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GDACSmobile - An IT Tool Supporting Assessments for Humanitarian Logistics

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ABSTRACT :
A rising number of people is affected by disasters, such as the 2010 Haiti earthquake, the 2013 Philippines super-typhoon, and the 2015 Nepal earthquake. In the immediate aftermath of a disaster, humanitarian decision makers have to assure that action is prompt and targeted although confronted with lack of needed information about the highly complex and dynamic operational context in the affected area. Mobile technology and crowdsourcing have emerged as technologies that can help supply much needed information. GDACSmobile is a mobile-enabled IT solution for the assessment of needs, issues of access, infrastructure damage and other cross-cutting operational issues. In contrast to similar tools, e.g. Ushahidi or KoBoToolbox, GDACSmobile is an integrated solution addressing both the general public and professional responders, which closes the information cycle between disaster managers and the affected population. After all, most first responders are local citizens. In this paper, we introduce the context of the application and its concept, including descriptions of user groups and information flows that enable effective quality control of information. Subsequently an application scenario based on the 2015 Nepal Earthquake illustrates the value of using GDACSmobile to involve logisticians and assessment experts to inform and control the processes of data collection and information analysis, wherein professional responders and citizens act as primary data sources.

KEYWORDS:
Humanitarian Logistics, Assessment, Data Collection, Information Analysis, Volunteered Geographic Information, Mobile Devices, Crowdsourcing, Social media

1. INTRODUCTION

1.1. Humanitarian Logistics

1.1.1 The role of humanitarian logistics

Humanitarian logistics plays a central role in disaster relief operations of humanitarian organizations, where it helps to meet beneficiaries' needs by procuring, storing and transporting goods that are either distributed directly to the affected population or that support the provision of services, like medical care. While the term humanitarian logistics seems to emphasize the physical handling of goods, it is an umbrella term referring to both logistics and supply chain management, which includes tasks for planning operations.

1.1.2 Tasks, decisions and information needs

During the 2015 Nepal earthquake response, Kathmandu international airport became congested and did only accept airplanes below a certain weight, which led logisticians who had this information to use road transportation from Delhi in India as an alternative. This illustrates the importance of information about needs, supplies, resources and other attributes like costs or delivery times to inform logistics planning, i.e. to identify

and evaluate effective and efficient ways of acting.

1.2. Assessment

Since humanitarian organizations often operate in countries with poor infrastructure and low levels of data preparedness, and disasters often drastically change the environment, so-called assessments take an important role in gathering sufficiently timely and accurate information. The aim of assessments is to generate information serving as a decision base for other functional areas.

1.2.1 Secondary and primary data collection

Assessments usually begin with collecting and analysing secondary data, i.e. data that has been available from before the disaster, in order to estimate the needs of the affected population as well as operational constraints. Secondary data exists in many forms, such as generic country overviews (see e.g. the CIA World Fact Book) that give an overview of demographics and other aspects, or specialized datasets (e.g. the Logistics Cluster's Logistics Capacity Assessments) that describe a country's logistics infrastructure and resources. If available secondary data is not sufficient to plan operations, primary data needs to be collected from the affected area via remote sensing, exploratory teams or other methods. In recent years, mobile technology and crowdsourcing have emerged as new ways of collecting needed data, not only impacting the capabilities of professional responders but also the role of the affected population.

1.2.2. Professional responders as data source

Professional responders are arguably the most important source of ground truth from an affected region due to their education, training and experience. Looking at logistics-related information specifically, for similar reasons field logisticians can be named as the most valuable source for logistics-related information. However, the limited capacity of individual responders in a highly demanding context requires a concerted effort of assessment experts, logisticians and other humanitarian workers who may contribute information, in order to fulfil logisticians' information needs to the greatest possible extent. While experienced assessment experts are highly proficient at adapting to and making sense of the overall situation at hand, most responders excel in other, specific areas of expertise and benefit from purposefully designed forms guiding their observations, like the Logistics Cluster's Logistics Rapid Assessment Tool that draws attention to the most critical aspects of e.g. airports. Although very useful, paper forms have several limitations in terms of processing speed, error rate and the ability to capture rich data like geo-located images. This is one reason why humanitarian organizations increasingly look at mobile devices like smartphones and tablets to support data collection, despite such devices having their own drawbacks, such as the dependence on electric power or access to telecommunication networks. Eventually, an effective mobile tool needs to be able to accommodate various kinds of professional responders while operating with an adequate focus. That is, limiting its application to an area where its usefulness can be expected without over-exceeding its capabilities by ignoring requirements and limitations, e.g. confining assessment experts to one particular form design.

1.2.3. Local citizens as data source

The affected population does not only take a primary role in humanitarian response as beneficiaries, but local citizens often act as first responders (e.g. saving most of the people trapped under rubble), possess relevant knowledge of the area (e.g. about local suppliers) and can provide information about their needs and the operational environment (e.g. about the state of the road network or the security situation). The increasing adoption of mobile phones for access to phone calls, SMS text messaging and Internet-based services among citizens enables humanitarian organizations to communicate with citizens, gaining information that can contribute to assessments. Since citizens aren't usually trained as disaster responders and aren't familiar with assessment methodologies, their observations should be guided by specific questions without ignoring the general chatter on public media like online social networks. Furthermore, collected data needs to undergo review before being released to professional responders to inform their decision-making, in order to prevent low-quality observations, however well intended, increasing information overload and adversely affecting

decision-making. These negative side-effects seem to concern practitioners, who haven't yet seen a convincing demonstration of the impact of e.g. results from social media analysis, despite visionary technologists and specialized researchers making strong efforts to advocate the usefulness of information from citizens. Integrating these various perspectives demands serious consideration of citizens' input, be it via the harvesting of social media data or involving people through smartphone apps, while protecting professional responders from information overload and useless distraction through a suitable review process.

1.3. Background of the project

Our research group from the University of Münster and the Joint Research Centre of the European Commission aimed at developing a solution that disaster relief professionals and the affected population can use to acquire and disseminate primary data within the first four weeks after a major sudden-onset disaster. A first design cycle in 2012 resulted in the solution "GDACSmobile", which enables disaster management professionals and the affected population to share their observations from the affected area, both via the GDACSmobile smartphone application and via Twitter as an exemplary online social network. The app also enables professionals and citizens to view published observations to gain valuable information for their decision-making. To ensure the quality of the information that is disseminated through the client application, the solution employs a concept to moderate incoming reports. A second design cycle in 2014 focused on improving and extending the existing solution in terms of usability, interoperability and perhaps most importantly the communication between moderators and users, establishing bidirectional feedback loops.

1.4. Structure of the Paper

In the remainder of this paper, we will describe the GDACSmobile concept, including the definition of user groups and a description of necessary information flows. Next, we describe an application scenario. Eventually, we draw conclusions and give an outlook on the tool's future development.

2. Concept of the Assessment Tool

2.1. User Groups

GDACSmobile distinguishes the following basic user groups.

- **Moderated users** can be assumed to submit observations that require quality control before reaching a satisfactory level of confidence regarding the information's relevance, accuracy and timeliness. General members of the affected population fall into this group due to their limited understanding of assessment methodologies and information quality. Technically, moderated users submit observations by including certain hashtags in their Twitter messages, by using the GDACSmobile smartphone app without a registered user account, or by registering for a user account without being assigned to an organization.

- **Non-moderated users** can be assumed to submit observations of a sufficient quality to inform decision-making in humanitarian organizations without prior review. They are affiliated with an organization, having received at least some training and probably having professional experience. Technically, a non-moderated user works with a registered user account that is associated with at least one organization.

- **Moderators** are able to control the quality of incoming observations. As such, they need to be skilled and experienced enough not only to make high quality observations but to judge their quality, how they fit into the emerging bigger picture, and which questions need to be asked to build an operational picture. Technically, moderators are non-moderated users with additional privileges for at least one organization.

- **Administrators** configure and maintain the system by specifying organizations, user privileges and

disaster-related attributes. Technically, administrators either have special, dedicated accounts that don't need to be associated with any organization and can serve as administrators system-wide, or they are moderators for at least one organization and can serve as administrators for that organization.

2.2. Information flows

Prior to information flowing in GDACSmobile, the system has to be configured, i.e. an administrator needs to build forms for the relevant disasters (alerts) that are pulled automatically from the GDACS website (optionally using templates based on previous disasters), optionally specify first organizations that are going to use the system and create private missions for these organizations, which are private spaces whose content is not automatically shared with users outside of the mission space. Once the initial configuration is complete, information may start flowing, as illustrated in Figure 1.

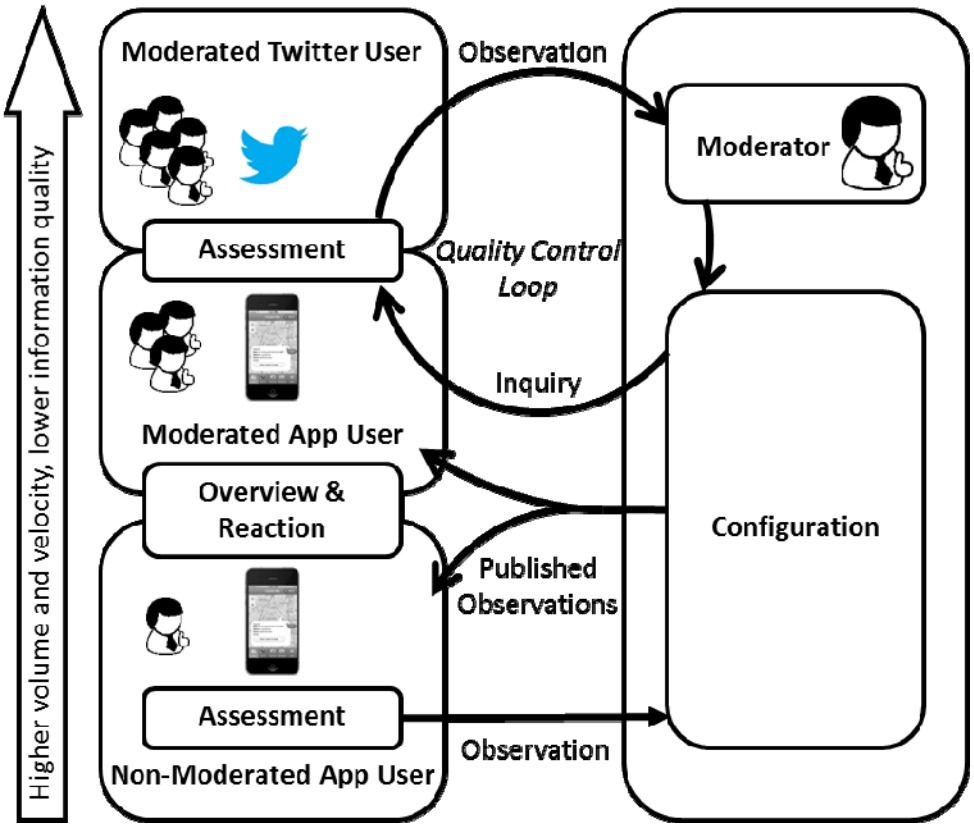

Figure 1. GDACSmobile Information Flows

The process begins with users submitting observations. If a non-moderated user submits an observation via the app, it bypasses moderation and will be published according to the initial configuration (e.g. only within a private mission space). If a moderated user submits an observation via Twitter or the app, it will enter a quality control loop. Therein, a moderator reviews the observation, possibly draws conclusions affecting configuration (e.g. by extending a particular form with an additional question) and, if needed, inquire further information from the observation's author (e.g. to clarify ambiguous phrasing or ask for more details). Once a moderated observation shows a satisfying quality, it can be published according to the current configuration (e.g. to all users in the public mission of a disaster or to a limited user group in a private mission space).

3. Application Scenario (Based on the 2015 Nepal Earthquake)

A 7.8 magnitude earthquake strikes Nepal, triggering several avalanches and aftershocks in different parts of the country. The situation worsens when another earthquake of 7.3 magnitude strikes the country only a few weeks

later. The United Nations Office for the Coordination of Humanitarian Affairs (OCHA) estimates 8,700 fatalities, thousands of injured people, and almost 800,000 buildings affected. Neighbouring communities in India, China and Bangladesh are affected as well, although with lower intensity. When the government requests international aid and assistance, aid organizations from different countries initiate the delivery of various goods (e.g. medicine, equipment, vehicles), financial support, and staff to Nepal; intending to provide relief services like search-and-rescue and medical assistance.

OCHA's Disaster Assessment and Coordination (UNDAC) teams run a GDACSmobile server. Once the magnitude of the disaster has become clear and Nepal has requested international assistance, an UNDAC administrator creates a private mission space for search-and-rescue (SAR) teams and use an existing earthquake template to rapidly configure data input forms, asking key questions for the rapid assessment phase. UNDAC utilizes the International Search-and-Rescue Advisory Group (INSARAG) and the Virtual On-Site Operations Coordination Center (VOSOCC) to notify search-and-rescue teams. Several team members are already familiar with the GDACSmobile app, as they have used it in previous exercises, and they are affiliated with their organization in the system. Once they open and log into the app, it downloads the private mission space and data collection forms, which the team members review to know where they are asked to direct their attention. After landing at their destination, they submit first observations about the airport and road infrastructure. Since the team members are trusted observers, i.e. they belong to the non-moderated user group, their observations become immediately visible to all members of the private mission space. The private mission space is accessed by an information manager from the Global Logistics Cluster Support Cell (GLCSC), who studies the submitted observations to update a previous Logistics Capacity Assessment (LCA) and draft a first situation report, which many logisticians refer to for their planning. Logisticians thus learn that there are too many aircraft targeting Kathmandu airport and that it is becoming a bottleneck, also because its (previously sub-optimal) condition worsened after the earthquake, to a degree where it seems like the weight of incoming aircraft will have to be restricted. This directs their attention to other airfields in the country that can be expected to still have unused capacity and lets them use airplanes of a smaller size for transportation. As an additional way of circumventing the emerging issue of airport access, they consider alternative points of entry, like road transportation from Delhi to Kathmandu. There, responders on some of the first transports use the GDACSmobile app to take pictures and enter short descriptions of constraints, such as blocked roads and issues with customs at the border.
Soon after the earthquake, OCHA activates the Digital Humanitarian Network (DHN) as the primary interface towards digital volunteer and technical communities (VTCs), including the Stand-by Task Force (SBTF) that focuses on the processing of social media messages and the organization Kathmandu Living Lab (KLL) that engages in crisis mapping. KLL soon emerges as an important actor possessing much needed local knowledge and the ability to guide volunteer efforts. VTCs don't only take UNDAC's information needs, as specified in GDACSmobile, as valuable input for their own social media collection and processing activities. They also support UNDAC in spreading knowledge of GDACSmobile, including Twitter access, among local citizens, and in moderating incoming reports from local citizens. SBTF members thus review incoming observations within GDACSmobile's public mission for the disaster, asking authors clarifying questions where necessary and marking promising observations as *accepted*, which makes them visible to professional responders. This sheds further light on the condition of local road infrastructure, which is utilized by KLL to update OpenStreetMap and by GLCSC to revise their maps of the area.

4. Conclusion

Logisticians need a variety of information, from up-to-date status reports about major airports to road conditions and customs procedures. Until date, practice focuses on secondary data (like previous capacity assessments) and field logisticians as sources of information. The advance of mobile technology and crowdsourcing is promising, however, so that logisticians may benefit from the potential of other humanitarian professionals and citizens acting as sources of information. Considering these emerging opportunities requires careful integration into existing work practices though, so that existing workflows and already strained human resources will not be disrupted by pushing low quality information, increasing information overload and frustrating responders with what can all too easily be disregarded as a hype with no impact and adverse effects. Utilizing the potential of mobile technology and crowdsourcing to supply information useful for logistics decision-making requires not only a clear understanding of logisticians' information needs and feasible structures and processes to integrate

new sources of information with existing work practices but also adequate technology that facilitates data collection and analysis.

We have developed GDACSmobile as a solution that incorporates professional responders and citizens as primary data sources. The solution utilizes, among other things, a novel user concept and information flows that incorporate flexible configuration and effective quality control. While being a promising innovation, the system does still suffer from various limitations that need to be overcome before its practical usefulness can be effectively demonstrated, which is a necessary prerequisite to adoption in practice.

- GDACSmobile still focuses on primary data, although secondary data, such as existing documents or websites, can be named as the most important source of information in the very first phase of a sudden on-set disaster.

- It is not realistic to assume that assessment experts would review each and every incoming observation from moderated users. One way to address this issue is to leverage the capabilities of experts, volunteer communities and automation in unison, e.g. via a moderation hierarchy featuring a machine learning system filtering information, which is further distilled by volunteers, until experts review the most promising pieces of information.

- Looking at the future of information systems supporting not only data collection and information analysis but also decision support, particularly planning, it is necessary to adapt the underlying data model and open interfaces so that 3rd party decision support systems can automatically collect and integrate generated information into planning and other areas of decision-making.

When these and further adjustments are made, we have reason to believe that the current positive feedback and interest from researchers and practitioners will further advance towards adoption and positive impact on humanitarian action.

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