

Collaborative problem solving in emergency situations. Lessons learned from a rescue mission*.

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Abstract. The focus of this paper is on time-constrained collaborative problem solving using common web-based communication systems. The rescue action of a missing Polish kite surfer conducted with help of the kiteforum.pl community created a unique opportunity to investigate how people organize such actions in the Internet and how they collaborate under the enormous pressure of time. Quantitative and qualitative analysis of phenomena that occurred during the people's interaction, has been done with help of natural language processing techniques. A list of recommendations for the designers of collaborative problem solving systems and people involved in such action has been proposed.

Keywords: collaborative problem solving, phpBB, emergency, rescue

1 Introduction

Teamwork, or more generally the approach of splitting a big task into smaller ones and assigning it to people, is probably as old as communities themselves, but the development of the Internet has substantially changed this process, both quantitatively and qualitatively. Even the biggest infrastructural projects conducted before the Internet era (among them the Egyptian pyramids) amassed at most tens of thousands of workers. In comparison, Wikipedia, which is the most famous crowdsourcing project in the Internet, has, only for the English version, almost 17 million editors³ and they have created 4 million articles⁴ that are comparable to the Encyclopaedia Britannica in the matter of quality [3].

The way people collaborate is shaped by many factors, among them: technology design [9], social presence [11], level of involvement, education of participants

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³ <http://en.wikipedia.org/wiki/Wikipedia:Wikipedians>

⁴ http://en.wikipedia.org/wiki/Wikipedia:Size_of_Wikipedia

and the pressure of time. Most of laboratory experiments lack the pressure of time and strong emotions. Therefore, the rescue action of the missing Polish kite surfer has created a unique opportunity to look at how people organize such actions on the Internet and how they collaborate. The SOS signal sent by Jan Lisewski has started a serious, community driven rescue action coordinated on the biggest Polish kite surfing forum <http://kitesurfing.pl> (KF). Users on the KF were: *brainstorming for the best solution, exploring social networks, disseminating information, calculating the most probable drift and collecting money for private charter a helicopter/boat*. As it is shown in the next chapters the efficiency of the collaboration and coordination was strongly influenced by the technology and the design of the phpBB based forum. Although the rescue action was successful, it is evident that many aspects suffered because of the limitation of technology.

The main objective of this paper is to study the way people have collaborated in organizing a successful rescue action with help of the Internet forum as an intermediary. The rest of the paper is structured as follows: the second chapter describes the expedition and the data set used in this paper, qualitative phenomena that appeared during cooperation is described in the third chapter, followed by the fourth chapter focused on quantitative analysis with help of natural language processing tools. The last chapter concludes the paper.

2 Related work

Related work concerns the study of diverse Web2.0 or crowdsourcing systems that have been used for collaboration under time pressure. Among these, the Wikipedia is still the most important and most well-researched. A question that stands out in research on crowdsourcing systems is the issue of motivations for participation. This issue is especially important for time-constrained collaborative work, which requires a fast mobilization of participants.

Although recent reports indicate that there is a constant decrease in the number of active editors on the Wikipedia [1] and a substantial gender bias exists among editors [2] the Wikipedia is an impressive achievement, considering that Wikipedia editors do not receive financial gratification. If not money, then what motivates people to spend their free time in such crowdsourcing systems?

Heng-Li and Cheng-Yu show in their publication [4] that recognition and reputation are not primary motivations of wikipedians. More important are the need to feel self-confident and efficacious. According to the NYU Students Survey conducted by Stacey Kuznetsov [7] the most important driving force behind people's commitment is reciprocity. Heavy users of Wikipedia are more willing to do some editing (e.g. correct errors and omissions) probably because they assume that other people do the same and, thus, they will benefit from the higher quality of Wikipedia articles in the future. People active in free software/open software projects point out a slightly different motivation. The will to learn new

skills and share knowledge are the two most commonly mentioned reasons to join open source projects according to the survey conducted by Berlecon Research⁵.

Wikipedia is just one, although the most prominent, examples of successful collaborative problem solving systems on the Internet. Crowdsourcing has been used by Facebook to translate the web site [6]. People have been asked to choose the right word mapping and then everyone could vote for the most relevant translation. The creators of alternate reality games (ARG) present a less utilitarian approach - entertainment. ARGs are based on the interaction between players and characters that have been created and are actively controlled by game designers. Usually, ARGs are designed to blur the border between the real world and the game and to encourage cooperation between participants (some of them even require it because of the level of complexity, among them one of the first and most famous game “the Beast” designed by Microsoft to promote the Steven Spielberg movie Artificial [5]. See [8] for an in-depth study of alternates reality games and identification of design concepts, which support collaboration and involvement.

3 The Expedition and the Rescue Mission

3.1 The Red Sea crossing

In the late-July of 2011, Jan Lisewski, a 42 years old famous Polish kite surfer, has crossed the Baltic Sea with a kite. He passed over 90 miles starting from Polish coast and finishing in Sweden without any assistance. It was the world’s first successful attempt to crossing the Baltic Sea on a board with a kite. Almost half a year later, encouraged by the success of the first expedition, Jan Lisewski decided to take the next challenge: crossing from El Gouna in Egypt to Duba in Saudi Arabia (ca. 130 miles). The general idea was quite similar to the first passage except the location: no boat assistance, no bidirectional communication (neither satellite phone nor VHF radio⁶), practically no support teams in Egypt and Saudi Arabia. The whole project was intended to be low-cost.

The success of the project was strongly dependent on favourable and stable weather. A kite surfer can sail close-hauled (the dead angle is strongly dependent on the type of board and kite but can reach around 100 degrees) but cannot sail without wind (if wind is weaker than three on the Beaufort scale). Although the speed record on a kite board is over 55 knots, the average speed during crossing is smaller because of tacking, weaker wind and waving. The Baltic Sea crossing has taken 12 hours what means that the average speed was ca. 8.5 knots.

In contrast to the Baltic Sea crossing, which has been a great success (although there were also some technical problems like flooded GPS or lack of connectivity), the attempt to cross the Red Sea has failed and required a serious

⁵ <http://flossproject.org/report/>

⁶ There is contradictory information about the full list of equipment but there is no evidence of bidirectional communication during the rescue action.

rescue action. After ca. 10 hours, 50 kilometres from Saudi Arabian coast, Jan Lisewski sent the 911 HELP signal with a SPOT2 device⁷ (Satellite Personal Tracker)⁸.

3.2 Dataset

The data used in this paper comes from the biggest Polish kite forum: Kiteforum.pl which has been founded in 2003 and is the oldest, and at the same time the biggest, Polish community focused on kite surfing. Currently, this forum contains almost 300 thousands posts in 38,000 threads and over 10,000 registered users. Technically, this web site is implemented using the phpBB⁹, a very popular, open-source, flat-forum bulletin board software. KF seems to be purely community based, and it is not associated with a company (or foundation). Nor are there any attempts on KF to monetize the web audience. Only registered users can publish posts (but anyone can read even without login) and each post is accompanied by information about author (including the date of first registration and *the number of published posts*) and date of publication (with accuracy of minutes).

The thread, which is the main object of the study described in this paper, refers to the Jan Lisewski attempt to cross the Red Sea with a kite. The thread is composed of 1519 posts that have been published within 3 months from the mid-December 2011 to the beginning of March 2012 (will be denoted in the further part of this paper as “Red Sea crossing”). For comparison, the thread related to the crossing of the Baltic Sea (composed of ca. 450 posts) was also analysed (denoted as “Baltic crossing”). All post that have appeared in these two threads have been downloaded and parsed. In addition, some statistics have been calculated for the whole forum.

4 Qualitative Effects of Collaborative Work on KF Forum

4.1 Interaction with mass media

Rapid provisioning of reliable, interesting, full of emotion, eye-catching and unique information is the mission of the vast majority of media. Therefore, it is not surprising that the rescue action has raised their interest. In the beginning information published by media were strongly based on posts from the KF. Because journalists have not always credited the source (or have not done it clearly

⁷ SPOT is not a professional device and is dedicated mostly to hobbyists. In the basic version it uses a one-directional communication and allows sending by satellite three signals: SOS, HELP and Check-in/OK, all bundled with exact position obtained from GPS. The main difference between HELP and SOS signals is that the first one notifies only friends/families (email addresses and mobile phones given *a priori* by spot owner) and the second one also local (according to location taken from GPS) emergency response centre.

⁸ <http://www.findmespot.eu/en/>

⁹ <http://www.phpbb.com/>

enough) for users on the KF forum it appeared as an external acknowledgment that mistakenly increased the credibility of information published on KF. Users have posted information from media and de facto created a bi-directional feedback, which could mislead people organizing the rescue. This shows the journalists' responsibility in emergency situations and the importance of source credibility management (which includes trustworthiness evaluation and exact source denotation). Later on, users on the KF forum noticed the journalists' practice, which finally changed the attitude towards journalists to negative (one of the users has even threatened legal action against media¹⁰).

Of course, the role of media cannot be seen one-sidedly. Viewership of national TV stations and number of visitors on the most popular web sites were a huge opportunity to mobilize public opinion and created pressure on policy makers. People directly involved in organizing the rescue action put a lot of effort to bring media on board and give the issue publicity with help of TV and radio stations. KF users have used their own social network to alarm particular broadcastings. Media also create a unique opportunity to reach people with a rare knowledge and valuable social connection but neither media nor rescue team noticed and used this chance (despite the fact that at least in few cases such a need existed, e.g.: *"If there is anyone who dive know anything about www.daneuroe.org please call me."*, *"URGENT!!! what is the ID number of the SPOT device"*, *"Does anyone have any contact in Saudi Arabia"*).

Although at the beginning of the rescue action media mostly cited the KF posts, after some time (ca. 1-2 hours) the national broadcasters started to gather their own information. Some high profile sources were, and probably will be, out of reach for KF community and are relatively easy accessible for traditional journalists, e.g. Foreign Minister, Polish Consul in Saudi Arabia or famous experts. Interviews with Radoslaw Sikorski (Polish Foreign Minister) and Igor Kaczmarczyk (Polish Consul in Riyadh) have delivered a rich material for analysis on KF but could be even more valuable if journalists would be equipped with precise information about the expedition and present status of rescue action (creating and maintaining a list of questions should be a high priority task for KF community).

The news about successful rescue of Jan Lisewski was accessible at the same time for the best journalists and the whole society because was firstly twitted by Radoslaw Sikorski (Polish Foreign Minister). Shortly after he twitts this information it was republished on KF.

4.2 Backup communication channel

One of the important functions of the KF during the rescue action was a backup communication channel. Most communication was carried out through mobile phones and KF was at the beginning used to exchange and broadcast phone numbers (e.g.: Kowis: *"Gregor, please, call me. I have two person speaking Arabic which can translate to English. My phone number is ..."*). Later on users have

¹⁰ *"cited all without credits. I expect a legal action later on."* posted by flash on 2012-03-04 01:32:00

started posting asks for calls either because some numbers were busy or out of range (e.g. “*Kargul, Pinio, pick up the phone!!!*”, “*Zielwandam, call me if you can. My phone number is ...*”). Widespread distribution of phone numbers of people organizing a rescue action (and phone number of SAR in Poland also freely available in the Internet) have caused that a lot of people started to call those numbers just to gather some information. As a consequence many phone lines have been blocked making communication almost impossible. Therefore, an appeal on the KF has appeared asking for stop calling and blocking lines. Gregorg, one of the person directly involved into the rescue action posted: “*Please do not call Janek. You are blocking the telephone line.*”

4.3 Problems with performance and bandwidth

As already has been mentioned, the KF is a non-commercial project and, therefore, it is equipped only with a limited computational power to keep it low-cost. As the dissemination of the information about the missing kite surfer was speeding up (with substantial help of national TV stations), more and more people wanted to read first-hand information (and maybe also help) and visited KF web site. The easy to predict consequence was a slowdown of the web site. People have encountered problems with browsing the forum and posting. Although users have noticed problems and even posted about it (“*the kiteforum works very slow*”) no serious remedies have been implemented (except requests for logout). Visitors who could not gather information from the KF forum moved to other web sites related to rescue action, e.g. findmespot.com where tracking information from the SPOT device was published and caused a quasi-denial of service attack. It virtually cut off the rescue team from information about exact position of the castaway (“*People not involved directly into rescue action please log out and leave the findmespot.com web site because it is overloaded.*”).

Limiting the access for people from outside of the community will decrease chances for finding crucial social connections (jaroo posted: “*My friend from the maritime academy gave me an URL address*”) and knowledge (flash posted: “*I’m not interested in kitesurfing but I’ve knowledge about sea rescue*”). 46 newcomers¹¹ (15% of all users taking a part in discussion) wrote 179 posts, which accounts for 11% of the total *but all except one were posted after the first SOS signal*. In comparison, the Baltic Sea crossing has attracted only 5 new users (ca. 3% of all active users), who have posted 8 times (total number of posts is 465).

4.4 Lack of updated information

A single web page of the phpBB contains (at least in the configuration used by the KF) 15 posts. If this number is exceeded, content is paged and users can move between previous and next posts by clicking on arrows at the top (or

¹¹ Not every new account can be attributed to a newcomer. Eska, a member of the core coordination team, has created separate accounts for this purpose (login: Rescue).

bottom) of the web page. Users have published during the rescue period on average 22 posts per hour (detailed information can be found on fig. 2). The rapid flow of posts made following the situation a little bit difficult. Informative posts were pushed up by short comments and new visitors had to click backward to find the most relevant information. Many users instead of doing it preferred to repeatedly asking about the up-to-date information (Stani21: *“Do you have any new information about location?”*, Bastek_kite: *“Any new information?”*, Solution: *“Gregor, do you have any information?”* etc.).

Next to the design of the phpBB bulletin another reason causing the flood of questions was the very basic dilemma: if there is no information it could be either because of lack of new facts or because no one shares it on the forum. Everyone involved into the rescue action¹² wanted to be as up-to-date as possible. The core members of the rescue team had not noticed this issue but after 30 hours and the explicit request made by Ksiaze they have created a continuously updated whiteboard¹³ with all contacts. It was only a moderate success because of problems with effective redirecting all people looking for information to this web page.

4.5 Credibility problems

Similarly to other open knowledge communities, the credibility of disseminated information must be verified by the participants. The KF forum participants reacted strongly to the posting of incorrect information. In one case, a new users published one post that claimed that the missing kite surfer was already rescued. As expected, this resulted in a heated discussion. When the post turned out to be wrong, the user was banned from the forum. However, such a strong reaction creates the concern about reducing voluntary participation. A more appropriate reaction would be through a trust management or reputation system for source credibility evaluation.

5 Quantitative analysis

5.1 People’s involvement

The idea of crossing the Red Sea with a kite was preceded by the successful crossing of the Baltic Sea. Both expeditions were extensively commented on the kiteforum.pl. Similar subject but drastically different emotions make the comparison between these two threads extremely interesting. The threads vary widely in the matter of people’s involvement, dynamic of discussion, mentioned topics and behaviour patterns. Topics are discussed in-depth in the next chapter; therefore, in this section special focus will be put on purely quantitative effects.

¹² It is worth to notice that for many crowdsourcing systems there is no procedure for accepting new team member. Everyone can join freely. Being a member of a team is actually a personal mental state.

¹³ <http://www.kiteforum.pl/forum/viewtopic.php?f=27&t=44642>

As is shown in Table 1 the Red Sea crossing has attracted more attention than the Baltic crossing, both in the matter of users and the length of comments.

	Red Sea crossing	Baltic crossing
Avg. length of comments (in characters)	184	165
No. of posts	1510	465
No. of users	312	178
Posts per user	4.83	2.61
No. of new users	46	5
Timespan	Eleven weeks	Six weeks

Table 1. Basic statistic for different parts of the Red Sea crossing thread.

The substantial difference in the posts per user ratio between the Red Sea crossing thread and the Baltic crossing is caused by the hyper activity of the minority of users. 20% of the most active users generated 67.2% and 55.7% posts, respectively. Gini index values are respectively 0.60 and 0.48 and show that the distribution of the activity of users in the Red Sea crossing threads has a much longer tail.

The Red Sea crossing thread can be divided into four separate periods following the most important events. *Preparation* was started by the first comment in this thread and is followed by *crossing* triggered by the information about the start of Jan Lisewski. The first intercepted SOS signal indicates the end of *crossing* and the beginning of *rescue* period. Confirmed information about finding the kite surfer finished the rescue period and started the last one - congratulations. Table 2 shows basic statistics for all four periods.

	Preparation	crossing	Rescue	Congratulations
Avg. length of comments (in characters)	104.33	112.75	176.44	256.91
No. of posts	117	60	1020	313
Posts per hour	0.06	5.45	22.6	11.2
No. of users	70	34	203	168
Posts per user	1.67	1.76	5.02	1.86

Table 2. Basic statistic for different parts of the Red Sea crossing thread.

The user activity smoothly follows the dynamics of events even if there are no dramatic emotions. During the crossing people have posted almost 100 times more often than during the preparation but the length of comments were very similar. Except the rescue period users usually post on average less than two comments. Even if they have a lot of thoughts and observations to share they choose to make comments longer, rather than publish many posts. The rescue period is presented separately on Figure 1.

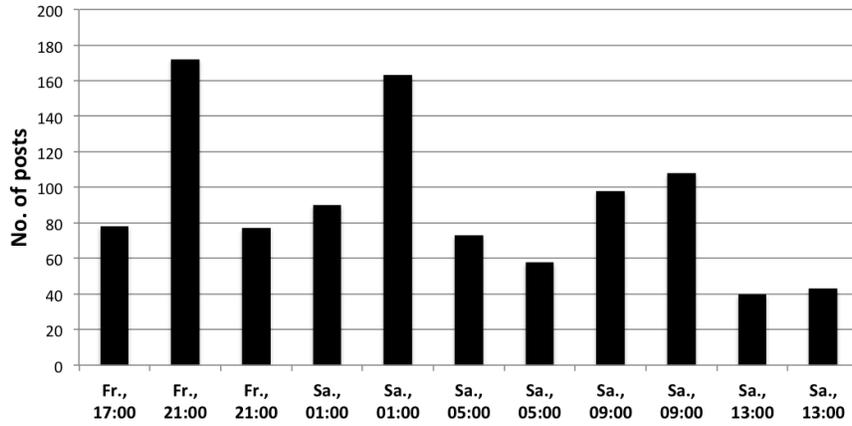


Fig. 1. Number of posts for the rescue period in two-hour intervals.

5.2 Sentiment in Posts

This section describes the sentiment analysis tools and algorithms applied to forum posts. In short, sentiment computation method is a lexicon-based one extended by a shallow parser. An version of the system used in this paper has been described in [10]. Figure 2 presents aggregated results of sentiment analysis. Sentiment of each message has been computed as positive (sum of positive word scores in a message) minus negative (sum of negative word scores) divided by the number of words in a message.

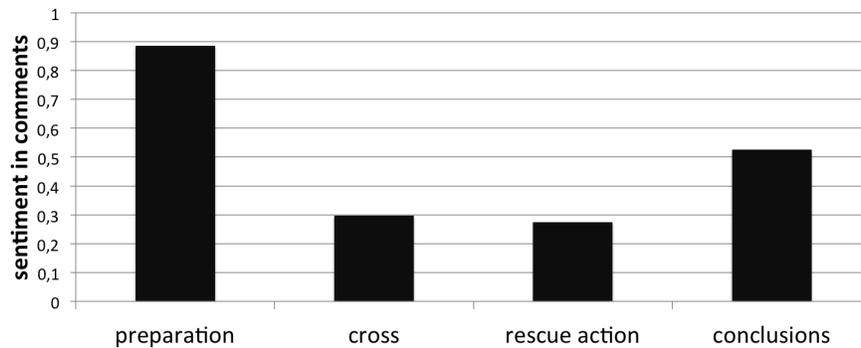


Fig. 2. Average level of posts' sentiment in four periods.

The results show a strong change in emotions after the preparation stage. Positive emotions appear again in the conclusions stage. The negative emotions

in the crossing stage can be explained by the fact that despite of promises given by team preparing the Red Sea Crossing, live tracking was available only by a limited time (at the beginning). Therefore, the initial optimism in the comments has been later on displaced by concerns. So, posts published during crossing period were less positive than would be expected.

5.3 Posts Topic Modeling

This section describes the results of automatic topics identification of the discussions in the two threads of the KF forum related to the Baltic Sea and Red Sea crossings. The main hypothesis related to this investigation has been that the two threads concern a variety of diverse topics, and that the thread organization of the KF forum is not fine-grained enough to allow such a usage (which resembles sub-threads).

The topic modeling technique we have used is the well-known Latent Semantic Indexing (LSI). The algorithm involves two steps: construction of a term-document matrix and application of singular value decomposition (SVD) to obtain singular value and singular vectors matrices. One popular claim of the method is its ability to capture conceptual content of a corpus of texts by establishing associations between terms that tend to co-occur. Singular vectors can be seen as representations of latent topic variables and their contents approximated by terms with the highest weights.

The discussion of results of topic modeling analyses on both datasets, Baltic and Red Sea, is mostly qualitative. It focuses on interpretability and usefulness of obtained topic representations. Quantitative parameters such as energy spectrum covered (LSI) are of considerably less importance if topic representations are not meaningful. Each topic is approximated by a set of its distinctive terms with their associated weights (the meaning of weights depends on an algorithm).

The results have been presented for 10 most important topics (in terms of singular values). Limiting to 10 factors discards 61.980% of energy spectrum in the case of Red Sea data and 58.209% of energy spectrum for Baltic data. The LSI technique, originally not designed for topic modeling, performs good. Both Baltic crossing and Red Sea crossing data generate quite distinctive and mostly interpretable topic representations. This is especially evident in capturing English language in two separate topics in Red Sea and one topic in Baltic data, not disclosed.

In Red Sea crossing data, five topics are generic discussions of the trip which include mentions of Saudi Arabia, coast guard, surfer's name and surfing alone. Two presented topics are special and more interesting. Topic #6 is focused on organizing help using the satellite signal, while topic #7 on reading gps positions from the receiver and time-position speculations. Selected two topic representations for Red Sea are as follows (English translations in parentheses):

- #6 : -0.250*(device) + 0.237*(be able) + -0.213*lisewski + 0.208*(help) + -0.169*(sea) + 0.157*(satellite) + -0.139*(signal) + -0.132*(number)

- #7 : 0.251*(be able) + -0.242*gps + -0.206*(clock) + -0.196*(receiver) + -0.159*(ground) + -0.132*(position) + -0.128*(use) + 0.128*(arab) + -0.127*(readings) + -0.121*(satellite)

Baltic data topics are focused on concepts like keeping fingers crossed, gsm range and words of joy such as congratulations, achievement. Topic #0 is the one mostly focused with gsm network range. Topic #2 is devoted to wave discussions: breaking waves, wave crests, but also kite. Two selected Baltic data topics are as follows:

- #0 : 0.300*(wave) + 0.262*(transmitter) + 0.163*(range) + 0.153*(longitude) + 0.140*gsm + 0.134*(to sail) + 0.122*(Baltic) + 0.116*(sea)
- #2 : -0.434*(wave) + -0.197*(break) + -0.178*(crest) + -0.178*(move) + 0.170*(transmitter) + -0.144*(Baltic) + -0.128*(kite)

6 Conclusions

Each rescue action is different, therefore, any generalizations should be made very carefully. There is no single recipe for making collaboration of a bunch of anonymous people efficient but even if it was the pressure of time, emotion and limited resources could effectively prevent its implementation. A list of recommendations that come from the analysis of Jan Lisewski case are presented below:

- People prefer to use tools they know and stay within the existing communities; there is no easy way to redirect traffic and, thus, it is better to ask people for help in places where they feel comfortable; although some of dedicated web sites (communities) were created to help Jan Lisewski the most active still remains the kiteforum.pl.
- Over time, even the most dramatic events evoke less emotion; sustaining commitment and mobilizing people is crucial, especially since no one knows how long the rescue mission will take.
- More people usually means a greater chance of success; therefore it is important to encourage people to join the community and share their thoughts (for the kiteforum.pl the number of visitors easily surpassed few thousands but only a 312 users have posted anything).
- Everyone who wants help should be confronted with a list of tasks where he/she can pick up that what best fits his/her skills and resources; volunteers in a crowdsourcing system should not be forced to ask for task allocation.
- Users should be instructed that discussion, even full of guessing and presumptions, is good, but should be supplemented with information about author's level of knowledge, experience and education because it will protect people from implementing untested assumptions.
- Few simple templates for repeatable (periodical) messages will eliminate the omissions (e.g. every post about signal from the SPOT device should contain type of signal, position and exact time).

- Information is indispensibly connected with the source (it will help judge credibility of information).
- Translation and information dissemination were two tasks which were carried particularly efficient by the KF community.

The rescue action of Jan Lisewski, and particularly cooperation of ordinary people in the Internet, creates a unique opportunity to investigate how the Internet technology influence the efficiency of such tasks. Further research should be extended to a survey of people involved in the rescue action and an in-depth analysis of interaction between different communities and web sites.

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