Towards a Taxonomy for Classification of Coordination Systems for Spontaneous Volunteers

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ABSTRACT

Spontaneous volunteers have always been a relevant factor in disaster management. Digitalization and modern technologies such as social media and mobile devices had a great impact on the quality of spontaneous volunteer engagement and their mobilization. However, their targeted integration into official disaster management measures remains often challenging. In the last decade, there were different scientific and practical approaches to develop information systems for coordination of spontaneous volunteers addressing different scopes and scenarios. In this article, we have analyzed the current state of the art and use a methodological approach to develop a taxonomy for classifying existing and emerging developments in the field. The taxonomy is intended to assist practitioners in selecting appropriate systems for their respective purposes as well as support researchers in identifying research gaps. The resulting research artifact has undergone an initial evaluation and can support maintaining a better overview in a growing subject area.

Keywords

spontaneous volunteers, unaffiliated volunteers, taxonomy, coordination system, volunteer management

INTRODUCTION

Spontaneous volunteering in crisis and disaster situations is not a new phenomenon, but a common reaction to such events (Aguirre et al. 2016). They are already providing assistance while official responders have not yet reached crisis or disaster areas or cannot reach them due to their expansiveness and lacking infrastructure (Whittaker et al. 2015). In the recent past, many disaster events, such as Hurricane Katrina or the 2013 Central European Flood, have seen tens of thousands of spontaneous responders repeatedly rally and participate in response efforts in a very short period of time, supported by social media and mobile communication devices. (Barraket et al. 2013, Thieken et al. 2016). Since the turn of the millennium, it has become apparent that the nature of volunteerism is changing and is less and less associated with strong identification and permanent membership in civil protection agencies and organizations (CPAO) (Hustinx 2003). In this article, we define spontaneous volunteers as civilians without affiliation to a CPAO who voluntary support civil defense activities with physical labor. Purely digital helpers do not fall within the scope of this paper.

The large number of spontaneous volunteers represents a great potential for CPAO in managing disaster impacts. In theory, efficient integration and coordination of spontaneous responders can improve the quality of the response and contribute to saving lives and assets (Nielsen 2019). However, many CPAO are hesitant to integrate spontaneous volunteers into coping efforts because they fear various challenges and risks (Volunteer Florida

2005).

Fernandez et al. (2006b) have identified two main risks. The first risk involves the failure of CPAO to effectively deploy spontaneous volunteers. CPAO are often bureaucratic and resistant to change, which can result in reluctance or inadequate response to or use of offers of assistance from spontaneous responders (Daddoust et al. 2021). In this regard, a lack of guidelines, scheduling, and the convenience of official staff present further challenges to CPAO in using spontaneous volunteers. Also, a lack of awareness of the importance of adequate public outreach on the part of CPAO lead spontaneous volunteers to engage independent and self-coordinated (Larson 2004; Skar et al. 2016). A second risk is related to the liability and volunteer management issues regarding skills of untrained and uncoordinated volunteers (Fernandez et al. 2006a). According to Orloff (2011), there are uncertainties about liability arising from the complex laws and protections that vary from country to country.

To reduce existing barriers, recent research has focused intensively on how to coordinate and integrate spontaneous volunteers in an efficient, effective, and structured manner (Daddoust et al. 2021). As digitalization is a major factor in the current events surrounding spontaneous volunteers, many approaches also propose the use of IT tools to address specific problems (e.g. Havlik et al. 2016, Kristikj et al. 2022, Sperling & Schryen 2022) or try to support the whole coordination process (e.g. Betke 2018., Fuchs Kittowski et al. 2018, Schimak et al. 2020). The growing number of different approaches makes it difficult for disaster managers and researchers to keep track and differentiate focal points. To the best of our knowledge, there are approaches that address a classification of organizational approaches to volunteer management (e.g. Schönböck et al. 2016) as well as the approach of Mengistu and Che (2019), which focus primarily on the technical implementation of volunteer management systems and do not specifically focus on spontaneous volunteers.

Therefore in this paper we suggest a taxonomy for classification of coordination systems for spontaneous volunteers. The paper wants to give a first answer to the research question: What characteristics and dimensions are suitable to provide a classification of existing and upcoming IT system approaches for spontaneous volunteer coordination? The resulting taxonomy is intended to be a tool that is useful for both researchers and practitioners by allowing a classification of respective systems based on relevant features, but also on the most important parameters of the application context. A classification of existing approaches into the taxonomy is not part of this work in progress but will be aimed at in future work steps of this project. The taxonomy also indicates important properties to consider when developing new systems. We show the methodological path to the development of the taxonomy following Nickerson et al. (2013), provide its current status and insight into initial evaluation results.

In the next chapter, we introduce the multilevel research procedure before presenting the taxonomy in the third chapter with description of its characteristics and dimensions. After a look at the results of an expert survey to assess the taxonomy, we conclude with an outlook on the next development steps of the research project.

RESEARCH METHODOLOGY

In this chapter we describe our research process to give evidence about the research rigor and validity of results. The procedure for developing the taxonomy follows Nickerson et al. (2013), with additional methods incorporated in the execution of some steps (see Figure 1). The first step involves the definition of a meta-property, that is, a comprehensive feature at the highest level of abstraction. The meta-property - in this case "Features of IT-based coordination systems for coordination of spontaneous volunteers in disaster management" - forms the basis for the selection and derivation of dimensions as well as specific (sub)properties of the resulitng taxonomy. Subsequently, in the second step, ending conditions are defined, at the fulfillment of which the taxonomy, according to objective and subjective points of view, has reached a satisfactory result. In this paper we use the 8 objective and 5 subjective ending conditions (OEC and SEC) as suggested by Nickerson et al. (2013). The third step follows the iterative development of the taxonomy according to the empirical-to-conceptual approach. With the help of a structured literature analysis according to vom Brocke et al. (2009) 45 relevant real objects (papers) containing valuable information could be identified. Next, the actual development of the taxonomy follows by identifying dimensions and characteristics until all ending conditions are met.

To evaluate the taxonomy created in this way, an expert survey on performance and effort expectations was first conducted with the aid of the evaluation criteria according to Venkatesh et al. (2003). The comments and criticisms of these survey, were analyzed and used for a verification of existence in the real-objects, in the second iteration with the Conceptual-to-Empirical approach. Finally, the current version of the taxonomy could be created considering the 8 objective ending conditions and matching the subjective ending conditions as shown by the survey.

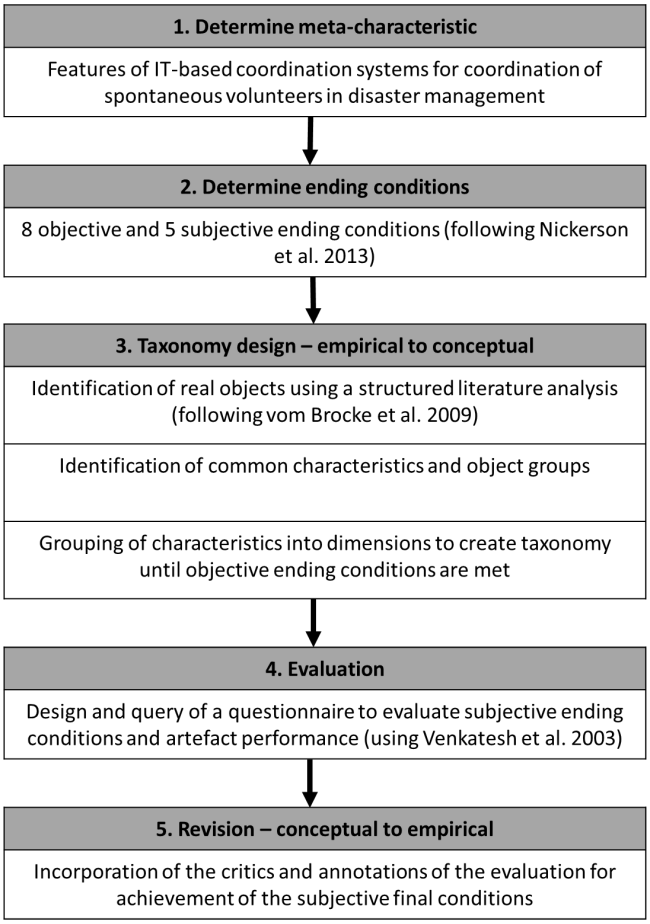

Figure 1. Research Methodology Process

In the following two sections we want to give further explanation about the structured literature review used to derive the source objects for the taxonomy building.

Structured Literature Analysis

The state of the art was examined by a literature analysis according to the method of vom Brocke et al. 2009 The whole process is represented in Figure 2. In a first step, the following five scientific databases were searched for suitable hits: (1) ACM Digital Library, (2) ISCRAM Digital Library, (3) Science Direct, (4) SpringerLink, and (5) WILEY. We used the plain term "Spontaneous Volunteer" to search the databases items in title and abstracts. This yielded a manageable number of 304 articles. Furthermore, the search results < 10 years were filtered to ensure the timeliness of the papers as required by the research goal. Only articles in English were considered. Among the papers selected for in-depth analysis are not only those that present ready-made systems, but also conceptual and theoretical work that has not yet been brought to implementation in a demonstrator, as well as studies that contain requirements or proposals for future developments.

In the next step, we performed a title-based selection of all research papers. Due to a lack of topic relevance, a predominant number of hits (237 items) were sorted out. Some matched the topic of "volunteering" but were in a different context (physicians as volunteers in health care emergencies). With the remaining 67 titles, we underwent an abstract-based selection to consider only thematically appropriate articles in the taxonomy creation process. Due to too specific focus, for example exclusively digital volunteers, another 16 articles could be excluded. Finally, a full-text based selection with 51 research papers was conducted, eliminating a further 10 articles. Thus, 41 relevant objects resulted after the full-text based selection. During the review of the literature, a backwards search took place, in which articles relevant to this work were included in the literature selection. The backwars search ended with four relevant articles, so the literature selection process ended with a final selection of 45 articles. Due to formal restrictions for WiPe articles, we do not list all identified papers here.

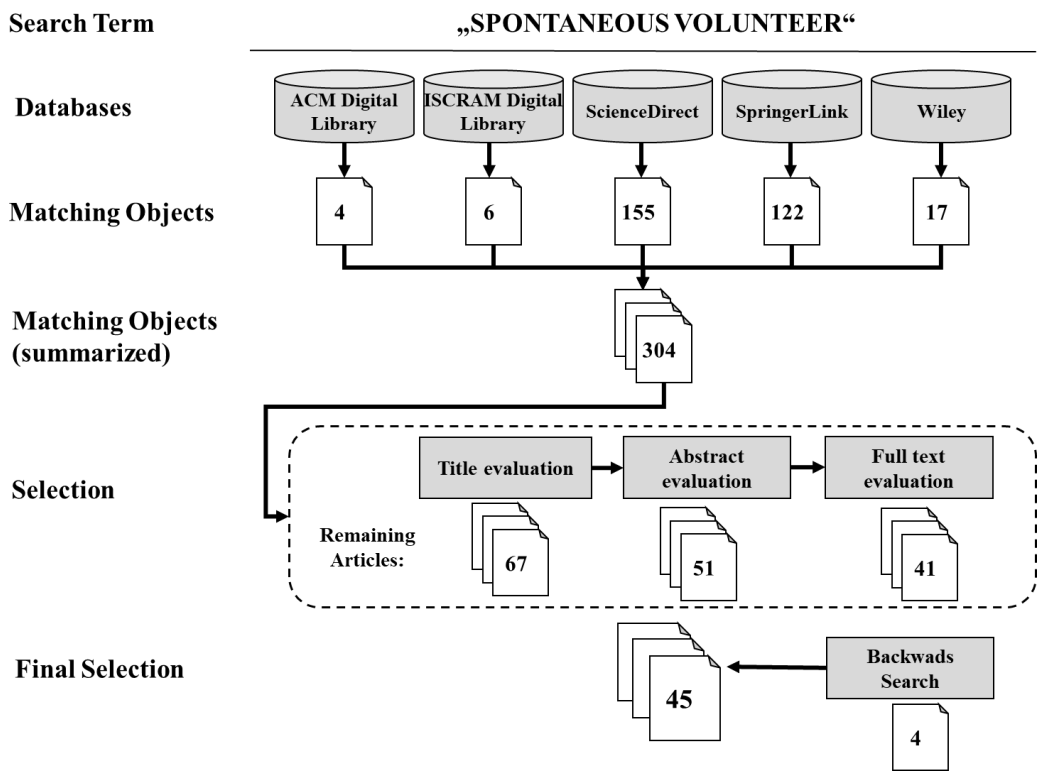

Figure 2. Literature Search Process

TAXONOMY FOR SPONTANEOUS VOLUNTEER COORDINATION SYSTEMS

In this chapter, we present the resulting taxonomy and describe the elements it contains. The version presented here is the revised version in which content-related comments from the evaluation have already been implemented (after step 5 in the methodology process model). In order not to overload the paper, we refrain from presenting the first version and the implemented changes in detail. The results of the evaluation and the acceptance of the taxonomy are discussed in a further chapter.

The current version of the taxonomy, as shown in Table 1, includes 13 dimensions and 37 characteristics, which have been clustered into 4 categories for ease of reference. Each characteristic also contains the number of mentions in the papers considered (see numbers in parentheses). An approach categorized according to this taxonomy can fulfill more than one characteristic of a dimension, since the taxonomy does not contain exclusive characteristics. The taxonomy is explained below on the basis of the categories.

Utilization Context

The first category of dimensions describes the general field of application under which a spontaneous volunteer coordination system is used or which it supports.The dimension **User** captures which groups of people are intended to be users of the system. These user groups include governmental disaster management agencies, e.g., at the national, state, or county level. Volunteer organizations include NGOs that are active in civil defense and conduct operations where spontaneous volunteers could be involved. The third group is spontaneous volunteers themselves. These are listed separately here because there is also the opinion that spontaneous volunteers should only be coordinated directly on site and that the systemic support should only refer to the official responders. The dimension **Ablilities** determines whether the system supports coordination of untrained or trained volunteers. Training here refers to specific prior knowledge in the field of civil defense. Although the majority of volunteers usually have no training, approaches that require some prior training are discussed more in the context of targeted coordination. With regard to the **Tasks** supported, a distinction is made between physical work, such as setting up an evacuation center or carrying sandbags, and obtaining information, e.g. on the state of the infrastructure. A finer subdivision of tasks is possible in this context, but is not conducive to the overview and user-friendliness of the taxonomy. The **Disaster Phase** indicates for which of the classic phases of disaster management the system is intended to be used primarily. Since spontaneous volunteers are usually ready to help in the immediate aftermath of a disaster, the Response and Recovery phases are also mentioned more frequently.

Category	Dimension	Characteristics				
Utilization Context	User	Disaser Management Agencies (7)	Volunteer Organizations (15)	Spontaneous Volunteers (33)		
	Abilities	Untrained (4)	Trained (7)			
	Tasks	Information Retrieval (3)	Physical Work (9)			
	Disaster Phase	Preparedness (3)	Mitigation (5)	Response (11)	Recovery (8)	
Volunteer Assessment	Registration	On Site (9)	Off Site (15)			
	Information retrieval	Agency/Organization (7)	Self-Assessment (14)			
	Information	Demographic (10)	Abilities (4)	Equipment (2)	Experience (3)	None (1)
Task Assignment	Task Selection	Self-assignment (2)	Task-proposal (2)	Central-assignment (7)		
	Automation	Manual (7)	Semi-automatic (2)	Automatic (2)		
	Centrali-zation	Decentralized (6)	Centralized (10)			
Technical Implementation	Application Interface	Desktop (6)	Mobile App (11)	Website (9)	Social Media (1)	
	Communi-cation	1:1 (6)	1:n (5)	n:m (1)		
	Integration	Stand-alone (4)	Integrated (2)			

Table 1. Revised Taxonomy for Spontaneous Volunteer Coordination Systems

Volunteer Assessment

This category records how and what information about the spontaneous volunteers is collected by the system. The **Registration** dimension indicates whether spontaneous volunteers register directly at the site or independently at any location. A central added value of a coordination system is the simple IT-supported registration of potential helpers. However, it is assumed that many volunteers also arrive at the site without having registered in a designated system beforehand, the reasons being e.g. destroyed infrastructure, unwillingnes to register through an official system or simply ignorance of the system. **Information Retrieval** indicates by whom the information on spontaneous responders is entered into the system. Self-assesment is very efficient, but may not always be desirable if, for example, special knowledge is to be recorded and the entries must be absolutely trustworthy and should accordingly only be made by official responders. It also addresses the possibility of adding persons to the system who are not able to register themselves. The dimension **Information** indicates what kind of information is collected about the spontaneous volunteers. There are many different views here, ranging from as little information as possible for reasons of data protection to as much information as possible for the most effective involvement of volunteers. The characteristic "none" refers to systems that simply record how many people are on site, but do not collect individual information.

Task Assignment

This category includes dimensions that describe the way spontaneous volunteers get suitable assignments. In the area of **Task Selection**, spontaneous volunteers can freely assign themselves to advertised tasks (self-assignment), e.g. via some kind of bulletin board, or receive pre-selected task proposals, according to their preferences and abilities. Most often, a fixed assignment of tasks is discussed by official disaster management, where the best decision can be made on how to use volunteers wisely. Here, a distinction is made between an approach that still

allows spontaneous volunteers to choose between different tasks that come into question according to their profile (Task-proposal) and the strict assignment of a specific task (Central-assignment). In order to give the volunteers a form of co-determination, this is usually combined with the possibility of accepting or rejecting the task. The degree of **Automation** indicates the extent to which the assignment of volunteers to tasks is supported by decision support algorithms. In the case of manual assignment, there is no algorithmic support. Semi-automatic assignment determines suitable proposals that must be approved by disaster management decision-makers before volunteers are alerted and can be adjusted if necessary. In the case of complete automation, volunteers are assigned without human input according to the available tasks and alerted if necessary. However, full automation is viewed very critically by practitioners. **Centralization** indicates how networked the organizational structure is when assigning tasks. In the case of a decentralized assignment, each CPAO can assign volunteers for its own needs. In this case, there are several pools of spontaneous volunteers, so that, for example, the volunteers who have registered with the red cross can also be placed only by the red cross and not by fire departments. In the case of centralized control, there is a central office in which the individual requests for spontaneous volunteers are coordinated and served. In order to prevent volunteers from having to register with various systems and to obtain a uniform situation picture, a central, networked platform is discussed more frequently.

Technical Implementation

The last category contains features for the software-side development of the coordination systems. Most approaches discuss more than one **Application Interface**. Where a desktop solution or a website are often discussed as a work interface for CPAOs, mobile apps are primarily mentioned for spontaneous volunteers, but websites are also mentioned again in some cases. The possibility of offering a user interface to the coordination system via existing social networks, where spontaneous volunteers otherwise coordinate themselves, could increase the willingness to participate. In the area of **Communication**, various strategies are discussed. In the context of 1:1 communication, this can mean both the exchange between two spontaneous helpers working in the same task, for example, as well as the individual communication of the disaster management with an individual volunteer. 1:n communication is already implemented in many existing demonstrators to the extent that disaster management sends messages, such as task alerts or warnings, to all volunteers or selected groups, to which they can in turn respond. As m:n communication, for example, the exchange of all volunteers assigned to a task in a chat group could be implemented. The last dimension includes the degree of **Integration** of a coordination system into existing mission command systems. A frequently discussed hurdle for the use of a spontaneous volunteer coordination system is the effort required for the introduction and training of another new IT system. This problem can be partially circumvented if the features of the coordination system are implemented as back-end services and accessed through the user interface of existing, wellknown systems.

EVALUATION

To evaluate the first version of the taxonomy, which was derived from the literature and is not presented in this paper (after step 3 in the methodology model), we conducted an expert survey using a questionnaire. On the one hand, we wanted to determine whether, in the opinion of the survey group, the subjective ending conditions according to Nickerson et al. (2013) were fulfilled. On the other hand, the performance and effort expectations according to Venkatesh et al. (2003) were queried in a second questionnaire section. Furthermore, there was an opportunity for respondents to provide comments and suggestions for improvement on the first version of the questionnaire. Some respondents took advantage of this opportunity and provided very constructive criticism, which was accepted and resulted in a second and final version of the taxonomy presented in the previous chapter. It should be emphasized at this point that the results of the survey are influenced by the subjective perception of the respondents, and a survey of a different group of experts might have led to different results. In the following, the procedure for creating the questionnaire and selecting the sample size will be explained, followed by a discussion of the survey results.

Questionnaire and Sample Size

By way of introduction, the questionnaire contained a brief description of the research project as well as a possible scenario in the context of a software development in which the taxonomy is used. In the scenario, respondents were asked to put themselves in the role of a member of the disaster management agency of a particular major city that is frequently affected by flood events. The agency now wants to introduce a coordination system to counteract the problems that have arisen so far in connection with the self-organization of spontaneous volunteers and to make targeted use of them. The first section of questions was followed by statements on performance and effort expectations. As described above, these were based on the approach of Venkatesh et al. (2003), who combined various action, motivation and acceptance models to create the Unified Theory of Acceptance and Use

of Technology (UTAUT). In the second section of questions, statements were made about the subjective ending conditions. Respondents rated the statements using a 7-point verbal-numeric Likert scale (1 = disagree..., 4 = partially agree...,7 = agree, 99 = no opinion). The resulting scale items of the questionnaire are presented in Tabke 2.

Index	Scale Items for Performance Expectation	Index	Scale Items for Effort Expectations
SI 1	I find the taxonomy useful for my work.	SI 5	My interaction with the taxonomy is clear and understandable.
SI 2	Using the taxonomy helps me accomplish things more quickly.	SI 6	It is easy for me to become skillfull at using the taxonomy.
SI 3	Using taxonomy helps me increase my productivity.	SI 7	I find the taxonomy easy to use.
SI 4	Using the taxonomy increases my chance of achieving things that are important to me.	SI 8	Learning how to use the taxonomy is easy for me.
Index	**Scale Items for Subjective Ending Conditions**		
SEC 1	The number of dimensions allows the taxonomy to be meaningful yet not cluttered or overwhelming.		
SEC 2	The dimensions and characteristics allow sufficient differentiation between the objects of interest.		
SEC 3	All objects or a (random) sample of objects within the area of interest can be classified.		
SEC 4	A new dimension or characteristic can be easily added within an existing dimension.		
SEC 5	Dimensions and characteristics of objects are sufficiently explained.		

Table 2. Scale Items for Questionnaire

In choosing the sample size, we followed the so-called "10±2 rule" (Hwang and Salvendy, 2010), which states that 8 to 12 respondents are sufficient for evalutation of usefulness of an artifact or technology. The respondents were people different, but overall pronounced technical understanding and at least basic knowledge in the area of volunteer coordination. Four of them were IS-researchers with high experience in taxonomy building and research activities in disaster response. Four of them are practitioners and had already experience in design, implementation and operation of two different volunteer coordination systems. One person was an industrial designer with focus on solutions for disaster response.

Discussion of Evaluation Results

The results of the survey are shown in Figure 3. With regard to performance and effort expectation, the median of all eight scale items is between 5 and 7 and thus in the range of positive assessment by the respondents (scale value 4 is considered "neutral"). However, it is also evident that not all scale items are rated positively by all respondents, as neutral or weakly negative ratings were also given in SI 3, 4 & 5. We interpret the results regarding performance and effort expectation as good overall, but with room for improvement. Looking at the evaluation of the scale items of the subjective ending conditions, their median lies between 5 and 7, which indicates a high level of agreement. Noteworthy is the deviating negative assessment of one person in the evaluation of the sufficiency of the explanation of the taxonomy. However, due to the overall positive assessment of all statements, the subjective ending conditions are considered to be fulfilled. Since the respondents were also able to leave comments on the content and criticisms of the taxonomy, it was possible to identify various areas for improvement, especially with regard to the explanation of the characteristics and the delimitation between certain dimensions. These improvements were incorporated and finally led to the taxonomy as shown in Table 1. It can be assumed that the revision would have further improved the evaluation results. In summary, the consistently positive evaluation results indicate that the developed taxonomy can be useful for stakeholders within the target domain.

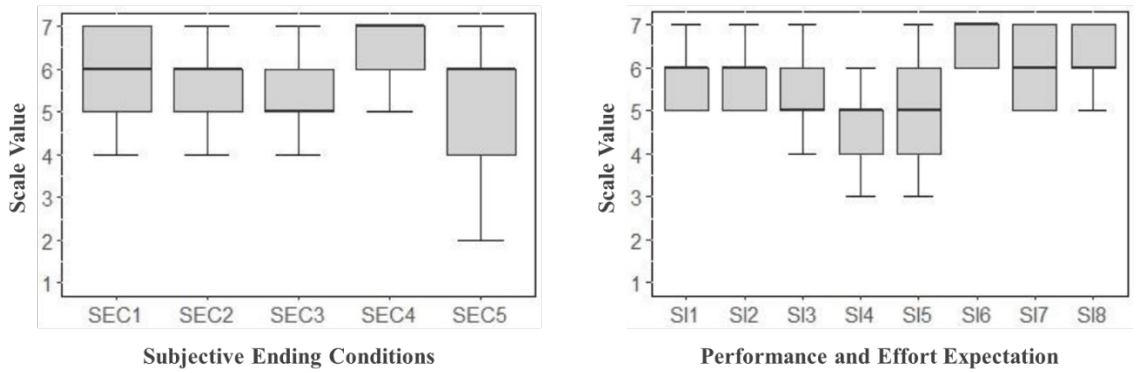

Figure 3. Evaluation Results

CONCLUSION

The management of spontaneous volunteers in disaster management has recently received more scientific attention than ever before. The approaches considered in this paper alone show that very different concepts are being discussed for integrating spontaneous volunteers into civil protection measures and coordinating them in a targeted manner. Therefore, the taxonomy introduced in this paper has been developed with the aim of categorizing existing and new approaches of coordination systems for spontaneous volunteers in order to support practitioners as well as researchers in their work. The approach presented here was attempted to build on a broad methodological basis with different established procedures in the individual steps in order to deliver results that are comprehensible and robust at this early stage of development. A first evaluation indicates that a benefit for the target groups could be generated. The taxonomy can serve as a tool to help scientists classify existing or future research approaches and identify research gaps for their own projects, for example, by considering combinations of characteristics not previously considered for a new approach. Disaster management practitioners can also use the taxonomy to make a decision about using the right IT system for their circumstances. In addition, the dimensions and characteristics provide initial guidance on relevant features and parameters of the application context to consider when designing new systems.

However, the results are also subject to some limitations that need to be addressed in further research steps. One important limitation is the subjectivity of the taxonomy resulting from the individual steps. Despite the methodological foundation, the selection of suitable sources in the literature analysis is already influenced by the authors' understanding of the topic and their specialist knowledge. This also applies largely to the derivation of suitable characteristics and dimensions of the taxonomy, which are also strongly determined by the individual target visions of the authors. The underlying literature is further limited by the search term. Spontaneous volunteers are often also referred to as, for example, unaffiliated (Barsky et al. 2007), informal (Whittaker et al. 2015), or episodic volunteers (Hyde et al. 2014). Sources using this terminology or generalized terms like volunteering or volunteerism are not included in this paper. Also just one specific search term was used and no OR-connected of suitable words. It cannot be ruled out that a large bias exists here. Since extensibility is one of the subjective ending conditions considered when creating the taxonomy, the subsequent addition of further dimensions and characteristics is possible, however, so that this limitation is not permanent and will be addressed in further iterations. Also the knowledge and experience of the authors in the research filed of volunteer coordination led to the fact that not always necessarily the characteristics were selected from that were mentioned most frequently, but also those that were assessed as relevant on the basis of many years of experience. When conducting the evaluation, the sample size and selection of respondents influence the results. In order to keep the effects as low as possible, we tried to address a heterogeneous group of respondents including researches as well as practitioners with differing levels of technical understanding.

Future research efforts, in addition to working on the limitations, could also aim to provide an overview of existing approaches that have been classified using the taxonomy. This would create a tool in which practitioners could directly identify approaches suitable for their purposes and provide researchers with the existing state of the art.

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