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CROWDSOURCING IN RESCUE FIRE SERVICE – PROPOSED APPLICATION

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Abstarct: *This article describes the author's proposal to apply crowdsourcing in Polish rescue fire service. This article also describes basic principles for implementing an crowdsourcing information platform in rescue fire service as well as the scheme of its implementation. The Author of this paper also describes the genesis of this proposal related to the evaluation of research conducted by the author on text mining analysis and extraction of information in the design of information systems.*

Keywords: *crowdsourcing, design of information system, information system, text data mining, methods of analysis of textual data, exploratory analysis of text data, text analyzing*

1. INTRODUCTION

This article describes the possibility to apply crowdsourcing in Polish rescue fire service.Crowdsourcing is a form of cooperation that involves outsourcing of conventional tasks and duties of company or institution employees to a distributed undefined group of people or community [1, 2].Those tasks are presented to the community in form of open calls. The community solves the tasks and returns the results to the source of the problem to be solved.Thus the community may be treated as the collection of agents, who can assist the institution in selected rescue fire service tasks as well as corresponding information systems [3-6].It may also act as the second, important pillar of the decision support systems based on agents, where, apart from software solutions, also community-related aspects are included [3].The author has not found in the professional literature so far any proposal of community activation and engagement in assistance of initiatives associated with community-based information platforms.Community-based IS can be defined for the purpose of this paper as systems which, either directly or indirectly influence social aspects, e.g. on the system safety.Those systems may be assisted by the community at the stage of their construction, supplementation and verification of information they contain, as described further in this paper.

The created framework of the crowdsourcing platform was discussed based on a sample use of the framework components in relation to IS designed by the author concerning *water intake points – Hydrants* [7].The author designed the system based on exploration analysis of textual data, where an additional information extraction process was introduced in order to supplement the system with information on selected topics [8, 9].The Project was intended to eliminate current shortcomings of the event recording system used by the rescue fire service (PSP), EWID-99 (shortly EWID) [10-13], which, after appropriate analyses, has not been approved as the operating data base used for real-time assistance of rescue-and-fire-fighting actions [7].Based on the analysis of the currently used event recording system as well as information collected, a different solution was proposed, i.e. an operating data base, or more specifically, IS concerning *water intake points – Hydrants.*That system gave grounds for the *case based reasoning system – CBR* [6, 14-16], which not only includes information on recommended way of neutralising the hazards, but also information on *water intake points – Hydrants* in order to use them for tanker filling up during PSP interventions. Results of the Author's research showed that the current event recording system includes, among others, information on *water intake points – Hydrants* checked during rescue and fire-fighting actions. 975 out of total

12753 studied segments (sentences describing rescue-and-fire-fighting actions) included information on a hydrant location.759 out of 975 segments concerned hydrant location expressed by the statement that a hydrant was present at a given street, e.g. *hydrant at Mickiewicza street 26* while 216 hydrants were located at street crossings, e.g. *intersection of Kordeckiego and Mickiewicza streets*.

In point 2 of this article, the author presented assumptions for the general PSP crowdsourcing platform.He also presented types and roles of the platform users, i.e. PSP on one side and the community network, hereinafter referred to as a community on the other side.Then the author described usage of the platform and the framework of the application used to platform implementation.Further in this paper, the author puts forward the proposal to make available to PSP and to the public the information platform with a working name "Namierz Hydrant" -NH (locate a hydrant), used for verification and updating of data collected during, among others, information extraction process and for recording and storage of information on new *water intake points – Hydrants* depending on their location, e.g. within the community member place of residence etc.Hence this solution is a voluntary, community-based action the aim of which is to assist the conventional PSP structure and IS implemented in PSP. The action is undertaken by external bodies which are not directly associated with PSP and its aims.

2. CROWDSOURCING PLATFORM FOR THE RESCUE FIRE SERVICE (PSP) – PROPOSED APPLICATION

General diagram including the idea of the designed crowdsourcing platform assisting selected PSP activities was presented in Figure 1.

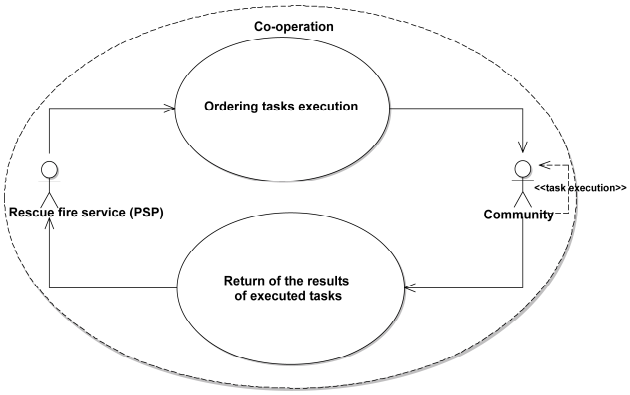

Figure 1 General diagram including the idea of the designed crowdsourcing platform assisting selected PSP activities. Source: [own study]

The diagram of the general platform of crowdsourcing for PSP presented in figure 1 includes two participants or parties of the collaborative.The first party includes PSP entities, such as firemen and activists of the volunteer fire department (OSP).They were called *internal participants* as they participate in the rescue-and-fire-fighting system and they are part of the system internal structure [17].The other party is the community beyond that structure, which may be stimulated to engage in common actions associated with selected PSP goals.At the beginning of each cooperation cycle, the list of open problems is defined.This task shall be implemented by the rescue fire service (PSP).When that list is defined, it is made accessible to the community (*external participants*).Those participants accomplish the defined goals and return the results of their completed works to *internal participants.*

That highly abstract model of cooperation was proposed by the author for the purpose of the assessment of research on information extraction performed by him [8].Moreover, the model has been further developed in order to verify the possibility to apply community networks in research on their use as an aid for selected aspects of rescue fire service (PSP) activities as well as for verification and supplementing community-based PSP information systems (IS) with new data.The designed framework of the crowdsourcing platform was further discussed based on a sample IS designed by the author during earlier research, concerning *water intake points – Hydrants* [7].That system can be used to store information on hydrant location in form of a catalogue implemented in an *noSQL ("not only SQL"*) database [18, 19].Data is stored in that catalogue in form of attribute-value records, and includes such attributes like:hydrant location, type, reasons for malfunction etc.

Figure 2 shows the diagram of the implementation of crowdsourcing platform in the rescue fire service (PSP).The diagram was presented in form of the *activity diagram* using *unified modelling language – UML* [20].

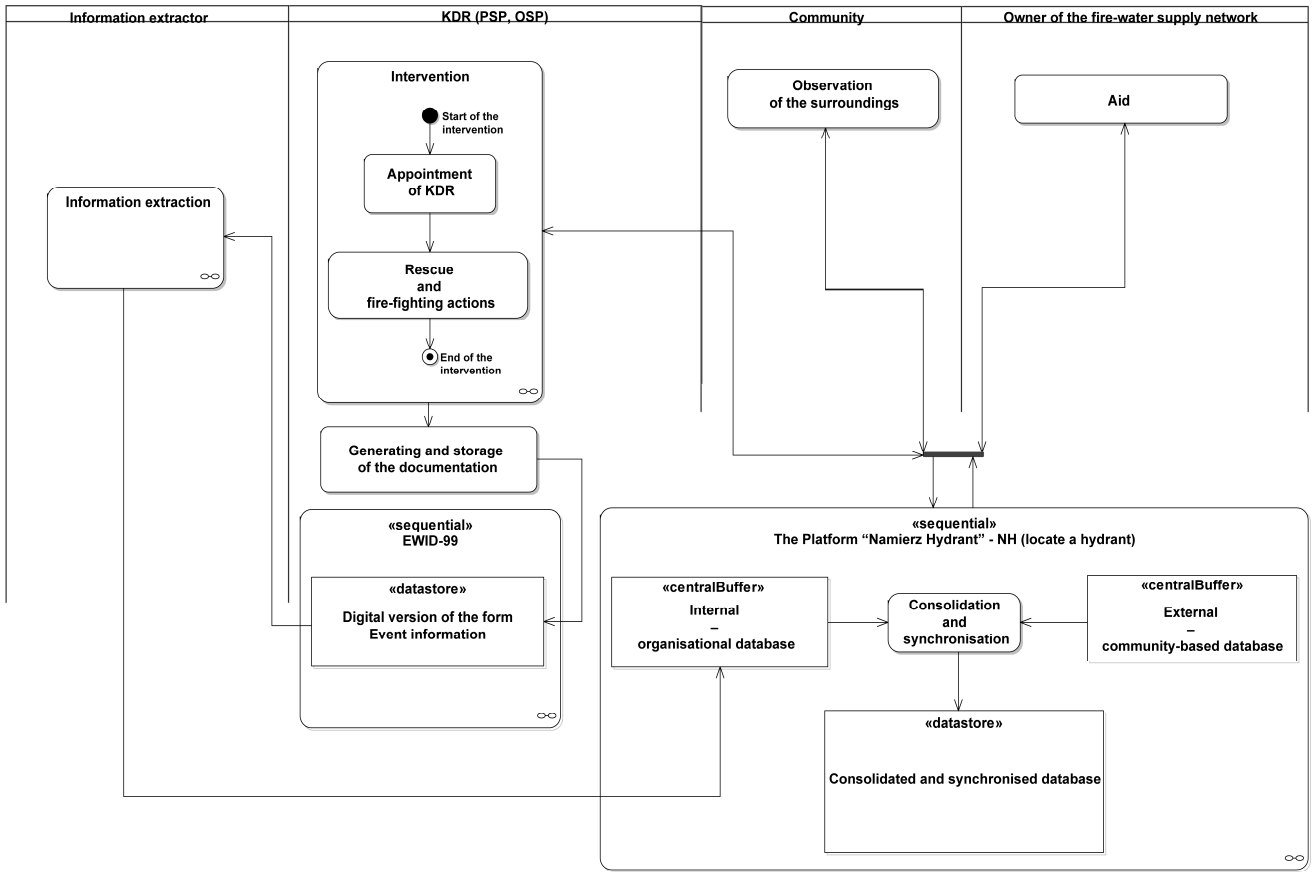

Figure 1 The diagram of the implementation of the PSP crowdsourcing platform.Source:own study]

In accordance with the diagram of the implementation of the PSP crowdsourcing platform shown in figure, 2, there are four main participants of the process.Parties participating in the cooperation process include:

− *Information extractor*, which is a programming unit (software), designed to extract information from electronic, digital section of the event recording system EWID in form of *The event information*, and, more precisely, from the field:*Descriptive data for the event information* [17].Based on earlier analyses of that section, the author created selected model of the domain in form of *water intake points – Hydrants*, which, in the discussed drawing. The model is represented by *The internal – operating database*, which fulfils the postulate of the operating database [17].This database collects data on *water intake points – Hydrants*, such as e.g. their location, condition or type.Information from text (fields *Descriptive data for the event information*) is extracted into model created in that way and stored there using information extractor developed by the author.That process was demonstrated using the following example.It was assumed that the report on the rescue and fire-fighting action is available in the following form:*PSP activities consisted in unfolding and putting the ladder up the balcony on the second floor to make it available to the police.The police squad was commanded by comm.----- Hydrant no. 11210 in working order, at Łukowska street 28.Weather conditions:western wind 2m/s, dense mist, temp.-8 C.”*.The following information is extracted from such report:hydrant identification number – *11210*, its location – *Łukowska street 28* as well as its condition: in working order or out of order.Moreover, in the geocoding process [21-23], data on relative location of a hydrant are obtained using latitude and longitude:latitude coordinate - *52.2382943*, longitude coordinate – *21.1003158*. Relative location of the *water intake point – Hydrant* is recorded in the event recording system with reference to some object, which is often the block of flats of a given number at a given street.Thus the absolute location defines exact location of *the water intake point – Hydrant* without the reference to other points.

− *The rescue action leader* (KDR) represents *the internal participant* from the structure of PSP or OSP, who is appointed during the intervention at the event place in order to manage the rescue and fire-fighting action [17].Following each intervention, simplified diagram of which is shown in figure 2, KDR generates event report recorded in the event recording system

EWID.As provided above, from text section of the documentation, i.e. *Descriptive data for the event information*, describing the rescue and fire-fighting action with natural language, the information on *water intake points – Hydrants*, is extracted and stored in *The internal organisational database*.During intervention, information on the location of *water intake points – Hydrants* can be retrieved from the data base created in that way, in order to tank up water to the fire tank truck.Apart from extraction of data on hydrants using NH platform, rescue action leaders (KDR) can also verify hydrant data, e.g. change relative location to absolute one, assess information obtained from community networks or add new records describing hydrants found in the area of performed rescue and fire-fighting actions.

− *The community* as well as an additional partner which is *The owner of the fire-water supply network* make up the group of external participants.Using NH platform, the community can send data on location and description of *water intake points – Hydrants* found, e.g. in their area of residence.This task is executed by providing the community with appropriate tools included in the graphical user interface – GUI, as well as mobile applications in order to allow remote recording and transferring such information to the system and storage in *the external community-based database*.The community performs also such tasks like verification, up-date and correction of information obtained as a result of information extraction process.The participant, who is the owner of the fire water supply system, is obliged by the low to inspect the condition of the fire-water network annually, including hydrants [24].Due to these reasons, that owner may support the process of consolidation and synchronisation of data on *water intake points – Hydrants* found using data stored in the owner's databases.The owner can also receive information from consolidated and synchronised databases, e.g. on damaged or malfunctioning hydrants.

The last aspect to be discussed concerns the way and strategy of evaluation and approval of data obtained from the information extractor and the community-based network.The assessment and verification is necessary as obtained information may be unreliable, i.e. it may not completely reflect actual absolute and accurate location of *water intake points - Hydrants*.This inaccuracy results from the fact that the information extractor records the relative location of hydrants and from the inaccuracy of global positioning system – GPS (available in mobile equipment), used by community network members to determine location of hydrants.The proposed strategy of monitoring, assessment and correction of the obtained data was presented using the activity diagram shown in the figure 3.

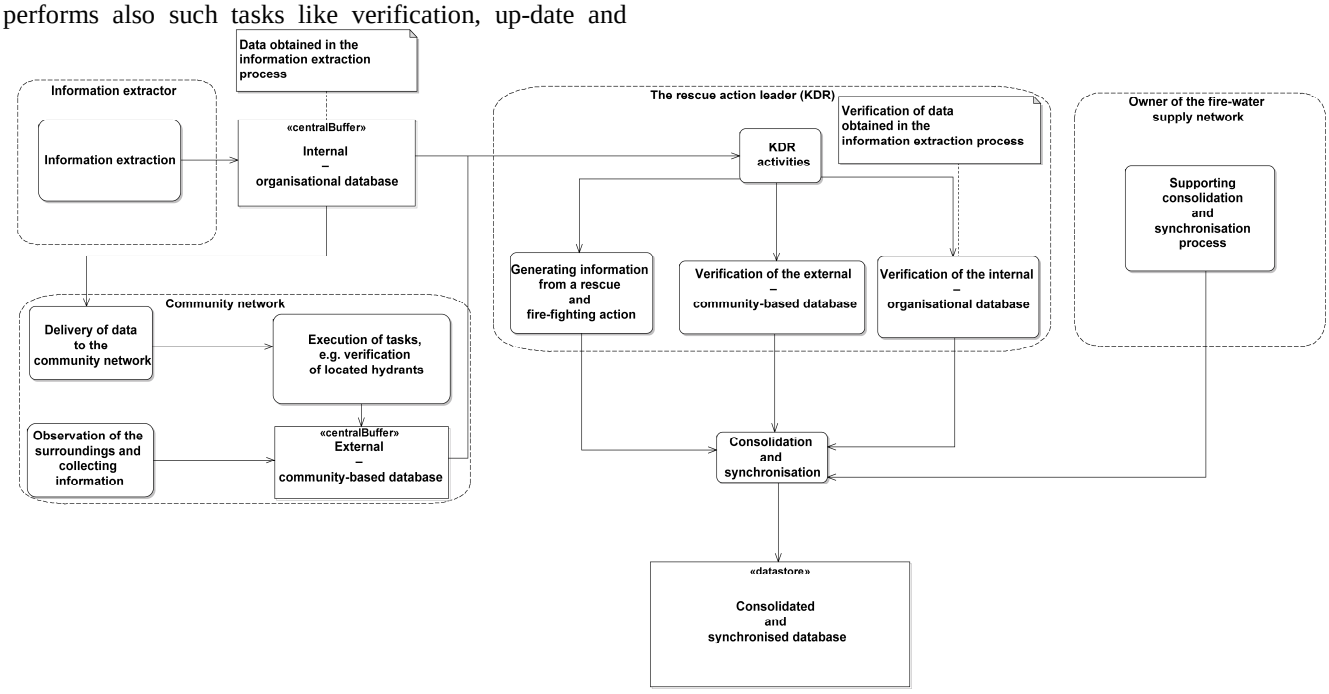

Figure 4 Information assessment and approval strategy – the rescue action leaders (KDR) as the hub. Source:[own study]

Figure 3 shows graphic representation of the proposed verification and approval process used to verify and approve information obtained from the information extractor and from community networks. Its main component is the rescue action leader (KDR), who is the hub, i.e. some kind of vertex of the graph which has most of or a lot of links with other nodes, graph components or elements of the studied process. The discussed figure

shows that KDR, apart from generating information on *water intake points – Hydrants*, also assesses information obtained from *External – community-based databases*, which include information on those points. Those bases are populated with data obtained from the community-based direct initiative, participants of which observe their surrounding and record appropriate data on *water intake points – Hydrants* located there.That information may also be obtained from *indirect initiatives*, i.e. those generated by the internal participant e.g. in form of the list of hydrants to be inspected, which was created using the information extraction system, i.e. information from the Internal - organisational data base unverified by KDR yet.Information obtained both from the *External* and the *Internal* database are verified by KDR and then consolidated and synchronised in order to create verified, consolidated and synchronised record of *water intake points – Hydrants*.The owner of the fire water supply network may participate in the consolidation and synchronisation process by providing additional attributes e.g. in form of accurate, absolute location of *water intake points – Hydrants*.

3. SUMMARY, CONCLUSIONS AND FURTHER RESEARCH AND DEVELOPMENT

This article describes the proposed crowdsourcing for Polish rescue fire service (PSP), developed on the basis of the problem connected with assessment of information retrieved from the process designed by the author for exploration-based analysis of textual documentation in form of *Descriptive data for the event information*.To facilitate verification of information concerning location of given *Water intake points – Hydrants* as well as to make generation of that record easier, it was proposed to include into that process, apart from KDR, also the community.In the proposed solution, data from both of those sources are subject to final verification and approval by KDR.As seen above, the platform can be easily scaled by introduction of new users, such as e.g. *the owner of the fire water supply network*, who may provide or retrieve information useful for him e.g. on damaged *water intake points - Hydrants*.The proposed solution is a ready framework of the application developed by the author for assessment of the IS concerning *water intake points – Hydrants* implemented and populated using the information extractor.IS assessment, testing and verification phase is the next step after it has been designed and implemented (coded) during software generation stage [25, 26].Thanks to introduction of community-based components, this phase offers new opportunities and approach to IS assessment, verification and testing problems.Possible further research in that scope shall include development and supply of an appropriate IT solution in form of NH platform designed for collection, verification and consolidation of data obtained from the community network.It is also necessary to consider ways to activate and encourage the community to carry out defined tasks.Whereas the consolidation process itself must include the existing record of *water intake points – Hydrants*, supplemented (populated) with data collected during the information extraction process as well as data entered by the rescue action leaders (KDR) after individual interventions or with data supplied by the *owner of the fire water supply system*.The quality of data obtained from the information extractor and from community networks shall also be the problem to be solved in the studied platform.Further research is also necessary to confirm if or to what extent information obtained from those sources complies with the actual state and if it is sufficient for the rescue action leader (KDR) to find water intake points – Hydrants at or on the way to the place of the event.If tests are successful, then it would be possible to relieve KDR of additional verification operations.It seems to be justified to assume that shortcomings of the process related to the fact that the relative location is recorded by information extraction or resulting from possible inaccurate fixing the position of the water intake point – Hydrant by the community network members do not disqualify use of those solutions in practice.Sometimes it is sufficient to know approximate location of a given object to be able to find it.Finally, social aspect of the proposed further research on the developed IS should be emphasized.The definitions of such words like “state” and “national” provided in the Polish language dictionary mean internally organised independent society dwelling specified territory, having its own government and law.So, activities of the State (National) Rescue Fire Service (PSP) may, by all means, include community initiatives which can be executed using the PSP crowdsourcing platform discussed and described above.

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