
		Response time	Turn-around time on specific requests

Usage performance indicators			
Lvl	*Indicator*	*Measure*	*Applied measure*
1. Information & support	*System quality*	Availability	Ease to reach, uptime, access
		Usability	Ease of use, matching needs
		System features	Customization of information products
	Information quality	Understand-ability	Presentation of gathered information
		Consistency	Provided information is consistent
		Importance	Relevance of provided information
2. Process & user perform.	*Individual impact*	Awareness	Better situational awareness
		Decision effectiveness	Enhanced effectiveness of job
		Individual productivity	Increased personal productivity
	Organization impact	Decision effectiveness	Increased effectiveness of operations
		Capacity Increase	Information products save resources
		Organizational productivity	Improve outcomes of processes

information products. This survey is intended for the users of the supplied information products and systems – in this scenario the humanitarian organizations using the supplied information products. The surveys present the respondents with several statements for each indicator as illustrated in Table 4. These statements originate from the conducted interviews and represent a specific measurement applied to the context of volunteer-driven information products for humanitarian organizations. A Likert-scale is used to capture the attitude of the respondents towards the statements. The survey, including the results, will be available on http://kmeesters.blogspot.nl/

Table 4. Example survey statements

Awareness	AW 1	The information products enhance my own awareness, rethink job related information	Disagree
	AW 2	I feel more confident in my job through the use of the information products	Neutral
	AW 3	My situational awareness has increased due the information products	Strongly Agree

4.2 Participants

Through cooperation with UN OCHA, Cordaid and the DHN we have presented the survey to respondents involved in provisioning the information products both as staff of humanitarian organizations and as volunteers. Furthermore we presented the survey to humanitarian decision makers (managers) that have used the information products provided by volunteer initiatives or by the traditional means to make their decisions. Both studies have been conducted in an in-field research in Port-au-Prince, Haiti in December 2011.

In the aftermath of the 2010 earthquake in Haiti, several DHN bodies have offered their services to assist decision makers. One of these DHN initiatives was based on the Ushahidi platform, facilitated and managed by volunteers this platform, enabled decision makers to enhance their situational awareness [23, 27].

Besides the systems and services offered by the DHN, NGOs develop and employ their own, internal, information systems and products. More and more NGOs are transitioning from ad-hoc created spreadsheets to more structured and rigid information systems [28, 29]. The development and implementation of these systems and products is done for example by external consultants or by own (management) employees. Due to the opportunity to do field research in Haiti the scope has been extended to also include the provision of these information systems. The in-house development project of an assessment monitoring and evaluation tool for a Dutch NGO was used for this research. Broadening the research allows additional validation of the results from the evaluation for DHN supplied systems against the 'normal' provision of information systems for non-governmental organizations, illustrating the difference in impact between these two cases.

Overall 78%, of the people approached responded to the digital, online survey Table 5 shows the number of responses per category. Of these respondents 72% have been actively involved in humanitarian operations in the past year and 65% has been involved in more than 5 different missions. From the 51 respondents that use information products 78% need to make regular (once a week) decisions directly influencing the actions undertaken by their organization. 90% of those who provide information products have a professional IT background. During active deployments both volunteers and employed staff spend equal amounts of time on developing information products (~30 hours per week).

Table 5. Survey respondents

	Provisioning	Usage/Employing
Volunteer-driven information products	*N*=21	*N*=27
Internal provisioned information products	*N*=19	*N*=24

4.3 Analysis

A t-test is used to determine if a significant difference can be found between the survey responses for the information products provided by the volunteer community and those provided by internal systems and processes. [30]. The survey is complemented with post-survey interviews conducted with the respondents. These interviews further examine and interpret the differences between the two types of information product provisioning.

5 Results

The results show that for some measures there is a significant difference between the observed impacts of the two types of information products provisioning and use. These differences in information supply (system resource perspective) are most notably present in allocation of the facilities (FA: μ_v:3.87 > μ_t:2.11), data collection efforts (DC: μ_v:3.80 > μ_t:1.92), productivity (PD: μ_v:3.73 > μ_t:2.44) and response time (RT: μ_v:4.00 > μ_t:2.93). In these categories, the efforts which were required to generate the information products by volunteers show a significant positive difference compared to the in-house information development.

The statistical analysis of the information usage measurements (goal centered perspective) show less significant differences in favor of the products by the volunteers. In one category (understandability (US: μ_v:4.00 > μ_t:2.56)) the information products provided by the volunteer communities have a significant higher impact compared to the in-house developed products. However these internally provided products have a significant higher impact in regards to capacity increase. (CI: μ_v:1.90 < μ_t:3.50) and importance (IM: μ_v:3.53 < μ_t:3.78).

5.1 Information products supply

The combined survey results for the information supply are depicted on the left in Table 6. At the resource level (1), the facilities provided by volunteer initiatives are valued higher. According to the post-survey interviews, the volunteer community in

Table 6. Survey results

Information product supply		Volunteer		Traditional		T-test
		$\mu_v\sum(x)$	$\sigma_v\sum(x)$	$\mu_t\sum(x)$	$\sigma_t\sum(x)$	$p_v<0.05$
Level 1. Resources						
System development						
Facilities allocation	FA	3.87	0.69	2.11	0.59	0.03
Schedule compliance	SC	3.60	0.67	2.01	0.59	0.10
Requirements definition	RD	2.35	0.59	3.92	0.46	0.09
Operational resources						
Data collection	DC	3.80	0.58	1.92	0.46	0.03
System maintenance	SM	3.20	0.67	3.56	0.72	0.47
Support, communicate	TS	2.65	0.82	3.92	0.46	0.13
Level 2. Capabilities						
Team capacity						
Productivity	PD	3.73	0.72	2.44	0.94	0.04
Required man-hours	MH	3.13	0.84	3.44	0.94	0.50
Operational capability						
Throughput	TP	3.67	0.67	2.78	0.74	0.20
Utilization rate	UR	2.73	0.72	3.11	0.59	0.50
Response time	RT	4.00	0.50	2.93	0.89	0.03

Information product usage		Volunteer		Traditional		T-test
		$\mu_v\sum(x)$	$\sigma_v\sum(x)$	$\mu_t\sum(x)$	$\sigma_t\sum(x)$	$p_t<0.05$
Level 1. Information						
System quality						
Availability	AV	3.40	0.64	2.50	0.67	0.46
Usability	UI	3.27	0.62	2.89	0.59	0.42
System features	SF	3.40	0.68	2.67	0.89	0.36
Information quality						
Understandability	US	4.00	0.53	2.56	0.49	0.03
Consistency	CO	3.53	0.70	3.56	0.72	0.38
Importance	IM	3.53	0.90	3.78	0.52	0.04
Level 2. Processes						
Individual impact						
Awareness	AW	3.80	0.67	2.89	0.79	0.36
Effectiveness	EF	3.73	0.39	3.56	0.72	0.27
Productivity	PR	3.87	0.46	2.89	0.40	0.14
Organization impact						
Decision effectiveness	DE	3.80	0.64	4.00	0.33	0.28
Capacity increase	CI	1.90	0.54	3.50	1.17	0.04
Orga. productivity	OP	4.10	0.54	4.00	0.33	0.23

general has the required technical facilities readily available or on standby, whereas in the traditional information product provisioning scenario the technical abilities is valued lower as their internal knowledge and facilities if often not sufficient and therefore need to rely on external resources and consultants. This is also reflected by the data collection measure. Volunteer initiatives often consists of experts who are experienced data administrators and can quickly identify sources of data, facilitated by better technical resources such a fast internet connections as they often are not deployed in the field and the use of 'crowd-sourcing' techniques. In regards to the operational capability the volunteer initiatives outperform the traditional development especially in regards to the productivity and turnaround time between data-collection (input) and the release of updated information products. This is mainly due to the large group of volunteers, spread across to globe working together. However this may not hold true change for longer lasting deployments.

5.2 Information products usage

The survey results from information product usage (effectiveness-oriented perspective) are presented in Table 6 on the right. Users indicate that both systems at the very least do what they are supposed to do. Systems and products are accessible, current and available whenever users need them to be. In general, the information products provided by the volunteer communities have a high value for the individual users; they are consistent and understandable.

However the organizational impact shows room for improvement. This is mainly reflected by the difference in capacity increase between the two cases. Where the traditional in-house development has a higher impact on the capacity increase then the volunteer products. The importance of the information presented in the systems is also valued higher for the non-volunteer based system. However this is -according to the users- mainly due to the management information available in that system.

6 Discussion

6.1 Potential of digital humanitarians

The digital volunteer initiatives have a great potential to change the efficiency with which information products and systems are provided to responding and/or in-field agencies. In the introduction it was already mentioned that various reports and studies indicate that there is significant opportunity for NGOs in working with these volunteer communities. What exactly this opportunity is and how it differs from the traditional provisioning of systems and products was not yet determined. The results of our research show that the differences are mainly noticeable in increased response or turn-around time when an information product is requested. This allows agencies to have quicker access to more up-to-date information. Furthermore the large data collection efforts also improve the accuracy of the developed services, systems and products. It provides agencies with access to larger data-set then they collect themselves. Another differences is that the volunteer networks consist of dedicated experts with access to and knowledge of the latest developments in software and systems, incorporating new technologies and options as they become available.

However, it has widely discussed in (scientific) research that a good development team, with the proper knowledge and resources will not necessarily have desired impact on the overall organizational performance. In order to assess the success we must not only consider the efficiency of supplying the information products but also look to the usage of these products, services and tools. [31].

6.2 Embedment in organizational routines

Considering the usage of the information products, the results indicate that the supplied information products have limited impact on the organizational capacity. Although some similarities exist between the volunteer driven and in-house developed products, the survey and interview results show an important difference. The volunteers can provide quick deployments, where the development of an internal information product takes longer. However the organizational impact (capacity increase) is limited. This is because of the distinct difference in use of the provided products and systems. The development of internal information products is done with the operational processes of the organization in mind. This ensure that the system supports and improves existing processes thus increasing the impact. The information systems form an integral part of the organization and its operations. Systems provided by the volunteers are less integrated in the organizational routines and are provided and designed as standalone services, in both technical and process sense. Therefore products and systems are not part of organizational structures and processes, lowering the adoption threshold of organizations and thus the organizational impact.

6.3 Evaluation framework

The evaluation framework, used to assess and improve the impact of volunteer-driven information products, presented in this paper serves three specific purposes, illustrated in Figure 2. First, it can be used to evaluate the real-time and post-action outcomes of volunteer initiatives in a particular response. The results of this evaluation help responding organizations and their partners by providing lessons learned for future improved operations. It serves as a feedback mechanism to the initiatives to demonstrate the value and potential of their work, and identify areas for improvements [20, 21].

Second, the framework can be used to evaluate the combined outcomes of initiatives, partner organizations, and emergency responders in an individual response. The volunteer communities and decision makers can use the results of these evaluations to extract lessons learned and develop general guidelines and best practices [22].

Third, the framework can be used to evaluate the effectiveness over several responses. In other words, it can be used to address the *general* impact that volunteer driven information products are having on emergency management. This information, in addition to helping the initiatives assess the benefits they bring to the table, helps policy and decision makers see the value added. These lessons can be helpful in procuring resources and advocating the value of collaborating with volunteers.

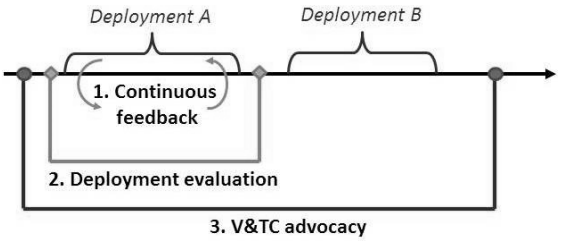

Figure 3. Various applications of the evaluation.

7 Limitations

We have examined a limited number of cases, which have limited representative value. As such the results presented here are indicative and explorative. A follow up empirical study is needed to generalize these findings. However the framework has a directly added value when used to assess the (technical) quality of systems and the embedment thereof in organizational structures and routines. This enables the applicants of the framework to assess the impact of systems on the users, compared to the efforts required to create the system.

Furthermore the accuracy of the evaluation framework itself could be improved by a closer examination of other parts of the process illustrated in figure 1, and their relation to the success or impact factors is needed. Understanding in more detail how information products are used employed by the responding humanitarian organizations and used by the decision makers. This would enable the research to move from evaluating the impact of volunteer driven information products on the organizational efficiency towards evaluating the organizational effectives of humanitarian organizations and operations [32].

8 Concluding remarks

In recent times, new opportunities for traditional humanitarian entities have risen in the form of online collaboration with digital volunteer communities. These new opportunities require a new evaluation approach is considers both the efforts of providing information products and the use of these products by organizations. Considering the various aspect of information system evaluation and translating these aspects to the context of digital humanitarian volunteers, the resulting framework aids in advocating collaborations with and communications between digital volunteer communities and traditional humanitarian organizations.

Our evaluation framework demonstrates the importance for these new initiatives to increase the interaction with the responding organizations. This includes direct interaction with the (potential) users of the system as well aligning with the existing organizational structures and processes. This not the sole responsibility of the digital humanitarians, but rather a shared opportunity from which also the responding humanitarian organizations and their beneficiaries could benefit.

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References

[1] Crowley, J., and Chan, J., "Disaster Relief 2.0: The Future of Information Sharing in Humanitarian

Emergencies", Harvard Humanitarian Initiative and UN Foundation- -UNOCHA, 2011,
[2] Gao, H., Barbier, G., and Goolsby, R., "Harnessing the Crowdsourcing Power of Social Media for Disaster Relief", Intelligent Systems, IEEE, 26(3), 2011, pp. 10-14.
[3] Meier, P., "Crisis Mapping in Action: How Open Source Software and Global Volunteer Networks Are Changing the World, One Map at a Time", Journal of Map & Geography Libraries, 8(2), 2012, pp. 89-100.
[4] Heinzelman, J., and Waters, C., "Crowdsourcing Crisis Information in Disaster-Affected Haiti", 2010,
[5] Morrow, N., Mock, N., Papendieck, A., and Kocmich, N., "Independent Evaluation of the Ushahidi Haiti Project", Development Information Systems International, 8(2011,
[6] Stauffacher D, W.B., Hattotuwa S, "Crisis Management: Understanding the Real Impact of Icts, Social Media, and Crisis Mapping", ICT4Peace Foundation, 2011,
[7] Scriven, M., "Beyond Formative and Summative Evaluation", 1991,
[8] Bloom, B.S., "Handbook on Formative and Summative Evaluation of Student Learning", 1971,
[9] Scriven, M., "The Methodology of Evaluation. In. Tyler, Rw, Gagne, Rm, Scriven, M.(Ed.): Perspectives of Curriculum Evaluation", in (Editor, 'ed.'^'eds.'): Book The Methodology of Evaluation. In. Tyler, Rw, Gagne, Rm, Scriven, M.(Ed.): Perspectives of Curriculum Evaluation, Rand McNally, Chicago, 1967
[10] Kriebei, C.H., and Raviv, A., "An Economics Approach to Modeling the Productivity of Computer Systems", Management Science, 1980, pp. 297-311.
[11] Mclean, E.R., and Soden, J.V., Strategic Planning for Mis, John Wiley & Sons Inc, 1977.
[12] Ginzberg, M.J., "Improving Mis Project Selection", Omega, 7(6), 1979, pp. 527-537.
[13] King, W.R., "Strategic Planning for Management Information Systems", MIS quarterly, 1978, pp. 27-37.
[14] Norton, D.P., and Rau, K.G., A Guide to Edp Performance Management: Systems Development, Computer Performance, Operations, QED Information Sciences, 1978.
[15] Quinn, R.E., and Rohrbaugh, J., "A Competing Values Approach to Organizational Effectiveness", Public Productivity Review, 1981, pp. 122-140.
[16] Campbell, J.P., "On the Nature of Organizational Effectiveness", New perspectives on organizational effectiveness, 1977, pp. 13-55.
[17] Molnar, J.J., and Rogers, D.L., "Organizational Effectiveness: An Empirical Comparision of the Goal and System Resource Approaches*", The Sociological Quarterly, 17(3), 2005, pp. 401-413.
[18] Cooper, R.B., "Understa1sding Management Support System Effectiveness: An Organization Theory Perspective", 1988,
[19] White, H., "Theory-Based Impact Evaluation: Principles and Practice", Journal of development effectiveness, 1(3), 2009, pp. 271-284.
[20] Briceño, B., and Gaarder, M., "Institutionalizing Evaluation: Review of International Experience", 3ie Research Paper. London: 3iE (www. 3ieimpact. org/reports/India_Report_DFID. pdf), 2009,
[21] Fitz-Gibbon, C.T., and Morris, L.L., How to Design a Program Evaluation, Sage Publications, Inc, 1987.
[22] Rossi, P.H., Lipsey, M.W., and Freeman, H.E., Evaluation: A Systematic Approach, Sage Publications, Inc, 2004.
[23] Munro, R., "Crowdsourcing and the Crisis-Affected Community", Information Retrieval, 2012, pp. 1-57.
[24] Gelderman, M., "The Relation between User Satisfaction, Usage of Information Systems and Performance", Information & Management, 34(1), 1998, pp. 11-18.
[25] Myers, B.L., Kappelman, L.A., and Prybutok, V.R., "A Comprehensive Model for Assessing the Quality and Productivity of the Information Systems Function: Toward a Theory for Information Systems Assessment", Information Resources Management Journal (IRMJ), 10(1), 1997, pp. 6-26.
[26] Delone, W.H., and Mclean, E.R., "Information Systems Success Revisited", in (Editor, 'ed.'^'eds.'): Book Information Systems Success Revisited, IEEE, 2002, pp. 2966-2976.
[27] Walle, B.V.D., and Dugdale, J., "Information Management and Humanitarian Relief Coordination: Findings from the Haiti Earthquake Response", International Journal of Business Continuity and Risk Management, 3(4), 2012, pp. 278-305.
[28] Meesters, K., and Van De Walle, B., "Towards an Impact Evaluation Framework for the Collaborative Information Supply Chain in Humanitarian Crisis Response"
[29] Van De Walle, B., Turoff, M., and Hiltz, S.R., Information Systems for Emergency Management, ME Sharpe, 2009.
[30] Pallant, J., Spss Survival Manual: A Step by Step Guide to Data Analysis Using Spss, Open University Press, 2010.
[31] Ives, B., and Olson, M.H., "User Involvement and Mis Success: A Review of Research", Management Science, 30(5), 1984, pp. 586-603.
[32] Herman, R.D., and Renz, D.O., "Advancing Nonprofit Organizational Effectiveness Research and Theory: Nine Theses", Nonprofit Management and Leadership, 18(4), 2008, pp. 399-415.