LINKS

Strengthening links between technologies and society for European disaster resilience

D4.1 DCT KNOWLEDGE BASE

A CONSOLIDATED UNDERSTANDING OF DISASTER COMMUNITY TECHNOLOGIES FOR SOCIAL MEDIA AND CROWDSOURCING

Research Report

THERESE HABIG – SAFETY INNOVATION CENTER E.V.
RICHARD LÜKE – SAFETY INNOVATION CENTER E.V.
TORBEN SAUERLAND – SAFETY INNOVATION CENTER E.V.
DANIEL TAPPE – SAFETY INNOVATION CENTER E.V.

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AUTHORS & CONTRIBUTORS		
Author	**Institution**	**Authored Sections**
Therese Habig	SIC	Entire Document
Richard Lüke	SIC	Section 4, Entire Document
Torben Sauerland	SIC	Section 2
Daniel Tappe	SIC	Entire Document
Contributor	**Institution**	**Contributed Sections**
Lars Scheuermann	SIC	Entire Document
Christoph Schwentker	SIC	Section 2.3, Section 5
Simon Gehlhar	SIC	Entire Document

REVIEWS		
Reviewer	**Institution**	**Reviewed Sections**
Kees Boersma	VU	Entire Document
Chiara Fonio	VU	Entire Document
Nathan Clark	VU	Entire Document
Anne Bach Nielsen	UCPH	Entire Document
Emmanuel Raju	UCPH	Entire Document
Sara Bonati	UNIFI	Entire Document
Veronica Pazzi	UNIFI	Entire Document

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EXECUTIVE SUMMARY

About the project

LINKS "Strengthening links between technologies and society for European disaster resilience" is a comprehensive study on disaster governance in Europe. In recent years, social media and crowdsourcing (SMCS) have been integrated into crisis management for improved information gathering and collaboration across European communities. The effectiveness of SMCS on European disaster resilience, however, remains unclear, the use of SMCS in disasters in different ways and under diverse conditions. In this context, the overall objective of LINKS is to strengthen links between technologies and society for improved European disaster resilience, by producing sustainable advanced learning on the use of SMCS in disasters. This is done across three complementary knowledge domains:

- Disaster Risk Perception and Vulnerability (DRPV)
- Disaster Management Processes (DMP)
- Disaster Community Technologies (DCT)

Bringing together 15 partners and 2 associated partners across Europe (Belgium, Denmark, Germany, Italy, Luxembourg, the Netherlands) and beyond (Bosnia & Herzegovina, Japan), the project will develop a framework to understand, measure and govern SMCS for disasters. The LINKS Framework consists of learning materials, such as scientific methods, practical tools, and guidelines, addressing different groups of stakeholders (e.g. researchers, practitioners, and policy makers). It will be developed and evaluated through five practitioner-driven European cases, representing different disaster scenarios (earthquakes, flooding, industrial hazards, terrorism, drought), cutting across disaster management phases and diverse socioeconomic and cultural settings in four countries (Denmark, Germany, Italy, the Netherlands). Furthermore, LINKS sets out to create the LINKS Community, which brings together a wide variety of stakeholders, including first-responders, public authorities, civil society organisations, business communities, citizens, and researchers across Europe, dedicated to improving European disaster resilience through the use of SMCS.

About this deliverable

To improve community resilience, the growing heterogeneous use of technologies within disasters and the increasing intransparency about the market, needs to be addressed and faced. As a first step towards, the purpose of this deliverable is to provide a state-of-the-art of technologies for the usage of SMCS within disasters covering different processes.

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This document is a research deliverable that will support in building a methodology for an iterative case-based assessment of the LINKS Framework.

Methodologically, this deliverable is a result of a twofold analysis: a related literature review with focus on the technological perspective within SMCS for disasters and a business market analysis of existing relevant technologies for the use of SMCS within disasters. Both approaches in combination leads to the draft DCT-schema that offers a sustainable opportunity to structure collected data about existing DCTs and to make them more comparable.

In the knowledge domain that this deliverable addresses, 'Disaster Community Technologies' (DCT), we analyse how SMCS affect the use of technologies during disasters across all phases of the Disaster Management Cycle (DMC). While this deliverable takes the first step in establishing a consolidated understanding of SMCS technologies for disasters, the connections to the two other knowledge domains (DRPV and DMP addressed in forthcoming Deliverables 2.1, 2.2 and 3.1 of the LINKS project) cannot be ignored. The three domains are emblematic for three crucial dimensions of disaster resilience: investigating interactions among social, institutional, and technological dimensions while recognising diversity at the individual, institutional and systems levels. Furthermore, the outcomes from the studies across the three domains form the foundational knowledge bases on which the LINKS project is built.

The state-of-the-art of the literature review is divided into a) good practices of DCTs (covering different levels of involvement of technologies), b) negative impacts and challenges, c) existing guidelines, and d) existing relevant IT-classifications. The key findings can be summarised as follows:

- Good practices of DCTs: The preparation to start to use SMCS and three strategies dependent on the level of engagement are presented: 'information dissemination & data monitoring' of social media in DMP, 'data monitoring & analysis': Introducing DCTs in disasters, and 'conversations & coordinated actions' by crowdsourcing in disasters;
- Negative impacts, challenges and solution approaches when working with SMSC are presented with some concrete examples. The focus is especially on the challenges, which need to be considered when proceeding with the development of the LINKS Framework;
- Existing guidelines: In addition to good practices, a technological analysis of the findings were conducted as they offer technical input for the DCT understanding;
- Existing classifications of
    - IT-systems in general;
    - IT-systems used and developed for disasters;
    - SMCS analysis tools.

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The state-of-the-art from the business market analysis of existing relevant DCTs results in a list of 68 technologies (status: November 2020). All identified technologies were carefully selected, evaluated, and finally added to a structure, the DCT-schema. During the selection and evaluation properties were continuously extracted and analysed due to their relevance for the DCT-schema. The draft DCT-schema enables the structuring of the collected data about existing DCTs and a comparison among those and is the main output of this deliverable.

The main objective of Deliverable 4.1 (D4.1) is to provide a common understanding of SMCS technologies used for DMP, referred to as DCTs. With this deliverable we summarize the state-of-the-art with a technological perspective and create a knowledge base for the future work in LINKS.

The final results of this research deliverable will be used in the LINKS Framework that encompasses the three knowledge domains of DRPV, DMP, and DCT. The results are in particular intended for an audience of researchers and practitioners in the field of disaster management who already work with SMCS or plan to do so in the future.

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LIST OF ACRONYMS

Abbreviation / Acronym	Description
A2A	Authorities to Authorities
A2C	Authorities to Citizens
API	Application Programming Interface
BBK	Bundesamt für Bevölkerungsschutz und Katastrophenhilfe (translated: Federal Office for Civil Protection and Disaster Assistance Germany)
C2A	Citizens to Authorities
C2C	Citizens to Citizens
CAP	Common Alerting Protocol
CDC	Center for Disease Control and Prevention
COSMIC	The COntribution of Social Media In Crisis management
DCT	Disaster Community Technologies
DM	Disaster Management
DMC	Disaster Management Cycle
DMP	Disaster Management Processes
DMO	Disaster Management Organisation
DoA	Description of the Action
DRPV	Disaster Risk Perception and Vulnerability
EDM	Event Detection Module
EmerGent	Emergency Management in Social Media Generation
ESI	Emergency Service Interface
FODA	Feature Oriented Domain Analysis
FP7	Seventh Framework Programme
GDPC	Global Disaster Preparedness Center
H2020	Horizon 2020
HOT	Humanitarian Open Street Map Team

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IATA	International Air Transport Association
ICT	Information and Communication Technology
IFRC	International Federation of Red Cross and Red Crescent Societies
IT	Information Technology
ITU	International Telecommunication Union
LCC	LINKS Community Center
NER	Named Entity Recognition
NHC	National Hurricane Center
OASIS	Organization for the Advancement of Structured Information Standards
SMCS	Social Media and Crowdsourcing
VOST	Virtual Operations Support Team
WP	Work Package
XML	Extensible Markup Language

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DEFINITION OF KEY TERMS[1]

Term	Definition
Citizens	Citizens can be considered via the same levels as the other stakeholders, and for LINKS, particular relevance should be given to local citizens who are likely to be impacted by the case-based assessments. LINKS identifies two key sub-categories of citizen stakeholders: Civil Society and Vulnerable Populations.
Crowdsourcing	Describes a distributed problem-solving model where the task of solving a challenge or developing an idea is 'outsourced' to a crowd. It implies tapping into 'the wisdom of the crowd' (LINKS Glossary, builds on Howe, 2006).
Disaster	A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability, and capacity, leading to one or more of the following: human, material, economic, and environmental losses, and impacts.
Disaster Community Technology (DCT)	A DCT is a software(-function) for interaction with, within or among groups of people who have similar interests or have common attributes (communities) in case of a disaster as well as performing analysis of these interactions.
Disaster Management Organisation (DMO)	In this deliverable, we refer to Disaster Management Organisations as those authorities and entities working with the management of disasters, crises, incidents and emergencies, including first responder organisations, (e.g. fire and police departments), civil protection agencies, as well as non-governmental organisations.
Disaster Management Processes (DMP)	A collective term encompassing a systematic series of actions or steps taken to reduce and manage disaster risk. Disaster management processes are often associated directly with the phases of the DMC. In the context of LINKS, we specifically refer to DMP as the policy frameworks, tools and guidelines developed to govern disasters across all phases of the DMC.
LINKS Community Center (LCC)	A flexible and user-friendly web-based platform for online sharing and integrating lessons learned and ongoing experiences and knowledge within the LINKS Community, as well as with broader EU and international networks.
LINKS Framework	A set of learning materials, such as methods, tools and guidelines for enhancing the governance of diversity among the understanding of SMCS in disasters for relevant stakeholders. Methods in LINKS refer to

[1] All definitions are retrieved from the LINKS Glossary (forthcoming)

	approaches that will enable researchers and practitioners to assess the effects of SMCS for disaster resilience under diverse conditions. Tools are practical instruments supporting first-responders, public authorities and citizens with the implementation of SMCS in disaster and security contexts. Guidelines are recommendations for improving national and regional governance strategies on SMCS as well as introductions and explanations of how to apply the methods and tools under diverse conditions (LINKS Glossary).
LINKS Knowledge Bases	The outputs and knowledge obtained from the assessment of three knowledge domains. This knowledge is used to develop the LINKS Framework (LINKS Glossary).
LINKS Knowledge Domains	The three crucial domains of analysis for studying European disaster resilience and SMCS. These include: Disaster Risk Perception and Vulnerability (DRPV), for assessing changes in the citizens' perception of disaster risks induced by SMCS, as well as assessing the changes in the vulnerability of practitioners and citizens. Disaster Management Processes (DMP) for analysis of how SMCS changes the procedures and processes within the crisis and disaster management. Disaster Community Technologies (DCT), for assessing SMCS related technologies used by practitioners (and citizens) in disasters.
Best Practices	This encompasses the preferred actions in a specific type of situation to efficiently and effectively achieve a certain objective. Best Practices may be formalized in internal policy documents such as handbooks and standard operation procedures and could be based on one or several lessons learned approved by decision-makers.
Social Media	A group of Internet-based applications that build on the ideological and technological foundations of the Web 2.0 and that allow the creation and exchange of user-generated content. Forms of media that allow people to communicate and share information using the internet or mobile phones. Web 2.0 is the Internet we are familiar with today in which people are not just consumers of information but producers of knowledge through social networking sites and services like Facebook, Twitter, and Instagram (LINKS Glossary, builds on Kaplan & Haenlein, 2010).
Sustainable Advanced Learning	A maintainable and evolving collection of knowledge and best practices produced for and by relevant stakeholders. Sustainable advanced learning entails a cognitive dimension (the capability to gain in-depth knowledge of

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	crises and crisis response) and a social dimension (the ability to implement the knowledge into new practices) (LINKS Glossary).

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1. INTRODUCTION

Since the beginning of this millennium, social media and crowdsourcing (SMCS) has been used in disasters and its use is increasing by citizens collaboratively coping with a crisis (Reuter & Kaufhold, 2017). This circumstance is confirmed by the wide range of existing technologies (and apps), even growing every day.

The focus within Work Package (WP) 4 in general and of this deliverable is on technologies related to SMCS during all phases of a disaster, called Disaster Community Technologies (DCT). The topic of this document, Deliverable 4.1 (D4.1), is about establishing the knowledge base for DCTs.

Coming from the LINKS Glossary, the knowledge base is defined as 'the outputs and knowledge obtained from the assessments of the knowledge domains. This definition contains two basic elements, which are covered in this deliverable:

- knowledge - is obtained through scientific research and analysis of DCTs in Disaster Management Processes (DMP)
- outputs – are derived from the knowledge gathered and intended to be translated into new practices that can be learned and used by various stakeholders.

To cover the first element, the main objective of D4.1 is to provide a common understanding of DCTs. To analyse and derive the DCT knowledge base, a structured literature review, the analysis of results from finished and on-going research projects as well as a detailed and worldwide business market analysis were performed. The research examined good practices, as well as an insight into positive and negative impacts of SMCS related to DCT across Europe and beyond. Furthermore, existing relevant guidelines for DMOs and citizens about the use of SMCS were identified and analysed towards technical aspects.

Furthermore, a global business market analysis was carried out. Existing and relevant technologies were identified, evaluated, and analysed to derive a basic understanding and common structure of DCTs. Building on this, a first draft of a category system, the so-called DCT-schema, was developed and gets described in this deliverable. The DCT-schema enables the classification and comparison of DCTs using an extensive set of categories. Features such as the functional scope of the DCTs (e.g. real-time analysis and automatic event detection) as well as technical requirements (e.g. interfaces for integration into third-party applications or the handling of metadata) are taken into account.

This serves to fulfil the second element, making the information gathered applicable to various stakeholders. The aim is to provide a variable scope and content of knowledge depending on the target group needs of the stakeholders. For example, it is not considered realistic or user-friendly

for a crisis manager to have to read through a hundred-page deliverable in order to get information about a suitable strategy of DCT-usage in a specific scenario. Consequently, the DCT-schema is designed as a register database, in which the stakeholders can find and learn about suitable DCTs for their purposes. The implementation and access of the consortium and external parties to the DCT-schema is planned through the LINKS Framework and LINKS Community Center (WP7).

A realistic application scenario would be a heat wave and long-lasting drought in Europe in which many communities facing water shortages and consequent official restrictions on water consumption. During a heat wave in previous years, there was public criticism. The accusation: the municipality had cared too little for the concerns of the citizens. The civil servant in charge now wants to use social media to find out about citizens' concerns (sentiment analysis) and thus improve the municipality's communication strategy. Consequently, the DCT-schema has the potential to offer the appropriate tool for the civil servant's purpose.

To ensure a practical orientation of the LINKS project, WP4 relies on a grounded and application-oriented research approach. Since the partner safety innovation center (sic) is formed by practitioners and researchers, the knowledge base and the general research approach was developed with practical applicability in mind. Preliminary findings and research results are regularly discussed internally. The findings of this deliverable were also discussed and developed in close cooperation with consortium partners.

From the findings in this deliverable, a DCT-focused methodology will be developed (D4.2) to refine and improve the DCT knowledge base and to analyse DCT-related outputs (D4.3). In cooperation with WP2 and WP3, which are responsible for the assessments of the two other knowledge domains (Disaster Risk Perception and Vulnerability (DRPV) and DMP), fundamental input is established to develop the LINKS Framework through an iterative process in the project (Figure 1).

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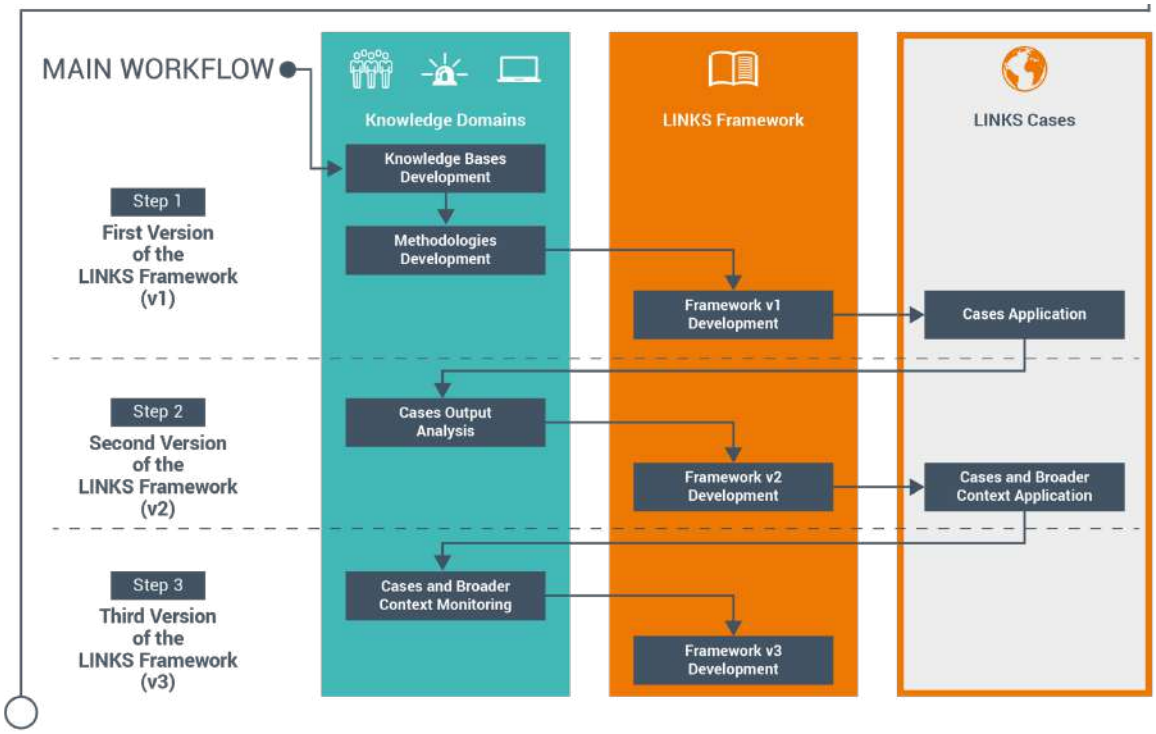
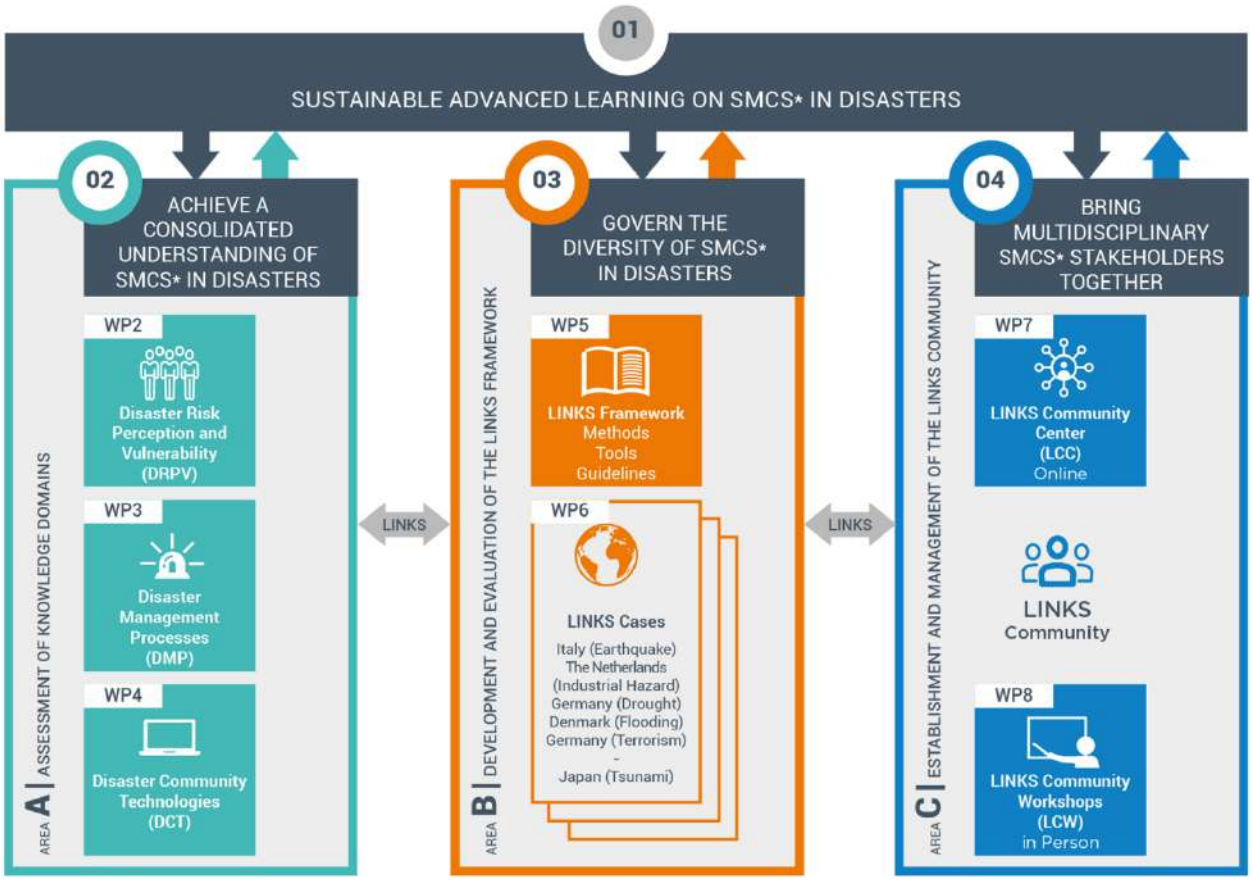
Figure 1: Workflow of LINKS



Source: LINKS

The LINKS Framework contributes to the primary project objective of producing sustainable advanced learning on the effective use of SMCS on disasters, at different levels and in different phases of the project. At its core, the LINKS Framework is envisaged to embody different learning materials (e.g. methods, tools and guidelines) and will provide access to a structured and varied amounts of knowledge on SMCS in disasters for different stakeholders. The DCT-schema and the knowledge base that has been created will be part of the LINKS Framework and lead to learning material. The work plan for the development of the LINKS Framework is presented in **Deliverable 5.1** (Fonio & Clark, 2021a).The methodologies developed from the three knowledge bases, will give guidance and support for the case-based assessment of the LINKS Framework. The first work plan for the case assessment is presented in **Deliverable 6.1** (Fonio & Clark, 2021b). Furthermore, the knowledge bases will deliver input for a centralized, community platform (WP7: LINKS Community Center (LCC)) for producing sustainable advanced learning, by providing the environment for stakeholders within the LINKS Community to access and contribute knowledge. The overarching workflow of LINKS with WP4 as one of the three knowledge domains is shown in Figure 2.

Figure 2: Concept of LINKS



Source: LINKS

This document is structured as follows: In Section 2 the methodological approach is presented, which includes a literature review and a business market analysis. Section 3 provides an overview of some theoretical foundations: the definitions of SMCS, DCTs, the disaster management cycle (DMC), and the crisis communication matrix. Section 4 presents the results from the literature review by giving a technological overview about the good practices of SMCS in disasters, the opportunities, challenges, and negative impacts. Section 5 deals with the results of the business market analysis and presents a current overview of existing DCTs. The concept for the development of a sustainable categorisation for DCTs, the draft DCT-schema, is described in Section 6. The content of this deliverable ends in Section 7, with a conclusion and outlook into the future in general, as well as with regard to the next steps in LINKS.

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D4.1 is of interest both to the LINKS stakeholders[2] (Practitioners, Industry, Policy/Decision Makers, Scientific Community, Citizens) as well as to the wider research communities working on DMP, specifically on technological aspects related to the use of SMCS. This deliverable must be read in combination with **Deliverable 2.1** (D2.1) focusing on how vulnerability is conceived and analysed in existing literature and how it is affected by SMCS in disasters (Bonati, 2021), and **Deliverable 2.2** (D2.2) on risk perceptions in the context of disasters and SMCS (Pazzi et al., 2021). Further, **Deliverable 3.1** (D3.1) presents the knowledge base on DMP in SMCS by addressing how governmental actors increasingly rely on SMCS to promote faster information exchange and communication between public authorities, citizens, and private actors in an attempt to improve DMP (Nielsen & Raju, 2021).

[2] A broad stakeholder analysis was carried out in **Deliverable 8.1** (Philphot and Elodie (2021)).

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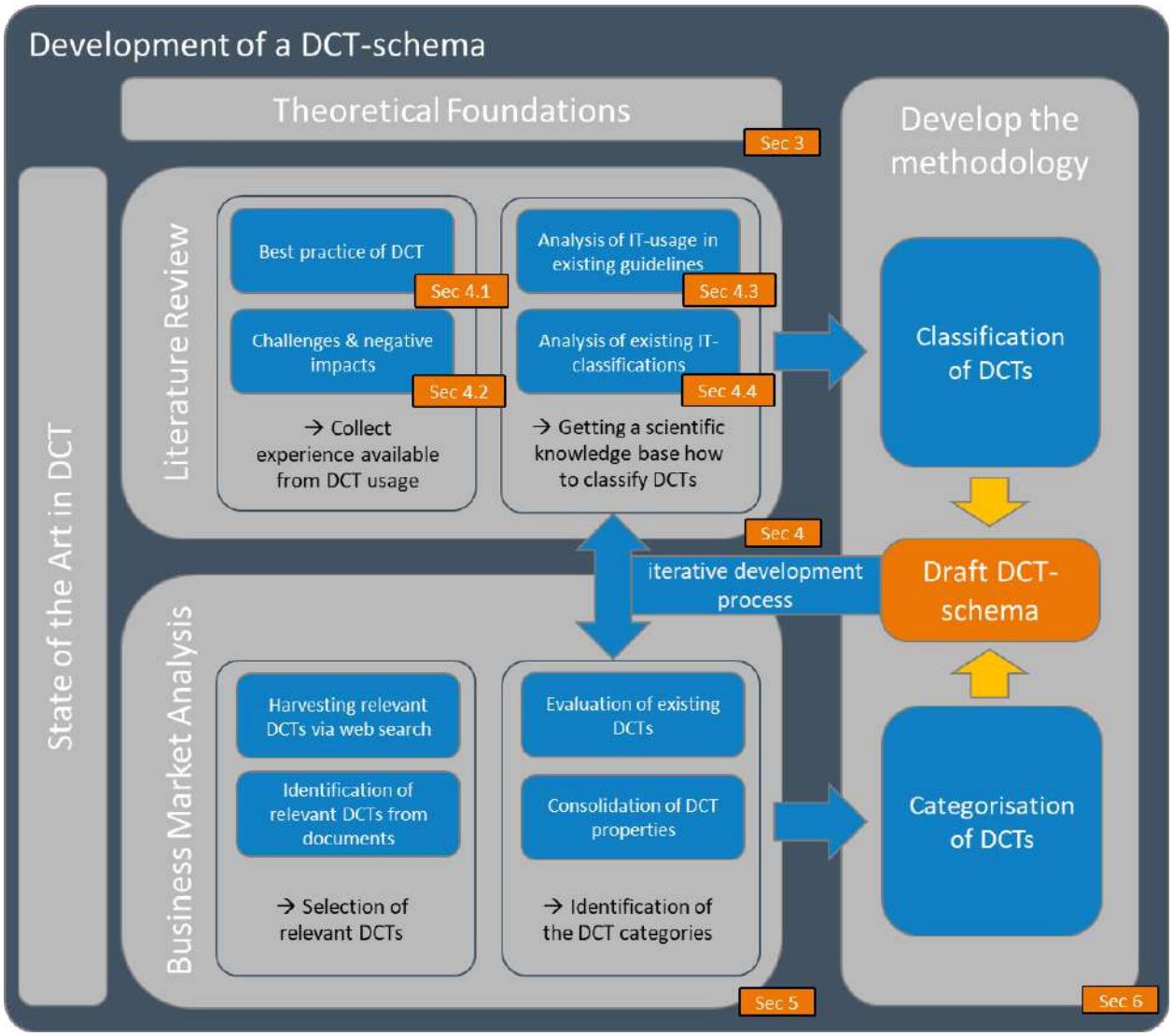
2. RESEARCH DESIGN AND METHODS

This section describes the research design for the establishment of the DCT knowledge base as well as the draft DCT-schema. After the used data sources are explained (Section 2.1), the process of the data selection and collection is described (Section 2.2). The analysis of the collected data is explained (Section 2.3) and the limitations are discussed (Section 2.4).

Figure 3: D4.1 Research Design



Source: Authors contribution

The complete research design is visualised in Figure 3 and described in the next subsections. This Figure gives an overview of the complete process to develop a DCT-schema, which is a long-term

process within WP4. This deliverable describes the first steps, covering the state-of-the-art in the field of DCTs and gives an outlook to the draft DCT-schema and the methodology (further) developed in D4.2 and D4.3.

2.1 Data Sources

The state-of-the-art within this deliverable focus - alongside the literature review - on the business market analysis of existing DCTs as the aim is to achieve a consolidating understanding of the technological perspective within SMCS. This state-of-the-art analysis has on the one hand collected best practices of DCTs, existing guidelines, existing IT-classifications as well as challenges and negative impacts. On the other hand, a very strong state-of-the-art analysis was on the collection and selection of existing DCTs.

The first set of data sources are **best practices** of DCT in DMP. The best practices were collected in two categories: Social media in DMP and crowdsourcing in DMP.

The second set of data sources are existing **guidelines** of SMCS use in DMP. These data source contains existing documents, guidelines, recommendations, and handbooks.

The third set of data sources are existing **IT-classifications**. As there are no dedicated DCT classifications available, the existing classifications for IT-systems in general as well as existing IT-classifications in DMP and for social media analysis technologies are addressed.

The fourth set of data sources are **challenges and negative impacts** of SMCS in DMP. This data gives an overview of the risks and concerns (referred to as 'challenges' as they need to be addressed adequately) that stakeholder will encounter when working with SMCS.

The fifth set of data sources are the actual **existing DCTs** used within DMP. These DCTs are based on existing market analyses and a deep web research.

Overarching the results and publications by ongoing and finished research projects were a significant input to all five sets of data sources. See the list of relevant research projects in the Annex I in Table I.

2.2 Data Selection and Collection

As shown in Figure 3, the data selection and collection for the state-of-the-art of the DCT knowledge base is carried out in a twofold way: The literature review for the scientific top-down-approach on the one hand, and on the other, the business market analysis of existing DCTs as a complementary bottom-up-approach, consolidating common properties from existing DCTs. Both in combination leading to the draft DCT-schema.

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2.2.1 Literature Review

In the literature review, scientific literature and existing **guidelines, best practices, IT-classifications, and challenges** for the use of SMCS in DMP and the associated DCT were examined. According to Snyder there are systematic, semi systematic, as well as integrative approaches to literature review. Whereas the systematic approach aims to provide evidence for specific narrow research questions, the semi-structured and integrative approaches are used to provide a state of knowledge for a broader field of research (Snyder, 2019). Therefore, a semi-structured approach is used here. A structured initial keyword search is followed by a qualitative analysis and further interpretation representing the main research areas useful for the DCT knowledge base.

The scientific literature was collected by searches in Google, Google scholar, Springer, H2020-, and FP7-projects and similar data bases using relevant keywords of the SMCS domain (see lists in D3.1) combined with specific keywords for the corresponding subtopics (see table below).

Table 1: Keywords in Literature Review

Keywords	i.e. guidelines, handbook, recommendation, best/good practice, IT-system, technology(-ies), analysis, extraction, aggregation, data analysis, how to, tutorial, challenges, difficulties, lessons learned, social media monitoring, disaster, alert tools, social listening API, alternative + 'tool name', classification of IT-systems, taxonomy, inventory, knowledge base, negative impacts, positive impacts, difficulties, problems, issues, digital volunteers

The timeframe was not limited but focused on the last ten years of literature (as the technological developments are fast-moving and information is quickly outdated), following discussion threads and references into the past.

For guidelines and best practices, as well as challenges were searched in the user-centered literature. This search contains similar keywords but used in semi-scientific publications targeted to DMOs.

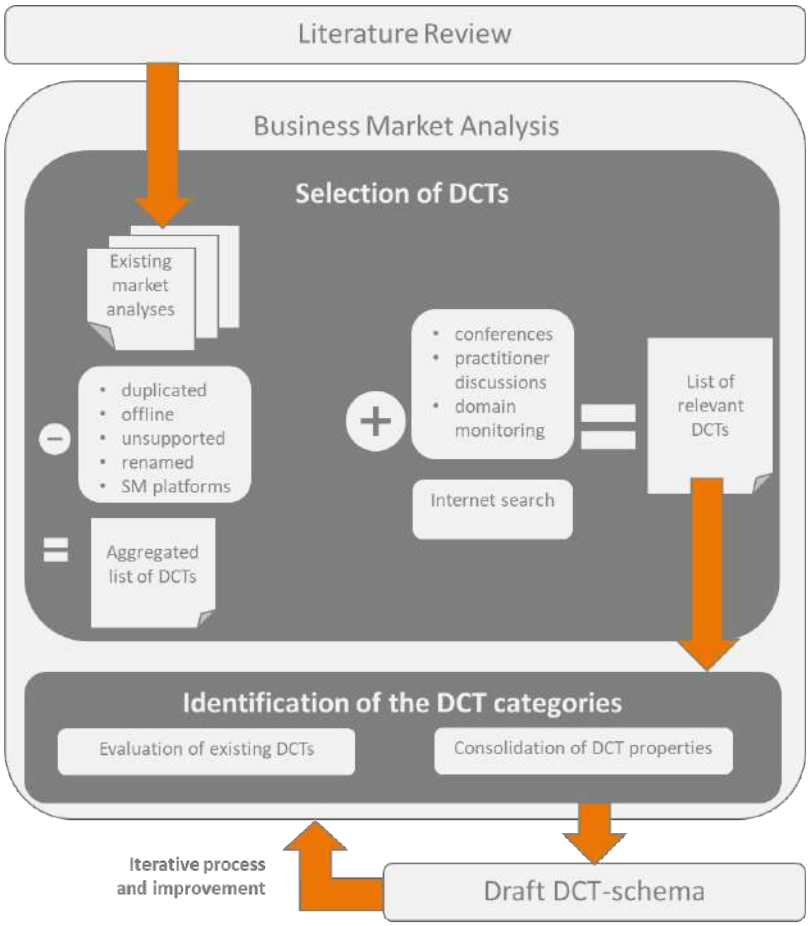
Overall, about 200 documents and online sources are used. The different research topics and discussion-threads elaborated within the searches are discussed in Section 4.

2.2.2 Business Market Analysis

In addition to the literature review, a thorough **business market analysis** was conducted. The selection of relevant DCTs is an ongoing process and will be continuously expanded (from the

web, existing collections/samples, and continuous observations). The approach of the business market analysis is shown in Figure 4 and described in the next subsections.

Figure 4: Approach of the Business Market Analysis



Source: Authors contribution

The business market analysis of existing DCTs provides an overview of DCTs already used by primarily DMOs. The business market analysis was not done from scratch, but existing market analyses identified in the literature review were aggregated and supplemented by newer and not mentioned DCTs. There are several existing market analyses of DCTs in DMP:

- (Trilateral Research & Consulting, 2015)
- (Kaufhold et al., 2017)
- (Kaufhold et al., 2019)
- (Pohl, 2013)
- (Ludwig et al., 2015)

- (Stavrakantonakis et al., 2012)

These market analyses as well as additional DCTs were collected by searches in Google, Google scholar, Springer, and similar data bases. The collection is focused on the data available in English language, supplemented by information in German language where appropriate. The DCTs collected were chosen based on the definition of DCT in Section 3.1. This rather informal approach enabled the collection of a broad overview of DCTs in very short time as a basis for the draft DCT-schema. As an iterative approach is used, this collection will be extended within the next iterations (D4.2 and D4.3), complementing the current overview to a sound business market analysis.

Overall, 220 DCTs are mentioned within the analysed sources. Besides these results of the literature review, the main information resources were discussions with practitioners, conference visits, and scientific presentations. The results of the business market analysis are provided in Section 5.

2.3 Data Analysis

The data analysis process is shown in Figure 4 above. In a first step, the results were clustered: The results of the literature review were analysed in the abovementioned categories guidelines, best practices, challenges, and IT-classifications. These results were used to develop DCT-classifications from a scientific top-down-approach.

The DCTs found in the business market analysis were consolidated concerning different properties and application areas (details in Section 6). Before this consolidation took place, duplicates (and name-changes) as well as outdated/renamed DCTs were removed from the list. The resulting first consolidation was then analysed, and categories were extracted, describing groups of DCTs with similar properties. Here we followed the idea of the Feature Oriented Domain Analysis (FODA) that is used in software engineering to identify common characteristics and differences within a family of (software) systems in a domain.

Kang et al. (1990) define domain analysis as 'the process of identifying, collecting, organizing, and representing the relevant information in a domain based on the study of existing systems and their development histories, knowledge captured from domain experts, underlying theory, and emerging technology within the domain'. FODA is a method for domain analysis with a focus on identifying the features 'a user commonly expects in applications in a domain' (Kang et al., 1990). Instead of creating complex relationship models, we decided to create a property comparison table which allows filtering the collected applications by properties and is easier to use for users with a non-technical background.

For relevant DCTs, various sources were examined for information on its properties. Primary sources include websites of the DCTs with public available documents (e.g. whitepapers, product manuals, or product videos). In addition, if available, free demo versions were tested. Secondary sources included information about properties extracted from product comparison sites (e.g. trusted.de[3] or g2.com[4]). These sites are specialised in (business) tools comparisons. We identified such sites using the keywords '<toolname> + alternative' as a keyword in a Google search.

The collected information was used to iteratively identify common properties among the technologies. The extracted properties were then grouped and categorised in a property comparison table.

From the combination of the literature review and the business market analysis the draft DCT-schema was developed. It contains the categories and properties of DCTs, aggregated from the top-down as well as the bottom-up-approach to analyse DCTs in a structured way.

While working with the draft DCT-schema, iterative adjustments are made for various reasons, e.g. user-friendliness, new developments of relevant DCTs and functionalities to keep the draft DCT-schema up-to-date, suitable, and as complete as needed. This process is just started and will continue in WP4.

2.4 Limitations

This deliverable is the first version of the DCT knowledge base. As the deliverable is due in Month 6 of LINKS, the results provided here will be extended and refined in iterative steps in D4.2 and D4.3.

Moreover, two challenges should be considered. The literature review does not cover all available literature concerning DCTs in SMCS as the timeframe and the approach of the literature review limits the type and amount of data. But the relevant approaches to provide a knowledge base for the development of the DCT-schema are elaborated and described in this document. The DCT-schema is a very first draft and a preview to the upcoming deliverables, as it was initially planned in D4.2 at the earliest. The categories developed in the DCT-schema are therefore preliminary and will be iteratively revisited and refined. In D4.2 and D4.3 the detailed methodology will be explained and a DCT-visualisation for more user-friendly insights will be provided.

One additional challenge is to keep the business market analyses up-to-date, as new DCTs steadily published and old ones abandoned. The application and refinement of the DCT-schema as well as

[3] https://trusted.de/social-media
[4] https://www.g2.com/categories/social-media-monitoring

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the engagement of stakeholders will be future work. The current list of DCTs is also a glimpse of the current status quo and needs to be updated continuously.

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3. THEORETICAL FOUNDATIONS

In this section the definitions of the key terms social media, crowdsourcing and DCTs are provided (Section 3.1). The four phases of the disaster management cycle (DMC, Section 3.2) and the four directions of communication in a crisis (communication matrix, Section 3.3) are explained as we initially used this fundamental classification for identified technologies. The four phases and the four quadrants enable a very broad and first classification to distinguish between DCTs and to discover different benefits of their uses.

3.1 Defining Social Media, Crowdsourcing, and Disaster Community Technologies

With increasing accessibility to the internet and the number of users worldwide, the amount of (relevant) data produced also increases. There are already many systems in the market to analyse the huge amounts of data for different purposes (most notably the daily used search engines such as Google and Bing). Looking at social media and crowdsourcing (SMCS): the use is nowadays an important component of everyday life for a large part of the world population. With regards to Europe, for example, 48% of the population aged from 16 to 74 used SMCS on a daily basis in 2019 (Statista GmbH, 2019). The huge amount of data can be classified as 'big data'[5] which needs dedicated analysis mechanisms if it shall be analysed and reused. The process of data retrieving, storing, processing, and visualising can be summarised as 'social media analytics' (Kumar et al., 2014). The majority of existing analytics systems for SMCS are used by companies for market analysis as well as image and product evaluations as they offer a broad customer market (cf. Hootsuite[6] or Ubermetrics[7]).[8]

However, the information on social media networks has a continuously increasing importance to DMOs. In particular, the potential for improving community resilience through social media has increasingly become the focus of research (Dufty, 2012). As Palen and Anderson point out, it is a common act of people to use information and communication technology to deal with uncertainty in crisis situations (Palen & Anderson, 2016). Social media has 'made it simpler to

[5]Big data is high-volume, high-velocity and/or high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, decision making, and process automation (https://www.gartner.com). Put simply, big data is larger, more complex datasets, especially from new data sources. These datasets are so voluminous that traditional data processing software just cannot manage them.
[6] https://hootsuite.com
[7] https://www.ubermetrics-technologies.com
[8]https://sproutsocial.com/insights/social-media-analytics-tools/ & https://www.capterra.com/social-media-analytics-tools-software/

interact with others without the limitations of geography and lack of time' (Dufty, 2012). The increase in communication and the associated facilitation of networking is an important prerequisite for the emergence of communities of practice or in the case of disaster 'disaster resilience learning communities' (Dufty, 2012). These informal communities can be helpful in allocating resources as well as sharing information. This is especially true on an organisational level. Based on the realisation that 'disaster situations require a cross-organisational response', DMOs enter into cooperations or partnerships (Gimenez et al., 2017). The constant flow of information as well as continuous cooperation between DMOs are crucial to effectively manage disasters and 'are necessary tasks in building organizational resilience' (Gimenez et al., 2017). Neglecting collaboration can leave the organisations susceptible to vulnerabilities (Gimenez et al., 2017).

Taken the human component into account, it becomes clear that the effective use of DCTs is a multidisciplinary field of research with elements from computer science and social science. The existing technologies analysed as part of this WP were either developed specifically for disasters (mostly from corresponding research projects) or can be used for the purposes of DMOs.

At first, the definitions from the LINKS Glossary are listed and then extended to the key term **Disaster Community Technology**:

Social Media (platforms)

> *A group of Internet-based applications that build on the ideological and technological foundations of the Web 2.0 and that allow the creation and exchange -of user-generated content (UGC). Web 2.0 is the Internet we are familiar with today in which people are not just consumers of information but producers of knowledge through social networking sites and services like Facebook, Twitter, and Instagram* (Kaplan & Haenlein, 2010).

Crowdsourcing

> *It describes a distributed problem-solving model where the task of solving a challenge or developing an idea get 'outsourced' to a cloud. It implies tapping into 'the wisdom of the crowd'. In the context of LINKS, crowdsourcing involves using ICTs (Internet and Communication Technologies). For example: crowdsource mapping in crisis zones. Digital volunteers/communities offer free services by mapping critical information related to disaster-affected zones* (Howe, 2006).

The term DCT is established within LINKS as the authors did not find an appropriate designation of technologies or systems that are used or designed for disaster management and can be used

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(ideally and primarily) for the interaction with any community of interest. The preliminary definition is as follows, but might be refined during the project:

Disaster Community Technology (DCT)

> *A DCT is a software(-function) for interaction with, within or among groups of people who have similar interests or have common attributes (communities) in case of a disaster as well as performing analysis of these interactions*.

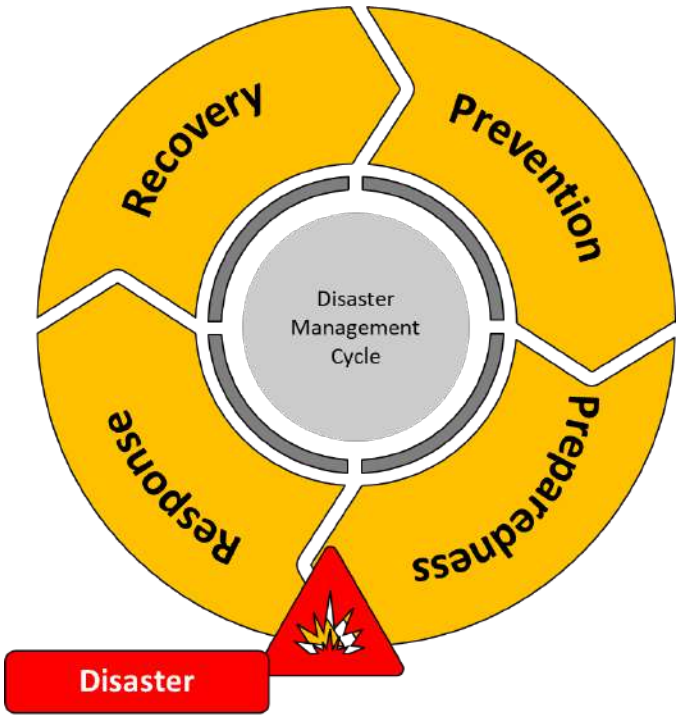
To give this relative high-level definition some more tangible explanation, here is an **example** what a DCT could look like: A DCT could have the aim to automatize monitoring, classification, or aggregation of crowd based content in a large-scale disasters. It can support DMOs and public authorities in several crisis management activities. These are e.g. obtaining a valid overview of the damage situation in almost real time, communication, and interaction with the population and volunteers as well as a widespread dissemination of information. The DCT might offer a collaboration platform between emergency agencies, e.g. for knowledge sharing and information exchange. Further, a DCT can also include communication between any other community (e.g. groups of citizens) with the restriction that the topic, objective, or context is any kind of disaster-related topic.

3.2 Disaster Management Cycle

The DMC (also known as emergency management cycle), shown in Figure 5, covers all activities before, during, and after a disaster (Harrison & Johnson, 2016). Thereby four phases describe an order of tasks focussing on the disaster management. The DMC begins with the phase of response, followed by recovery, prevention[9], and preparedness, that is followed by the next event, so that a recurring process is created. The division of the DCTs into one (or even more) of the four phases creates comparability among the DCTs and applicability towards specific aims and is therefore included.

[9] Some sources refer to 'mitigation' which can be used synonymously.

Figure 5: Disaster Management Cycle



Source: Authors' adaption of (Grünewald et al., 2003)

Prevention

Implementing long-term measures (structural and non-structural) to reduce or eliminate the impact of a disaster on people and property (before or after a disaster). Looking at SMCS, activities belonging to the mitigation are starting with identification of potential hot spots and informing/warning the public about certain facts regarding an incident. (Reuter et al., 2014)

Preparedness

Within this phase, the aim is to build the capacity to respond to and recover from disasters. Concerning SMCS again informing the public about certain warnings or directions regarding an incident like spread of hazardous substances are the main activities within the preparedness. (Reuter et al., 2014)

Response

This phase begins immediately after the occurrence of a disaster and includes short-term activities to take rapid action to save lives, protect property and the environment, and meet basic human needs. More specifically, it involves assessing damage, conducting surveillance, providing public health investigations or inspections, dispensing medication, or vaccinations, and

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establishing sheltering operations. For SMCS this means to inform the people about necessary actions, and to reduce or avoid the possibility of disaster escalations. (Reuter et al., 2014)

Recovery

After dealing with the short-term of a crisis the community must return to 'normal life'. Hence, the response phase is directly followed or overlapped by the recovery phase. Taking actions to return the community to normal life after a disaster: Providing oversight of the repair or rebuilding of infrastructure and public health investigations. These activities and information are the focus for SMCS as well: informing the people about medical aid and further behaviour. (Reuter et al., 2014)

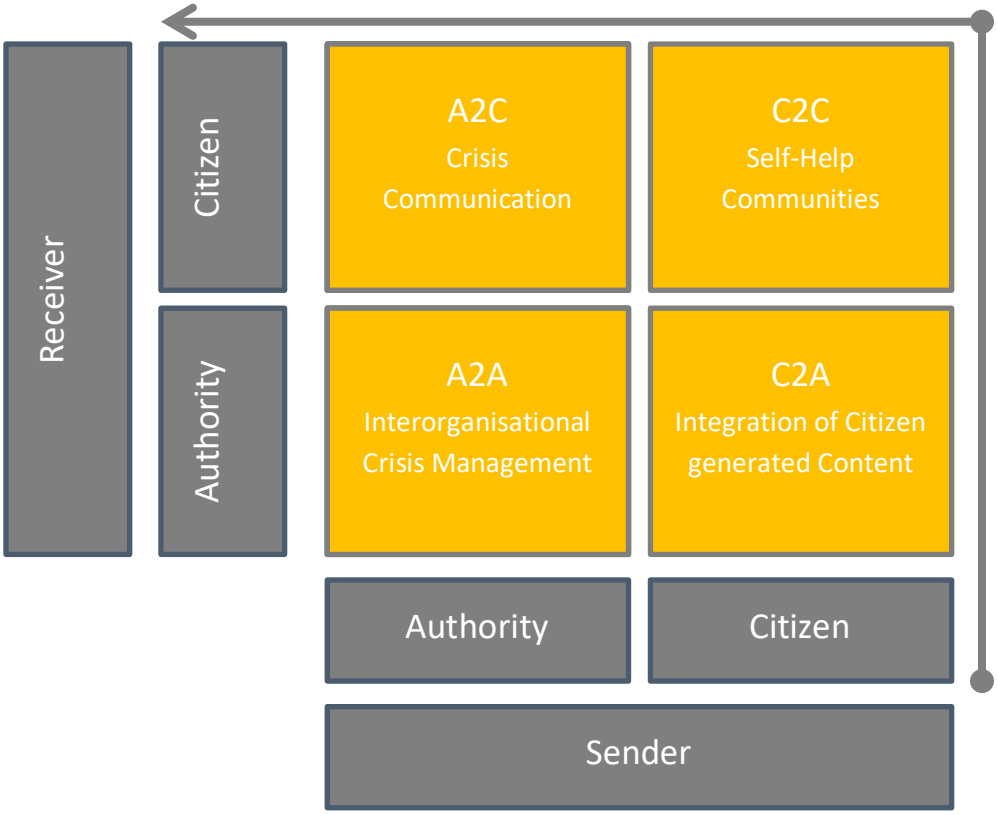
In all four phases of the DMC the communication is an important component of disaster management for DMOs and citizen to prepare and react to crises. The channels (within the so-called crisis communication matrix) where communication takes place are described in the next section.

3.3 Crisis Communication Matrix

The division of the DCTs into the respective directions of communication creates comparability among the DCTs and applicability towards specific aims in the draft DCT-schema in Section 6 and is therefore included here.

In terms of the communication matrix for social media in crisis (Reuter et al., 2011) four different directions for using social media in such a situation can be distinguished (Figure 6) depending on a distinction of authorities (A) and the public (C) as the senders and the receivers of information. The reason why 'authority' is chosen is that (especially with social media), citizens may be communicating with somebody that is not e.g. local police, county council, etc. The direction of communication is defined from a sender to a receiver and divides the crisis communication in four channels of communication: A2A, A2C, C2A and C2C.

Figure 6: Crisis Communication Matrix



Source: Authors' adaption of (Reuter & Kaufhold, 2018)

Authorities to Citizens (A2C):

A2C communication is the dissemination of information and official messages from public authorities to the public**.** In modern crisis communication public authorities increasingly integrate the use of social media in DMP (analysed in detail D3.1). The authorities are thus (at least in theory) able to provide the broad mass of the population with information via social media platforms such as Facebook or Instagram. Official bodies are thus able to support information channels such as warning apps (KatWarn[10], NiNa[11]) or official press releases. This communication can be used for one directional communication, but answers and comments can also be taken into account.

[10] https://www.katwarn.de/

[11] https://www.bbk.bund.de/EN/Home/home_node.html;jsessionid=43824586EB9E4ECC42C47E5AAB925645.1_cid345

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Citizens and Citizens (C2C):

On the public level, citizens and volunteers communicate with each other, via conventional media like telephones or social media such as Twitter or Facebook. One goal is to support or inform each other to offer mutual help and support. These communication channels are usually not monitored, which means that authorities have no influence on the content and credibility of the information.

Authorities to Authorities (A2A):

The inter-organisational communication of authorities is often not supported by social media. Mostly official and protected information channels are used first as social media raises concerns about integrity and privacy, among other things. Social media could help to improve inter-organisational awareness and informal processes.

Citizens to Authorities (C2A):

The C2A communication deals with the collection of data (messages, photos, videos, and metadata) from the population through social media. This can on the hand be done direct via specific channels (either embedded on platforms like Facebook or via specific warning apps) or on the other hand indirect by mining and analysing the communication (often this communication belongs to C2C). In the indirect communication, data mining and data analysis can be done with analysis tools, so that besides the content also metadata and other information can be evaluated. The communication direction C2A is essential for the use of SMCS in DMP.

Key takeaways from Section 3

- A **DCT** is a software(-function) for interaction with, within or among groups of people who have similar interests or have common attributes (communities) in case of a disaster as well as performing analysis of these interactions;
- The **DMC** describes an order of tasks focussing on the disaster management in four phases: Prevention, Preparedness, Response and Recovery;
- The **Crisis Communication Matrix** describes four different directions for using social media in case of a disaster: Authorities to Citizens, Citizens to Citizens, Authorities to Authorities and Citizens to Authorities.

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4. STATE-OF-THE-ART FROM LITERATURE REVIEW: DCT AND THEIR ROLE IN SMCS

This section includes a state-of-the-art analysis of DCTs for and in the context of SMCS to get a better understanding of SMCS technologies within DMP. Section 4.1 gives an overview about good practices of DCTs. This section is divided into four subsections: It contains the preparation for the use of SMCS (Section 4.1.1) and further, the opportunities are explained on the basis of three different levels of engagement of the DMOs into SMCS technologies (Section 4.1.2, 4.1.3, and 4.1.4). Section 4.2 deals with the challenges and negative impacts of SMCS and DCTs. Existing guidelines and their examination concerning technical aspects for the implications for the draft DCT-schema is explained in Section 4.3. To generate an overview of related approaches concerning the structuring and classification of technologies (as part of our business market analysis), different existing relevant classifications of IT-systems are presented in Section 4.4. The involvement of the consortium by means of a survey is explained in Section 4.5. All these results represent the DCT knowledge base and establish the foundation for the DCT-schema as input for the LINKS Framework and the LCC.

4.1 Good Practices of DCTs

In the frame of D4.1, the term 'good practice' is preferred over 'best practice, as Bretschneider et al. point out, a 'best practice'-analysis requires a comparative process in which the methods get evaluated using well-founded human judgement and, if possible, statistical approaches. Further, to achieve the state of 'best practice' the investigated use cases must provide a complete picture of existing actions (Bretschneider et al., 2004). Since the research field of SMCS is highly dynamic, nearly applied worldwide, and shaped by diversity, the fulfilment of the conditions in this area is not realistic and therefore the choice of the 'good practice' is more appropriate.

With proper use of social media, it has the possibility to provide near-real time information for DMOs to make effective decisions throughout the DMC process. Especially in large-scale disaster situations (like the six cases evaluated in LINKS: earthquakes, flooding, industrial hazards, terrorism, drought, and tsunamis) the sharing of information between citizens and authorities through social media has the potential to become a key concept of modern DMP. In the last two decades in particular, many research projects have analysed the role of social media in disasters and provide the DMOs well-founded theoretical backgrounds and practice-oriented instructions.

The FP7-project COSMIC has developed three key principles in order to work with social media in a DMO. The key messages, summarised under the acronym 'AID', are as follows (COSMIC, 2015):

- *'**A**cknowledging the fact that civil society can be trusted;*
- ***I**ncreasing the ability of civil society to take responsibility for further guarding its own well-being;*
- ***D**eveloping the capacities of public authorities for adapting to social media use by civil society.'*

The FP7-project EmerGent (Emergency Management in Social Media Generation)[12] investigated the positive and negative impacts of social media in emergency management and a primary goal was to strengthen DMOs in using social media within all phases of the DMC (EmerGent, 2015). As one of their earlier research results, EmerGent identified within a survey the high interest and even request for social media interactions as a DMO. In 2015, 1034 citizens were interviewed and 58 % of them would use social media to look for information about an emergency, 77% thought that information via social media are provided faster than due to traditional media channels, and 69% agreed on the thesis, that Emergency Management Services should monitor their social media channels to be able to respond promptly (Friberg & Reuter, 2015). Due to the increased consumption of social media, it is to be expected that the values have risen within the last five years. DMOs have recognised the benefits and resulting opportunities of social media (and crowdsourcing) and have started actively using them in the recent years, e.g. (Chaturvedi et al., 2015; Stieglitz et al., 2018).

The structure of the following paragraphs is based on the findings of Wukich's research (Wukich, 2015). Wukich analysed over 200 sources (journal articles, newspaper articles, research reports etc.) to get a fundamental understanding of the range of strategies and tactics for the use of social media in DMP. As a result, three strategies were identified (Wukich, 2015):

1. Information dissemination: Emergency managers disseminate information using a number of message types (Section 4.1.2).
2. Data monitoring & analysis: Emergency managers monitor and analyse data to accrue situational awareness (Section 4.1.3).
3. Conversations & coordinated action: Emergency managers engage others in conversations and coordinate collective action (Section 4.1.4).

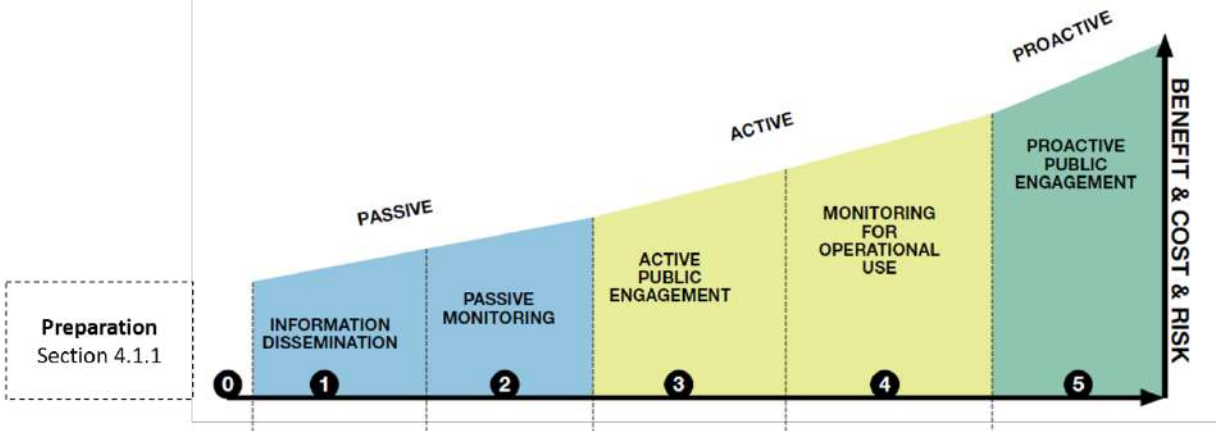
Based on the review of recommendations for action and guidelines, DMOs should have made several preparations before they start using social media. The key findings of the needed preparation are presented in Section 4.1.1.

As an integral part of the strategy, it is important to set the level of engagement into social media the organisation is aiming for. In the literature there are different levels of engagements

[12] http://www.fp7-emergent.eu/

described which are fundamentally similar in the distinction between passive, active and proactive (also called 'engaged'). The classification seen in Figure 7 is adapted from the Scottish Government and presents five different levels of engagements. Similar distinctions can be found in (Rive et al., 2012) and (Defence Science and Technology Laboratory UK, 2012).

Figure 7: Level of Engagements with Assigned Strategy and Technology



Strategy	Information dissemination	Data monitoring	Conversations & coordinated action	Data monitoring & analysis	Conversations & coordinated action
Technology used by DM organisations	SM	SM	DCT / SMCS	DCT	DCT / SMCS
Section	4.1.2	4.1.2	4.1.4	4.1.3	4.1.4

Source: Authors' adaption of (Scottish Government, 2013)

The **first** level of engagement 'information dissemination' is limited to the one-way distribution (A2C) of information via social media platforms. As a technology, common social media platforms are used. The **second** level of engagement 'passive monitoring' includes the reading and examining of user generated content related to the own organisation (e.g. reading comments and viewing uploaded event associated photos within the social network) with the aim to assess the public view on the organisation and increase the situational awareness. 'Active public engagement' as the **third** level of engagement extends the utility into a two-way communication with the audience (A2C & C2A) and contains the active responding on questions, requests, and comments. This is either possible with the conventional use of social media platforms (labour-intensive) or can be supported and simplified by using DCTs. The **fourth** level of engagement active 'monitoring for operational use' contains technology-based analysis and evaluation of a large volume of information from social media, achieved by DCTs, to identify necessities for action

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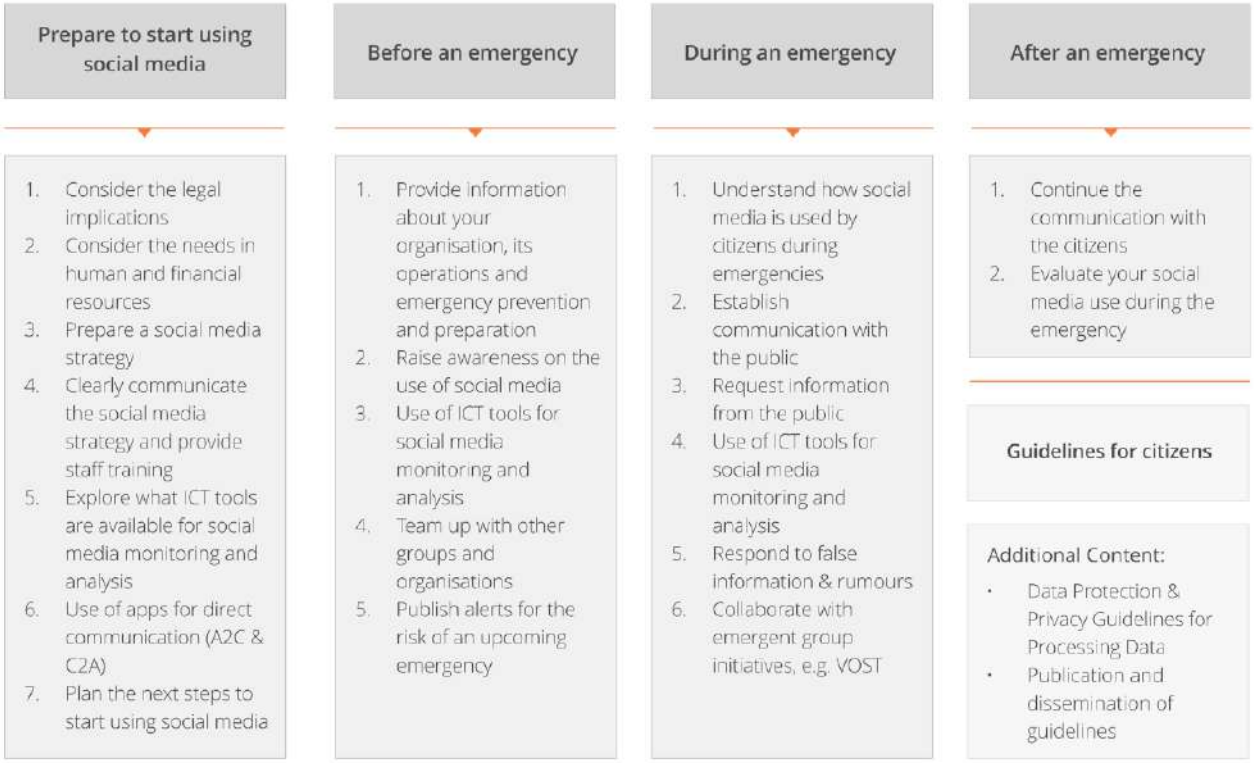
and support of strategic decisions. The most comprehensive (and last and **fifth**) level of engagement is named 'proactive public engagement' and includes a complete integration of social media in the daily business operations working in a fully networked community consisting of DMOs, citizens, and volunteer helpers. Technically, this requires the combination of SMCS platforms and DCTs.

As can be seen in Figure 7 the three identified strategies by Wukich can be assigned to the different level of engagements. The first strategy '**information dissemination**' can be allocated to the first level of engagement and is even identical in name. The Section 4.1.2 elaborates on the possibilities that can be implemented in the organisational structure with the active and intelligent use of one or more social media channel(s). Section 4.1.3**Error! Reference source not found.** presents the active **data monitoring and analysis** options for a DMO by using DCTs. The third strategy of Wukich ('**conversations & coordinated action'**) can be allocated to the third and fifth level of engagement. The research from Wukich is terminological limited to social media and aims at the cooperation of citizens and authorities. Therefore, in the context of this deliverable, this strategy can be assigned to the area of crowdsourcing due to the consistency of content and agreement on the definitions in Section 3.1. So, in Section 4.1.4, Wukich's strategy is taken up and expanded with research aspects of crowdsourcing in DMP.

4.1.1 Preparation of the Use of Social Media in DMP

The first step into SMCS from a DMP perspective can be the creation of a social media account representing the organisation. However, from the analysis of literature and results of existing guidelines for the use of SMCS in disasters (cf. also Section 4.3) it becomes clear that creating a social media account implies many preparations, obligations and additional tasks for the organisation. In the context of this research, detailed guidelines for the use of social media in DMP were published within EmerGent (shown in Figure 8).

Figure 8: Summary of the Guidelines for the Use of Social Media in DMP



Source: (Gizikis et al., 2017)

To describe the urgency of preparing the use of social media in DMP the lesson learnt 'If you are not doing social media, do it now. If you wait until its needed, it will be too late' (Gizikis et al., 2017) is well suited. The left part of the graphic summarises the preparation for DMOs, regardless of any impending disaster. Taking into account different **legal implications** (e.g. European data protection policies, national legislation, or operational policies), it must be clearly defined which social media activities DMOs are authorised to carry out and which obligations are associated with them. An interesting and unanswered question is whether a DMO needs to respond to emergency calls on social media. In order to answer such questions and to develop action-related guidelines, both experts from jurisprudence and social media are required. This leads straight to the next step of preparation: the early calculation and consideration of the short and long-term needed **resources**. In particular, the costs for human resources (salary, staff training, etc.) and the costs for the information and communications technology (ICT) must be taken into account when

planning the implementation of social media.[13] If taken seriously, depending on the level of engagement, it also has to be considered to devise a rotation system for the staff to be 'online' 24/7 (Defence Science and Technology Laboratory UK, 2012). An organisation chart about the **key positions** and stakeholders in a crisis communication team with an emphasis on social media was designed by the International Air Transport Association (IATA) and can be used as good practise example for DMOs (International Air Transport Association [IATA], 2018). The chart can be found in the Annex III (Figure I).

According to the EmerGent project, the next step is to develop the social media **strategy**. This includes e.g. an identification of the objectives, target audience, responsibilities within the employees, desired social media channels, and processes. It is important to point out, that the social media strategy should be integrated into the overall strategy to be consistent with the rest of the organisational structures. An important and not to be despised requirement according to '*a good practice guide for social media in emergency management*' from the Wellington Region Emergency Management Office is, that the top-level management is convinced of the benefits of social media. In many organisations, social media is still seen as a waste of time and the access from work computers is prohibited (Pepperell & Neely, 2014).

The International Telecommunication Union (ITU) published a very detailed guideline on how to ensure the communication (where social media is a big part of) during all phases of the DMC. This document includes generic aspects of the legislation, regulation, and policies as well as recommendations about the technologies and can therefore be used for the evolving a strategy.[14]

If the requirements above (consideration of legal implications, resource planning, and developing of a strategy) are met, DMOs are ready to seriously participate in social media. Several sources (e.g. (Roldan & Ordoñez, 2020) or (Rive et al., 2012)) provide checklists and evaluation sheets before starting with and for further developments of social media platforms. For the scope of this section the **'prelaunch checklist'**, provided by (Center for Disease Control and Prevention [CDC], 2009) is sufficient :

1. Is content disclaimer and site ownership disclaimer in place?

[13] The project EmerGent did not conduct research into determination of costs. For this purpose, the investigations by Trilateral and Research, which carried out a comprehensive comparison of social media analysis tools on behalf of the Global Disaster Preparedness Center (GDPC) provides approaches to determining the costs of the use of different social media technologies. Source: https://preparecenter.org/resource/social-media-analysis-tools-preparedness/. The GDPC was founded by the American Red Cross and the International Federation of Red Cross and Red Crescent Societies (IFRC).

[14] The guide aims to help national authorities to develop a national emergency telecommunication plan (NETP) and can be reached at: https://www.itu.int/en/ITU-D/Emergency-Telecommunications/Pages/Publications/Guidelines-for-NETPs.aspx

2. Is there a plan for regular content updating and content review in place?
3. Is a blog comment moderation policy in place?
4. Has the staff responsible for creating and maintaining CDC content been briefed on the Social Media Rules of Behaviour?
5. Is a plan for security vulnerability checks in place and staff assigned the review?
6. Has a written incident response plan been vetted and approved?

4.1.2 Information Dissemination & Data Monitoring of Social Media in DMP

After the preparations for social media usage in an organisation are established, this section provides an overview of the opportunities and possibilities if a DMO decides to go public with a social media account. As can be seen in the guidelines from EmerGent (Figure 8), the social media account is suitable for communicating information about the organisation. A distinction can be made among more static and long-term valid as well as dynamic information. The static information is long-term, organisational, and not tied to events such as disasters. They will help citizens to understand the actions and what they can expect from the DMO. The listing taken from (EmerGent, 2017b) summarises the basic information which should be provided by the DMP:

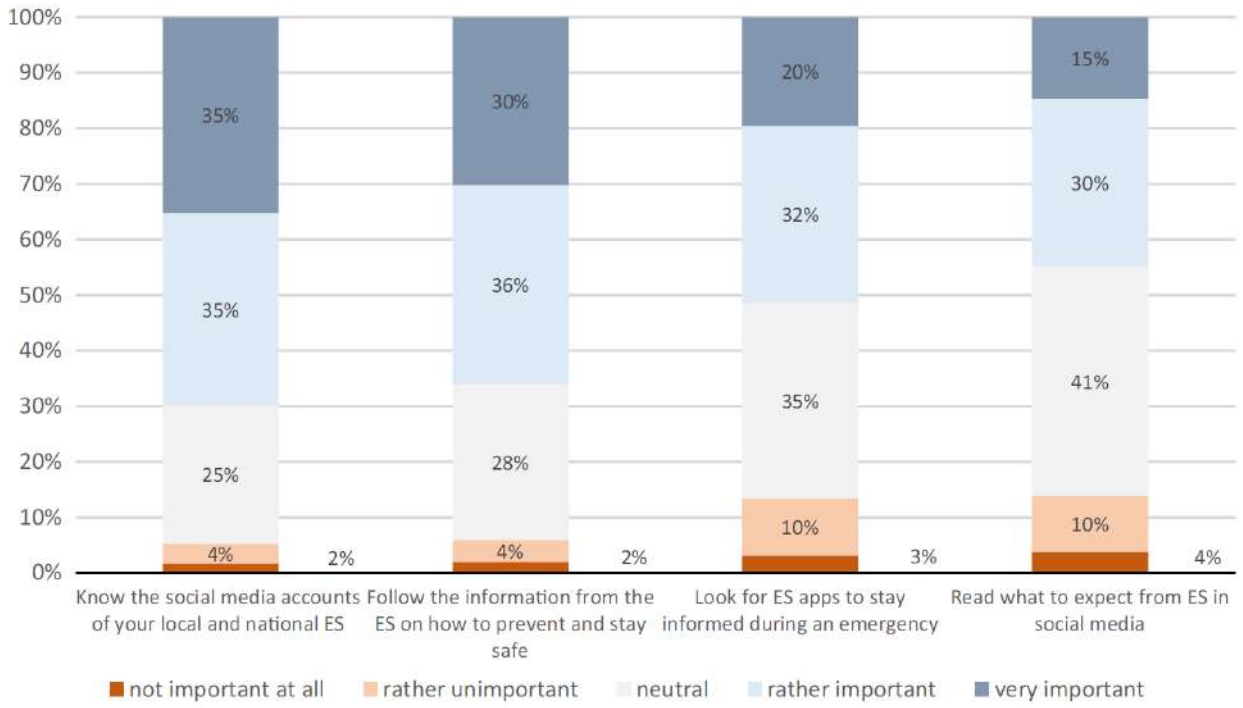
- 'Explain when to contact emergency services and the information needed when an emergency call is received;
- Remind people that 112 is the European emergency number available in all EU member states, useful to remember while travelling;
- Remind people how they can alert emergency services and the communication channels for people with disabilities;
- Explain the obstacles that affect the work of emergency services, e.g. false calls and how they can be avoided;
- If you offer an app for citizens, promote the download and use of the app.'

In close connection to the information provided above, it is also recommended that DMOs use their social media reach to foster the awareness of citizens on the use of social media as a helpful tool in emergency or disaster situations. An exemplary visualisation from EmerGent can be found in Figure II in the Annex III.

In order to underline the topicality and importance of the conscientious provision of information as a DMO before a disaster could happen, the result of a survey carried out by Kaufhold et al. in 2017 can be cited here. 1024 people in Germany were asked about their assessment of four different recommendations for the usage of social media before a possible disaster. The recommendations in Figure 9 reflect basically the content of the list above (e.g. 'If you offer an app for citizens, promote the download and use of the app' vs. 'Look for ES [emergency service]

apps to stay informed during an emergency'). Especially the high amount of people (at least two thirds) highlighting the importance of knowing the social media accounts for emergency services or following their information should encourage DMOs in their commitment to social media. Further results of the survey including assessments of the use of social media during and after an emergency with interesting key results can be found in (Kaufhold et al., 2018).

Figure 9: Results of the Research Question: How do you rate the following recommendations for usage of social media before an emergency?



Source: (Kaufhold et al., 2018)

In addition to the information above, DMOs can also publish event-related information for the citizens via their social media channels. The underlying events can vary in terms of time and scope. A rough distinction can be made among smaller scaled emergencies and large-scale disasters as well as the predictability of a disaster. For example, if it is possible to predict an incoming disaster like a hurricane, the use of social media is highly relevant in the phase of preparedness. According to Wukich the dissemination of information is one of the most important activities DMOs can carry out with social media. Within this strategy, Wukich distinguishes between four types of messages (Wukich, 2015):

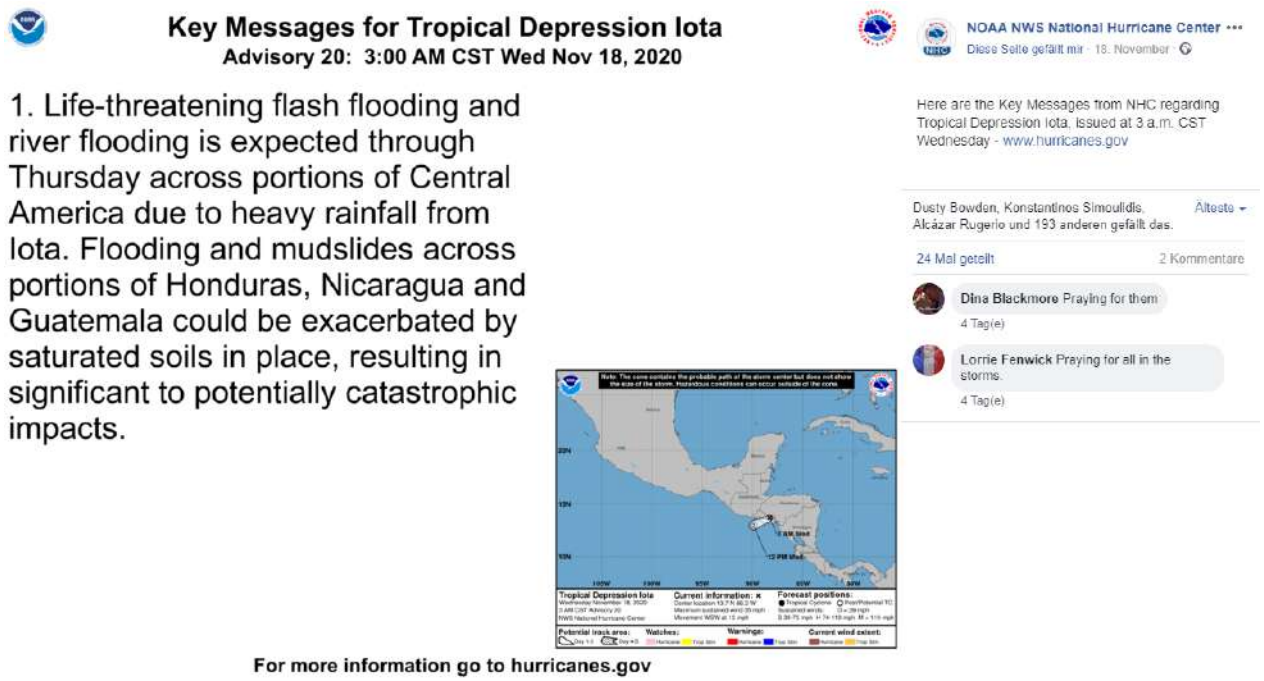
- **Alerts, warnings, and advisories**: DMP should try to provide near-real time protective information. These include a description of the impact of a hazard to the public and

suggestions (if needed expandable to instructions and orders) about actions the public should do or avoid. Information about planned and ongoing evacuations can also be disseminated;

- **Resource provision**: In particular, in a large-scale scenario this type of message becomes relevant. It informs the citizens about the accessibility and location for resources (e.g. water, food, supplies);
- **Preparedness education**: This type of information dissemination is closely related to the list presented from EmerGent at the beginning of this section, but also covers disaster-specific aspects of the current situation (an example could be the preparation of the own home considering a predicted earthquake (cf. (United States government, 2020));
- **Emotion and opinion-related messages**: Social networks allow DMOs to express emotions like gratitude, condolences, and comments to a broad audience. Regarding crowdsourcing for example, thanking volunteers is a big part of the motivation (Schimak et al., 2015).

An example of a warning message can be found in Figure 10 The National Hurricane Center (NHC) is part of the United States weather service and is informing daily about possible threatening developments of nature hazards (hurricanes, tornados, flooding etc.) which is a primary source of information for people living on the coasts of America.

Figure 10: Warning Message on Facebook Concerning a Predicted Flood



Source: (National Hurricane Center and Central Pacific Hurricane Center, 2020)

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There are many guidelines and documents for DMOs that describe exactly how a social media post should look for certain purposes. For example, the CDC's *guide to writing for social media* provides step-by-step instructions on how to post as a DMO on the major platforms Twitter and Facebook. It concludes specific features (e.g. hashtags), criteria for a good post (e.g. relevant, interesting) and a lot of good examples vs. weak examples (Centers for Disease Control and Prevention, 2012).

4.1.3 Data Monitoring & Analysis: Introducing DCTs in DMP

The next step in the integration of social media into DMOs involves the use of DCTs. This goes beyond the pure operation of one or more social media channels but, for example deal with the analytical evaluation of user-generated content according to definable patterns. Facebook, Twitter, and other social media platforms generate a high amount of unstructured data out of diverse sources. Particularly in disasters, a high volume of data arises in social media that could be relevant to DMOs, but it is far too much for the staff to view and evaluate this manually (Kaufhold et al., 2019). Therefore a key function of DCTs is to make this data useful to DMOs (e.g. by filtering, aggregation of data) (Ben Lazreg et al., 2018). As Wukich (Wukich, 2015) points out, during large-scale disasters millions of tweets are posted in a short amount of time. Therefore, to avoid an overflow of information, it is essential to use automatic techniques for evaluating the publicly accessible, user-generated content.

Another important aspect of DCTs is the ability to initiate or control crowdsourcing actions. This aspect of DCTs is covered in Section 4.1.4.

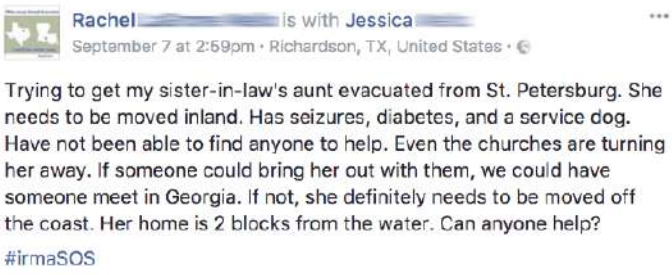
There is not always a need to own specialised software for running social media analysis since some social media platforms also offer their own analysis tools (e.g. Facebook analytics[15] or Twitter analytics[16]). There is an extensive amount of specialised software on the market (which for sure even will increase in the future), an analysis of these DCTs was part of this task and can be found in Section 5.

An essential task that DCTs have to fulfil is the **monitoring** of social media activities. According to our DCT-schema (cf. Section 6.1.5, Table 13), monitoring 'takes place in real time and can transmit collected information to analysis tools.' This includes activities on the own channel of DMOs (e.g. comments, likes) but also on other, topic-related channels from third parties as well as the analysis of keyword-related tweets or video sharing. A detailed overview of the types of data sources can be found as part of the DCT-schema in Section 6.1.8 'data sources'. Two examples of collectable data can be seen in Figure 11 and Figure 12. Figure 11 shows a help request from

[15] https://analytics.facebook.com/
[16] https://analytics.twitter.com/about

Facebook for moving a person because of an imminent threat of flooding. Figure 12 shows a picture of a flood in Oslo.

Figure 11: Help Request via Facebook



Source: (Ben Lazreg et al., 2018)

Figure 12: Photo of a Flood in Oslo from Twitter

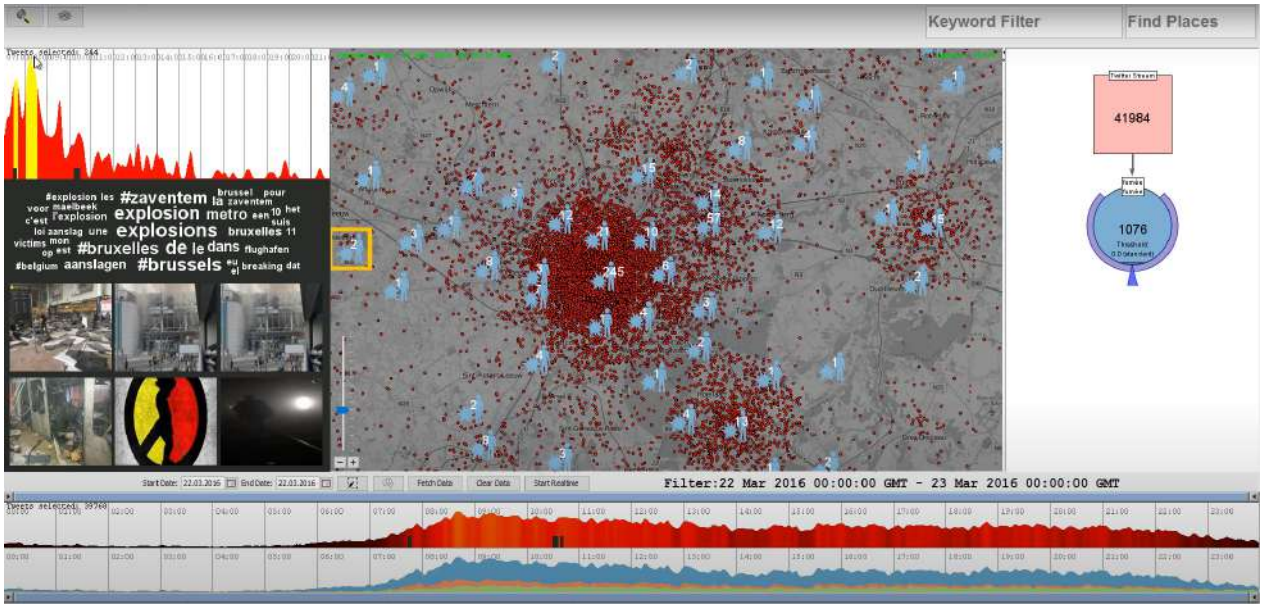
Source: (Ben Lazreg et al., 2018)

Information, as shown in the examples, can be useful for a variety of purposes. Therefore, a DCT could support the **analysis** of the collected data due to different methods. An example of the monitoring and analysing Software ScatterBlogs[17] is shown in Figure 13. Basic elements of a DCT can be seen here. The analysis is based on tweets from Twitter, which have been selected through certain filters (e.g. hashtag #explosion). On the left-hand side, a sudden increase in social media activity in connection with the key words shown below, can be seen as soon as the terrorist attacks begin. At the same time, related photos are loaded into the software. In the middle, the

[17] https://www.scatterblogs.com/

localisation of the filtered tweets is visualised with a focus on the place where it was posted (blue 245).

Figure 13: Demonstration of the ScatterBlogs Interface at the Terrorist Attack in Brussels 2016



Source: (ScatterBlogs, 2016)

One of the main tasks that monitoring and analysing pursues is the creation of **situational awareness** (Wukich, 2015). Situational awareness is 'the perception of elements in the environment with a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future' (Endsley, 1988). In the context of DMOs that means to acquire geographic-based, timely information which leads to a presentation of a comprehensive picture of the current situation. Due to the access of information strategic decisions can be made. (Federal Office for Civil Protection and Disaster Assistance Germany [BBK], 2017). A good practice example is the Digital Operations Center[18] (see Figure 14), launched in 2016 in response to the aftermath of Hurricane Matthew. The CEO of the American Red Cross North Texas Region said (RedCrossNorthTexas, 2016):

> Social media is a part of the operational DNA of the American Red Cross. We use the information we find in the digital space to help us make better decisions on where to open shelters and where to send supply trucks based on the needs of the people we're serving.

[18] The Digital Operations Center in North Texas is the second established center. The first one was established in Washington DC as a helpful tool against the hurricane Sandy

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> These digital volunteers are directly impacting our service delivery efforts and helping us to better serve those affected by Hurricane Matthew.
>
> *Keith Rhodes, CEO of the American Red Cross North Texas*

As can be seen from this example, DCTs can help with the **allocation and management of resources** (e.g. control of demands and supply offers).

Figure 14: Digital Operations Center of the American Red Cross

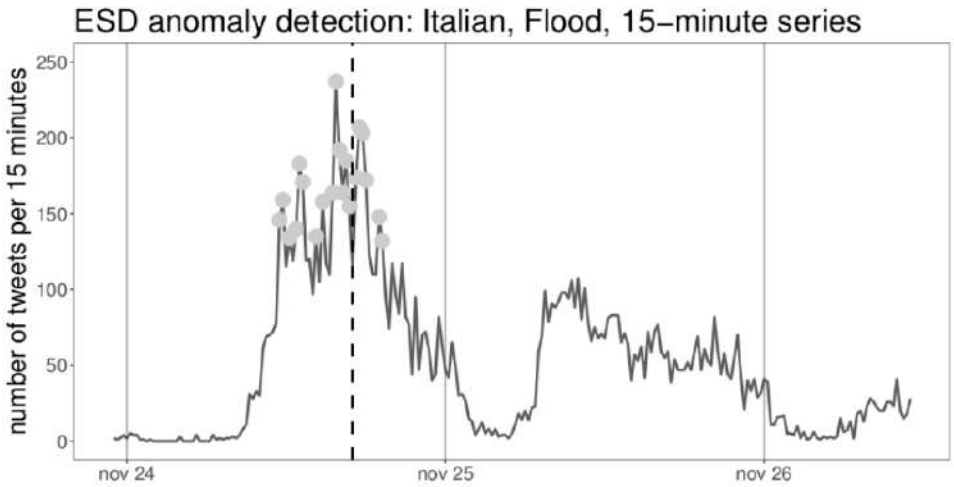
Source: (RedCrossNorthTexas, 2016)

The staff, which consists of paid and voluntary helpers, is faced with the challenge of making sense out of this data. In science and research as well as in practice there are various approaches to determine the **information quality**. In EmerGent, for example, a framework to assess the quality from user generated content in social media using different criteria (e.g. completeness, timeliness) was developed (Moi et al., 2017). Further explanation on how to access credible information in a disaster are discussed in the D3.1. Kaufhold et. al also developed a novel approach based on the EmerGent framework. The Emergency Service Interface (ESI) is an 'approach for generating social media alerts, which transforms the high volume of big social data into a low volume of rich content that is useful to emergency personnel and aims to mitigate the issue of information' (Kaufhold et al., 2019).

As an addition to the already presented tasks and opportunities the following list should give an overview of other tasks mentioned in several research papers and publications from DMOs that have already made (positive) experience with DCTs:

- **Early detection of anomalous events and trends:** Since a near-real time evaluation of data is provided and most of the social media content is geolocated (spatiotemporal), researchers in DMP have focused on finding temporal trends according to volume-based importance (J. Chae et al., 2012). This means that as soon as disaster-related events are noticed by the population, the density of social media posts with regard to certain keywords increases disproportionately. The H2020-project I-REACT (Improving Resilience to Emergencies through Advanced Cyber Technologies) presents an Event Detection Module (EDM). The EDM detects anomalies in social networks and automatically creates workflows in the information system after a validation progress. The time of detection (black vertical line) during a flood in Italy can be seen Figure 15. It was shown that the module can detect risks and hazards more quickly in certain scenarios than DMOs are partially alerted to (Bosca & Bielski, 2018);

Figure 15: Twitter based Anomaly Detection, Italy Flood of November 2016



Source: (Bosca & Bielski, 2018)

- **Sentiment-analysis:** In crisis situations the use of social media is a common way to cope with uncertainty (Palen & Anderson, 2016). Some DCTs are able to detect sentiments out of the public shared opinions. Kaur and Kumar present in their paper an brief overview of different methods for analysing the sentiment out of social media data (Kaur & Kumar, 2015). The sentiment analysis is particularly relevant for DMOs that deal with the emotional consequences of a disaster. It can also be used to follow up on DMP (evaluation of activities);

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- **Receive survivor's requests for assistance**: As already mentioned in 4.1.1, it is necessary to consider the legal implications and possible liability of DMOs to react on those requests (EmerGent, 2017b). An example of a help request can be seen in Figure 12;
- **Search missing people:** Due to its high reach (sharing and retweeting of posts), social media is well suited for searching for missing people. Mujahed reports that 2012 already one of five authorities started to use social media for finding missing persons in terms of law enforcement (Mujahed, 2019). Matthee and Hattingh elaborate on ways in which Facebook is used to find missing persons within a network of communities in South Africa (Hattingh & Matthee, 2016);
- **Internal communication within or between DMOs**: In crisis situations it is common for citizens to unite on social media platforms. DMOs adopted to it in various ways. One good example is the platform Ready2Help[19], developed by the Red Cross in The Netherlands. On this platform members of DMOs can transcend the boundaries of their belonging and communicate with other DMOs (Boersma et al., 2017);
- **Engaging volunteer helpers**: Boersma et al. found out that Ready2Help was also successfully utilised to incorporate volunteer helpers in response operations with providing a good structuring of most activities and therefore enabling coordination of e.g. meeting points and task allocation (Boersma et al., 2017). In general, DMOs gain the improved ability to collaborate with citizens and better prepare each other for disasters by communicating via social media. A more detailed analysis of the processes to engage citizens in different phases of disasters has been analysed and summarised in D3.1 of LINKS as an effort to consolidate understanding of disaster management processes.

The presentation of tasks and opportunities is not complete but gives an overview of the core tasks that a DCT already takes on in DMP or can take over broadly in future developments.

Further short insights: EmerGent also provides a detailed overview of possible uses of social media in the different phases of the DMC (can be seen in Figure III in the Annex III). To get an overview of the use cases already carried out, Reuter and Kaufhold reviewed the application of social media during different crisis situations, including role and perception patterns of public and administrative stakeholders within the last 15 years (Reuter & Kaufhold, 2017). Thereby an overview of 42 selected studies in which the use of social media in disaster situations have been analysed (cf. Figure IV and Figure V in the Annex III).

In summary, established social media platforms allow the dissemination of multimedia content in different directions of communication. Looking to the future: DMOs, if not already done, will and

[19] https://www.rodekruis.nl/hulp-in-nederland/ready2help/

almost should integrate the dealing with social media into their overall strategy to better manage disasters.

4.1.4 Conversations & Coordinated Action by Crowdsourcing in DMP

In close connection with the growth of the use of social media platforms there is an increasing spread and use of crowdsourcing technologies in the public (Almansoori & Habtoor, 2018). Referring to the general definition from Section 3.1, crowdsourcing from a DMP perspective can be helpful to deal with challenges that cannot be solved by the organisations alone.

Volunteerism in disaster situations is not a new phenomenon: More than 40 years ago (Quarantelli & Dynes, 1977) as well as (Stallings & Quarantelli, 1985) characterized these 'emergent groups' as 'private citizens who work together in pursuit of collective goals relevant to actual or potential disasters but whose organization has not yet become institutionalized'. According to (Quarantelli, 1984) the essential conditions for the emergence of such groups are

- A legitimising social environment;
- A perceived threat;
- A supporting social climate;
- A network of social relationships;
- And the availability of specific (immaterial) resources.

According to some studies citizens react in a largely rational way to disaster situations, rarely panic, are not helpless, and do not loot (Helsloot & Ruitenberg, 2004). They are instead capable of taking part in a large amount of rescue and response work. (Reuter et al., 2013) distinguish between activities in the 'real' and the 'virtual' world: real 'emergent groups' (Stallings & Quarantelli, 1985), which usually act in the form of neighbourly help and work on-site, and virtual 'digital volunteers' (Starbird & Palen, 2011), who originate from the internet and work mainly online.

Digital volunteering now exists in numerous approaches at national and international level. In the sense of crowdsourcing, digital volunteers create maps of crisis areas ('crisis-mapping') (Meier, 2011), analyse social media data (D. Archut, 2013) or help on site, e.g. for geodata analysis (UN Office for the Coordination of Humanitarian Affairs, 2017) or the establishment of an IT-infrastructure. The technical solutions of the large IT companies such as the Facebook Safety Check[20] and the Google Crisis Response System[21] are professionalised through cooperation with IFRC, UNICEF and national aid organisations and explicitly involve the cooperation of voluntary

[20] https://www.facebook.com/about/crisisresponse/
[21] https://crisisresponse.google/

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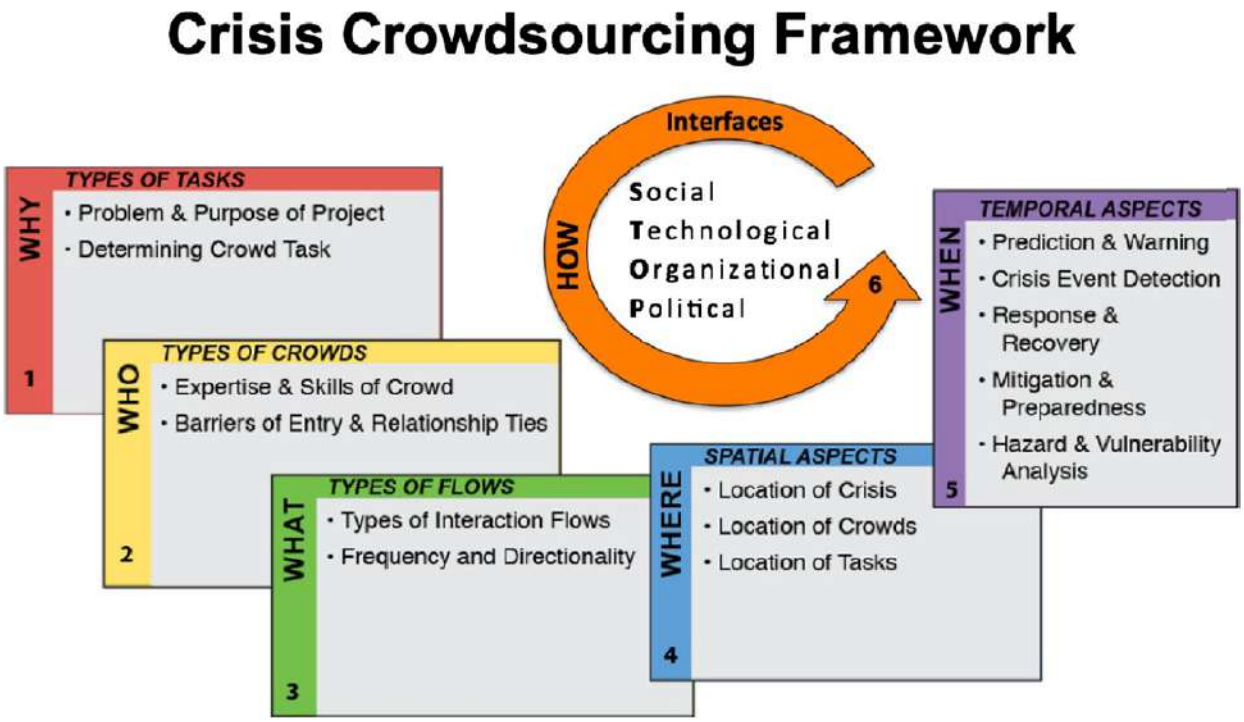
helpers. Platforms like Ushahidi[22] enable holistic disaster management for digital volunteers via applications. In addition to highly specialized groups such as the 'Humanitarian Open Street Map Team (HOT)', there are also international 'networks of networks' such as 'Digital Humanitarians' (Meier, 2015), which provide bundled help from various specialist communities. In Germany there are also the institutionalised Virtual Operations Support Teams (VOST) with the European counterpart VOST Europe (Susaeta et al., 2017). Digital volunteering approaches are also available in Asia. The University of Tokyo uses social media data to predict earthquakes (Sakaki & Okazaki, 2010). Petabencana.id uses georeferenced tweets to create a flood map of Indonesia (R. I. Ogie & H. Forehead, 2017). During the earthquake in Nepal in 2017, 'crisis mapper' (Jeke, 2015) and during typhoon Yolanda in 2014, the Digital Humanitarians Network was activated (Vieweg S. et al., 2014).

As Schimak et al. point out, the 'potential of crowdsourcing in crisis management is undeniably enormous' and that the 'information obtained through crowdsourcing is often more detailed and just as accurate as the information gathered through hardware sensors and through official channels' (Schimak et al., 2015). In their research paper, Schimak et al. discuss the relevance of crowdsourcing in crisis management and analyse the use of crowdsourcing in ongoing projects. However, as Section 4.2 shows, the negative impacts of SMCS are not negligible and should be included in the evaluation.

To get an overview of crowdsourcing in disasters, it is worth taking a look at the framework model created by Liu for describing strategy characteristics (Liu B. Sophia, 2014). The framework that can be seen in Figure 16 describes crowdsourcing in crisis with six key dimensions which should explain the why, who, what, when, where and how a crowdsourcing framework could be implemented in an overall strategy of DMOs.

[22] Ushahidi is an open source application which started with crisis mapping and is now also a tool for social activism and public accountability; https://www.ushahidi.com/

Figure 16: Six Dimensions of the Crisis Crowdsourcing Framework



Source: (Liu B. Sophia, 2014)

While the content of the dimensions *why*, *who, what, where* and *when* is relatively obvious the category *how* describes the different interfaces and possibilities for implementation. Socio-cultural norms, technology, organisational structures, and regulations has to be taken into account. For an effective conceptualizing of a DCT-schema, it is important to take a closer look at some aspects (properties of a crowd, the tasks and objectives and the motivation) of crowdsourcing and to understand how crowdsourcing can work.

The **crowd** is inherently non-hierarchical and organises itself independently of crisis managers. There are different types of crowds, which differ particularly in the degree of organisation and the associated skills. For example, Liu distinguishes between four types of crowds (Liu B. Sophia, 2014):

1. Directly affected populations/helpers: producing the most local, timely and direct information about the impacts, loosely connected to each other;
2. Diasporas: socio-cultural people with strong ties to the affected people;
3. Social networks: people with various backgrounds and the ability to quickly connect to each other;

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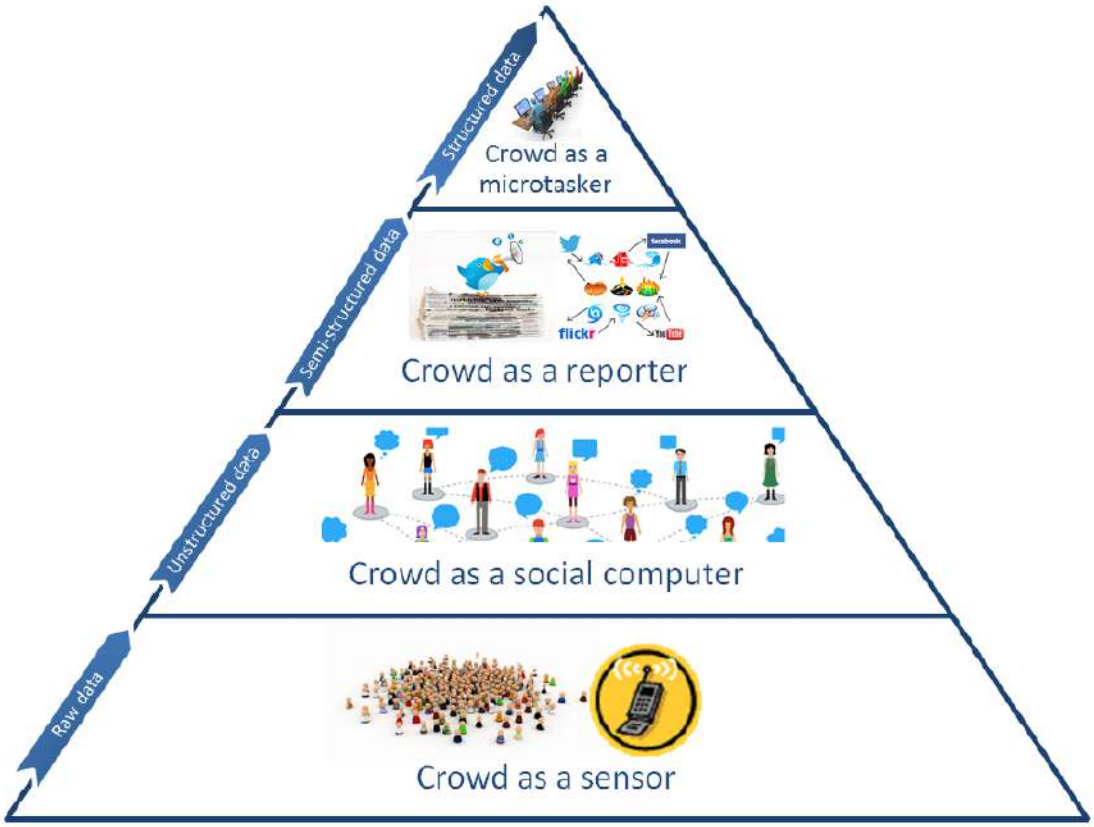
4. Digital volunteer communities: pre-organised communities with interests and capabilities in processing and managing a crisis.

Another related typology of publics is provided by D3.1. They looked across the two dimensions degree of participation and proximity to the disaster affected area and distinguish therefore between local techies, local passives, distant techies, and distant passives.

A similar role concept was developed by Poblet et al in their research, in which a set of online tools and platforms that are currently being applied in the area of DMP got reviewed and as a result of a taxonomy for its categorisation is proposed (Poblet et al., 2014). As can be seen in Figure 17, the crowd was divided into four roles, depending on their involvement in crisis management which goes along with the associated level of data. The crowd as a sensor, for example, only provides raw data that still has to be aggregated for effective use while the crowd as a conscious unit is able to provide the crisis managers with structured data to aid the decision-making.

Figure 17: Crowdsourcing Roles based on Users' Involvement and Level of Data Processing



Source: (Poblet et al., 2014)

The four identified roles were also assigned to the phases of the DMC (cf. Section 3.2) in Figure 18.

Figure 18: Crowdsourcing Roles and Disaster Management Cycles

	Crowd as a sensor	Crowd as a social computer	Crowd as a reporter	Crowd as a microtasker
Preparedness	•			•
Response		•	•	•
Recovery		•	•	•
Mitigation	•	•	•	

Source: *(Poblet et al., 2014)*

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Similar to the compilation of tasks for social media in Section 4.1.3, the following list shows the possible **processes** crowdsourcing could fulfil in DMP (the demarcation to the tasks of social media is fluid and, depending on the point of view, not always separable):

- Detect and report (e.g. sharing social media posts, pictures, videos) about the impact and aftermath of a disaster using human senses and help the DMOs to gain a better situational awareness;
- Collect large amounts of data in real time at potentially lower costs than traditional approaches;
- Creating metadata from machine-based sensors;
- Categorizing a large amount of data with keywords and hashtags;
- Contribute to crisis mapping: either using a participatory geographic information system or publish geolocated posts;
- Crowdsourcing is a way of risk communication through public relations and awareness-raising;
- Maintaining communication with the affected area (for many people it is the only communication line to emergency helpers);
- Enable direct help when the DMOs are overloaded, especially in large area scenarios (e.g. evacuations in the event of floods or the search for buried people after an earthquake).

Sources: (Associated Programme on Flood Management, 2017; Bott et al., 2014; Liu B. Sophia, 2014; Schimak et al., 2015; Sukhwani et al., 2019)

Another important aspect is the motivation of citizens and volunteers to participate in crowdsourcing. A rough distinction can be made between active and passive participation.

According to the processes already mentioned, some sources already denote the participation in social networks and thus the automatic provision of information as crowdsourcing (e.g. (Liu B. Sophia, 2014)) while other sources refer active participation in voluntary projects or neighbourhood help as well as the knowingly contributing to a database as crowdsourcing (e.g. (Associated Programme on Flood Management, 2017). For the latter, the motivation can be determined from the following components:

- The acknowledgment of the authorities, colleagues, and organisations might be the best motivator. Therefore, it is important to highlight the social benefits of participation in crowdsourcing in crisis situations and visualizing the added value;
- Attitude of a person: The more a person prefers positive behaviour, the more willing they are to display this positive behaviour themselves;

- The fun of action and the challenge involved in the task could motivate people to participate in crowdsourcing. Solving complex scientific issues can also be a motivator.

Sources: (Pinto & dos Santos, 2018) (Schimak et al., 2015)

As expected, the motivation in crowdsourcing consists almost exclusively of intrinsic motivation. Extrinsic motivation could only happen in the repayment of material costs (e.g. fuel), but is difficult to implement. Pinto and dos Santos take a more detailed look at the motivation in 'Motivations of crowdsourcing contributors' (Pinto & dos Santos, 2018). These aspects might be important for the development of the LCC (WP7) and the establishing of a sustainable community.

The literature review of research has shown that crowdsourcing is especially necessary for large-scale crisis damaging larger areas, although also smaller incidents have profited from crowdsourcing (e.g. search for lost persons). Well-known fields of application are crisis mapping during floods (a very detailed analysis can be found in (Associated Programme on Flood Management, 2017) and earthquakes (Steed et al., 2019). Furthermore Bott et al. notice the growing benefits of crowdsourcing in fragile states. The goal and wish of many citizens is increased participation in governance and greater transparency (Bott et al., 2014). In general, it is worth observing these initiatives further as the wisdom of the crowd is immense and can support several actions and measures within the crisis management. Furthermore, with these initiatives more vulnerable people and areas can be reached, included, and taken into account (see the knowledge base DRPV in D2.1 and D2.2).

On the next pages are two examples of crowdsourcing in DMP presented. The **first** one deals with a fast detection of seismic activity after an earthquake through social media (Steed et al., 2019). The **second** example presents the possibilities of crisis mapping in flood-disaster (Google.org, 2012); both examples highly relevant for the cases within LINKS.

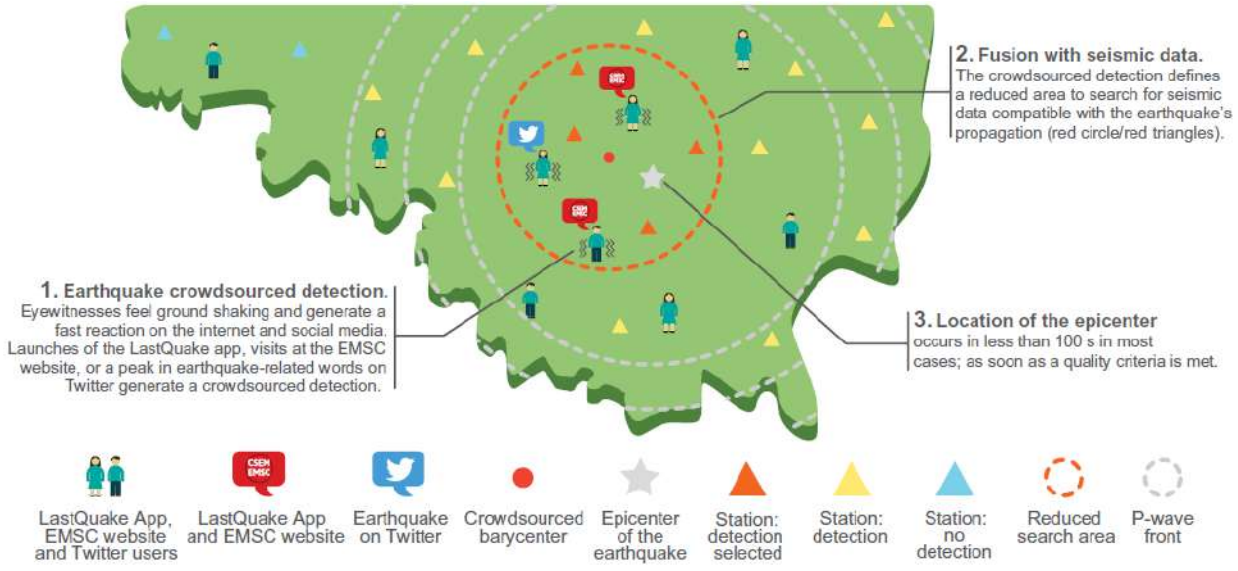
Example 1) Steed et al. present in (Steed et al., 2019) a new approach for a low cost detection of earthquakes via crowdsourcing. Currently used early warning systems like GEOFON[23] are very cost-intensive, require a lot of maintenance and cannot cover all regions in the world. The goal of those performant systems is to warn the population as quickly as possible, ideally before the arrival of seismic waves. At the same time the system is used for the fast allocation of rescue workers for the first response. The use of crowdsourcing in the context of earthquake detection is not new. For example, approaches in seismology have been using accelerometers in smartphones from citizens for an early detection with automatic forwarding via specific earthquake-applications (E.S. Cochran, 2018).

[23] GEOFON was developed by the German Research Centre for Geosciences and is a freely accessible source for displaying early earthquake warnings: http://geofon.gfz-potsdam.de/eqinfo/seismon/globmon.php

The introduced new approach is called CsLoc (Crowdseeded Seismic Location) and is designed as a side effect of the citizin's search for information and an evaluation of their online behaviour. Therefore, peaks in the rate of connections to the EMSC websites, LastQuake app launches, or social media posts on Twitter with specific keywords rapidly alert the EMSC that an earthquake is happening. What makes the use of crowdsourcing unique in this case, is not even the faster detection of a possible earthquake but rather the applying a clustering algorithm on the crowdsourcing activity to calculate the barycenter of help needed. The barycenter represents a center of the first response needed and is not necessarily to be equated with the epicenter of an earthquake (for example, when an earthquake occurs offshore or in an uninhabited region).

How it works can be seen in Figure 19. Through the use of applications and social media the 'crowdsourced barycenter' can be identified and in addition to the conventional earthquake detection systems, a quick overview of the situation for the dispatch of disaster services can be generated. CsLoc was retroactively tested in over 1500 earthquakes and in over 50 % of the cases the locations were found within 103 s, 76 s faster than GEOFON.

Figure 19: Functionality of CsLoc



Source: (Steed et al., 2019)

Example 2) Another well-known use of crowdsourcing in disaster situations is crisis mapping. The crisis mapping can be explained with three components (Associated Programme on Flood Management, 2017)(Meier, 2011):

- Sourcing of information (which methodologies and technologies can be used for the collection of information);

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- Visualisation (rendering the information collected in a dynamic and interactive map, so that visual patterns are can be recognized and grant maximum insight into the data;
- Analysis (application of the spatiotemporal data and techniques for a statistical evaluation and pattern detection).

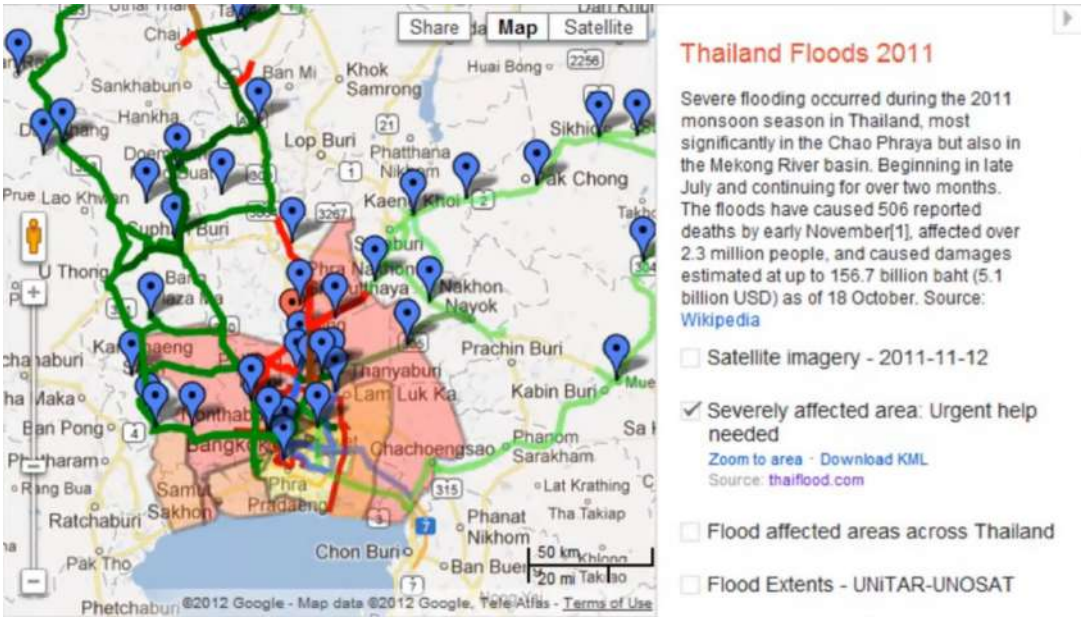
The basic idea of crisis mapping is that the collaboration of sources creates a comprehensive picture of the situation for various purposes. The crisis mappers are usually voluntary, but it is also possible that professional mappers or software developers who utilise their skills in crisis situations out of intrinsic motivation (Nama, 2010).

One of the main goals of crisis mapping is to provide a map to disaster services with the necessary information for their operations. In the case of major disasters, the services come from other countries or places and do not know the location or the infrastructure. The available map material forms the basis for the compiling of the information. It is mostly obtained from map services (e.g. OpenStreetMap[24]) and aerial photographs and satellite images. Open source crisis maps (e.g. Ushahidi) have the advantage that they can be edited by everyone and therefore a map with a large information density can be created in a short time. It also happens that volunteers move to the crisis area and primarily incorporate the status of the critical infrastructure into the interactive map (Patrick Meier, 2020).

Figure 20 shows an example of a Google crisis map from a flood in Thailand 2011. Google Maps is a worldwide standard and can therefore be easily understood by most people. The red area structures the affected region, the blue waypoints mark disaster shelter locations. Each symbol can be stored with information and other relevant markings such as evacuation zones, public alerts, traffic conditions, and more can be assigned (Associated Programme on Flood Management, 2017; Google.org, 2012).

[24] https://www.openstreetmap.org/

Figure 20: Google Crisis Map Example of a Flood in Thailand 2011



Source: (Google.org, 2012)

4.2 Negative Impacts, Challenges, and Solution Approaches of DCTs

It is obvious that SMCS has and even will have huge impact on the DMP, one motivation of LINKS. These impacts will not only offer huge opportunities and benefits and hence be of positive nature, but also negative impacts are a part of new technologies and need to be considered and observed carefully.

This section gives an overview of **negative impacts** as well as the risks and concerns (called challenges as they need to be addressed adequately) that DMOs might encounter when working with DCTs or information from SMCS. The table below gives an overview of potential negative impacts when using DCTs. As literature concerning negative impacts of concrete DCTs is quite scarce, but the negative impacts of SM platforms itself are quite related, these impacts are also listed below (Table 2).

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Table 2: Negative Impacts of SMCS and DCT Usage

Source	Negative impact
(thedaysofdigital.wordpress.com, 2018)	Users expect help after posting emergency in SM => negative impact, if that expectation is not matched/social media or DCT not monitored by DMOs.
(Alexander, 2013)	Potential to undermine the authority of DMOs.
(Alexander, 2013)	Potential to promote terrorist attacks.
(Abhay & Atre, 2020)	Spread of intentional fake news in case of pandemics [or other disasters].
(Abhay & Atre, 2020)	Spread of hatred in case of pandemics [or other disasters].
(Abhay & Atre, 2020)	Spread racism in case of pandemics [or other disasters].
(Kalson, 2015)	Unauthorized or inept use of the social media platform by the organisation's personnel could be damaging to credibility and ability to earn trust. Effective use of social media requires a commitment to policies and resources.
(Kalson, 2015)	Social media can also fan negative public opinions about the way first responders managed the disaster, possibly creating a post-disaster public relations crisis.
(Alexander, 2013) (Junge et al., 2014)	Potential to disseminate rumors in case of disasters, leading to panic or false DMP reactions.
(Kalson, 2015)	Spread of inaccurate information in SM [with negative impact to the reading SM users as well as the analysing DMOs if taken the information for truth].
(Kalson, 2015)	Many segments of the public, (e.g. elderly and infirm, economically disadvantaged, non-English speakers, etc.) do not typically use social media [– there is a risk to rely in A2C communication (and perception) tot much on SM, forgetting the 'real world'].
(Zoltick, 2014)	Social posts intending to be helpful or to announce the user's safety, can also unintentionally reveal information that can endanger others.
(D3.1, Section 5.2.3)	Collection of personal SM data in DCT could be used by the government or third parties for other unwanted uses, therefore data protection and privacy need to considered. More details can be found in the related D3.1.

(German Red Cross, 2013a)	Volunteers recruited have to be managed: If they feel that they could do a better job in another way, they can get their own dynamic and help in a way contradicting the efforts of DMOs.
(Bekkers, 2011)	Volunteers have different levels of trustworthiness, what can cause negative impacts if relying on them.
(Yudkin, 2016)	Relying on CS results for important decisions can have negative impact, as the quality and timeliness of the results are not reliable.
(Maron, 2013)	Scammers are using SM to steal cash in case of disasters.

After these theoretical negative impacts, in the following some concrete **examples** of SMCS in disasters are given, where these negative impacts actually occurred:

- Shooting in Munich: Several terrorists in whole Munich were assumed relying on social media posts, where only one single amok run took place. Therefore, way too big amounts of unnecessary DMP resources were used and a SM panic aroused (n-tv.de, 2016);
- SM panic during COVID outbreak in India (Abhay & Atre, 2020);
- Wrong suspect in SM during Boston Marathon bombing (Zoltick, 2014);
- Fake information by Donald Trump concerning COVID 19 (Hoffman & Valinsky, 2020).

The identified negative impacts are a first collection. They will influence the LINKS Framework as well as the LCC as they are part of the theoretical foundation for aspects to consider when working with SMCS. Following these potential negative impacts, several **challenges** using DCTs in DMP are identified. Table 3 includes those challenges and associated approaches to solutions found in the given literature. These findings already anticipate the challenges that need to be addressed and considered when selecting an appropriate DCT and adjusting the corresponding processes within the organisations. Besides the challenges mentioned below, see D3.1 for details to privacy, ethics concerns, and also concerning detailed consideration of information quality.

Table 3: Overview of Challenges and Solution Approaches when Working with SMCS

Source	General Challenge	Solution Approach
(Spielhofer et al., 2016) (Gizikis et al., 2017)	Needs of human resources, staff skills, DCTs, and organisational structures	Estimate and plan costs for human resources and needed tools before starting to use social media

(Papadimitriou et al., 2013)	Fast dissemination of confidential information e.g. police information	Establish publishing policies and a high degree of caution among employees
(Lüge, 2017)	Citizens' expectation for a quick answer from DMOs	Create awareness among the citizens by communicating regularly
(EmerGent, 2015) (Kaufhold et al., 2019)	Data quantity (information overload)	• Aggregation of citizens' information • Keyword-based creation of alerts • Consideration of qualitative context of social media messages
(Moi et al., 2017) (Kaufhold et al., 2019)	Data quality	Information quality framework (e.g. filter algorithms based on configuration)
(EmerGent, 2015) (Kaufhold et al., 2019)	Data validity (trustworthiness of information)	Authentication mechanisms (e.g. meta-data about the profiles)
Source	**Crowdsourcing-specific Challenges**	**Solution Approach**
(Associated Programme on Flood Management, 2017)	IT-infrastructure accessibility	• Appropriate strategies of development and democratization on a global, national and local scale • Alternative ways of spreading disaster information (siren alarms, flags, meetings, door-to-door messengers)
	Unequal distribution of skills	Web 2.0-enabled democratic revitalization
	Concerns regarding privacy, ethics, and safety of participating people	Development of a framework to protect and maintain the safety of sources
	Data quality	Crosschecking of content from several users

(Schimak et al., 2015)	Danger about inexperienced civilians in their actions in disaster situations	Good communication from disaster managers to the 'crowd' for the prevention of dangerous situations
(Schimak et al., 2015)	Participation incentives	DMOs should express their appreciation in several ways and point out in advance the social significance and importance of work in crisis situations

4.3 Analysis of IT-Usage in existing Guidelines

To understand DCTs and in particular the related processes within DMOs, it is important to know how SMCS technologies in general should work in order to enable meaningful use. A wide range of experts from several backgrounds have developed and prepared guidelines to support exactly those processes related to the use of SMCS technologies. The analysed guidelines address many of the challenges listed in Section 4.2 and offer practical solutions (or at least general advice).

For this reason, a selection of existing guidelines and handbooks have been analysed. Many of these recommendations have risen from the experience gathered by DMOs before, during or after a disaster. For the current publication, a total set of 28 documents were identified through literature research. The overview can be found in the Annex II (Table II). The list was set up in collaboration with WP3 and will be extended in the coming years during the project if necessary. WP3 also added regularity frameworks (e.g. European rules regarding cybersecurity or data protection).

The identified guidelines are described with the following aspects:

- Name, language, year
- Country of origin, publishing organisation/author
- Target group
- Description
- Source
- DCT-aspects (technical recommendations, concrete technologies, etc.)

The target groups for the majority of the documents are the DMOs and their communication or social media managers. Only very few guidelines (in most cases these are crowdsourcing-specific, e.g. (Sukhwani et al., 2019) or (Associated Programme on Flood Management, 2017), and the FP7-project EmerGent) provide information for citizens in a disaster situation.

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All analysed recommendations have in common that dealing with social media must be implemented in the overall strategy of the organisation. For effective use in disaster situations, the framework conditions and usage concepts must be established in advance of a disaster. The guidance documents mainly refer to processes and will therefore be considered and analysed deeper within D3.1 about the DMP.

For this deliverable, the selected guidelines were analysed specifically concerning recommendations towards **technical requirements** (or at least technical advices) which might deliver further and helpful insights for the understanding of DCTs. Some documents even refer to concrete technologies, which were then added to our list of DCTs.

Approaches towards technical requirements were found in ten[25] of 28 documents which differ greatly in scope and level of detail:

1. EmerGent - Guidelines to increase the benefit of social media in emergencies (EmerGent, 2017b):
   Here some generic aspects about ICTs can be found: functionality, ways of communication, roles and instructions how to collaborate;
2. Operationalizing crowdsourcing through mobile applications for disaster management in India (Sukhwani et al., 2019):
   An overview about 33 mobile apps used in India for crowdsourcing in crisis situations;
3. Crisis Mapping and Crowdsourcing in Flood Management (Associated Programme on Flood Management, 2017):
   This document describes the different type of sources for crowdsourcing and the use of technologies based on well-known practise tools;
4. Social media use in disaster risk management (Wukich, 2015):
   Here are strategies and tactics for disaster managers using DCTs discussed, divided into information dissemination, monitoring and action planning;
5. Social Media in Emergencies—UNICEF Guidelines for Communication and Public Advocacy (Social & Civic Media Section of UNICEF, 2012):
   A detailed guide on how to work with Facebook, Twitter, etc. and also with the DCT Hootsuite. An overview can be found in Figure VI in the Annex III;
6. Social Media Guidelines and Best Practices (Centers for Disease Control and Prevention, 2012):
   This collection includes technical explanations about social media technologies;
7. Lessons for Crisis Communication on Social Media: A Systematic Review of What Research Tells the Practice (Eriksson, 2018)

[25] Whereby the order of the list below does not cover any prioritisation.

An analysis of several advices (lessons learned) from researchers to practitioners when working with DCTs;

8. Innovative Uses of Social Media in Emergency Management (U.S. Department of Homeland Security, 2013):
   This document contains some examples about what a DCT should theoretically do to support the working processes;
9. ITU Guidelines for national emergency telecommunication plan (International Telecommunication Union [ITU], 2020):
   In this document the use, options, and technical properties of ICTs are explained;
10. Verification Handbook: An Ultimate Guideline on Digital Age Sourcing for Emergency Coverage (The European Journalism Centre, 2013):
    This detailed book contains concrete approaches and technical examples on how to verify user-generated content, images, and videos.

These ten sources offer in a first step a fruitful and understandable introduction into the challenges and the needs of the DMOs concerning the embedding of SMCS within their operating procedures. Thereby it was possible to define first required properties of DCTs which led to the draft DCT-schema. Additionally, several sources offered examples of DCTs which were added to the DCT-list and evaluated according to the methodological approach presented in Section 2.3. In general, it becomes clear that there is no standard guideline, even not one on a content-level what leads to the gap that there should be created more awareness among the published guidelines and their recipients to learn from each other.

4.4 Analysis of existing IT-Classifications

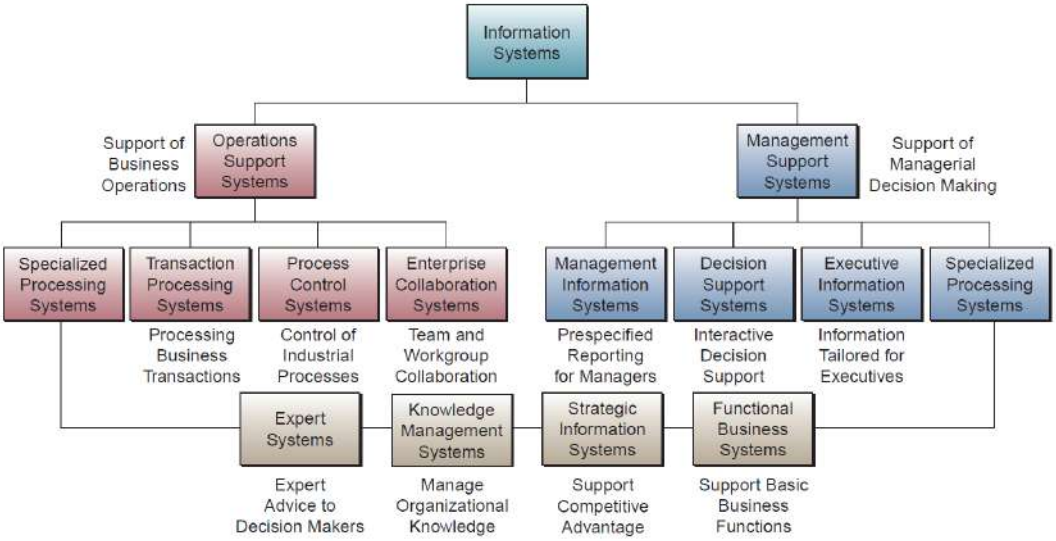
This section addresses the classification of IT-systems. As the term DCT is not standardised and it has been defined within LINKS, there is no specific scientific work on the 'classification of DCTs'. Therefore, related domains were analysed and elaborated. The analysis begins on an abstract level by analysing how IT-systems in general can be categorised followed by an approach that analyses the classification of IT-systems for DMP. Subsequently research is presented that has already examined and classified existing SMCS analysis tools. The analysed approaches are used as the basis for the development of the draft DCT-schema in Section 6.

4.4.1 For IT-Systems in General

O'Brien summarises the variety and boundaries of common information systems from the business and economic sector (O'Brien James A. & Marakas, 2007). As seen in Figure 21, information systems are differentiated between 'operations support systems' and 'management

support systems'. First ones are intended to support organisations and companies at the operational level in the fulfilment of tasks and processes. The purpose of 'management support systems' is to make managerial decisions easier with the help of gathered high level data. Considering the definition and intended tasks of DCTs (cf. Section 3.1), it is obvious that a clear assignment to one of these systems or their subsystems is not possible as they are special systems with mixed tasks from both areas. According to the classification of O'Brien, DCTs might be divided into either 'expert systems', 'knowledge management systems' or 'strategic information systems', depending on the characteristics and focus of the DCT.

Figure 21: General Overview of Information Technology Systems



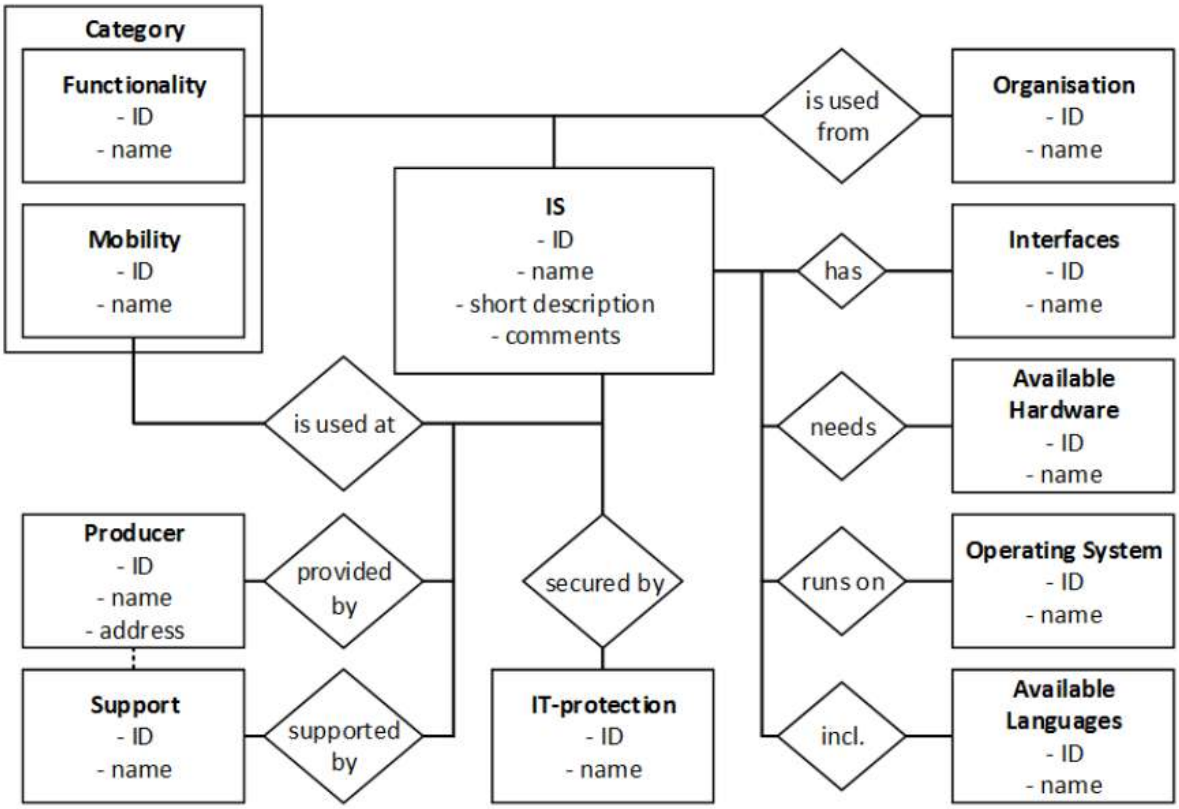
Source: (O'Brien James A. & Marakas, 2007)

The FP7-EU-project SecInCoRe[26] (*Secure Dynamic Cloud for Information, Communication and Resource Interoperability based on pan European Disaster Inventory*) provides a further approach to describe information systems (Schäfer et al., 2017). The overall objective of the project was the establishment of a pan-European inventory including a collection of datasets, processes, information systems and business models used by authorities in past crisis situations. A data model for the classification of information systems was developed in the project. The first version of the data model was created after a market analysis based on the definition of information systems according to Krcmar (Krcmar, 2005). The first version served as a tool for the classification of information systems during an extensive literature and web research. Based on an ongoing gathering of further available information systems the database was continuously expanded and

[26] website of FP7-project SecInCoRe: http://www.secincore.eu/

the categories have been adjusted. The final data scheme can be seen in the following Figure 22. The focus of the classification is not SMCS, but the technical properties of the analysis system offer valuable input for the definition of the draft DCT-schema.

Figure 22: Database Scheme for Information Systems



Source: (Schäfer et al., 2017)

4.4.2 For IT-Systems in DMP

Rammert examines the classification of IT-systems in the field of DMP and develops a method to describe 'management support systems' (Rammert, 2020). IT-systems in this domain are often divided into the following categories based on the practice-oriented processes in which they are used:

- Administration systems (in German[27]: Verwaltungssysteme)
- Management support systems (in German: Führungsunterstützungssysteme)
- Command & control systems (in German: Leitstellensysteme)

[27] As the original source is German and the used terms are standardised, we added the original translation to enable an easy traceability.

- Alert systems (in German: Alarmierungssysteme)
- Communication systems (in German: Kommunikationssysteme)
- Exercise support systems (in German: Übungsunterstützungssysteme)

DCTs can be most likely assigned to 'management support systems' and 'communication systems' since the main objective is to aggregate a big amount of data in order to derive strategic actions and support the associated decision-making (cf. Section 3.1). In case of 'management support systems' Rammert's classification is shown in Figure 23:

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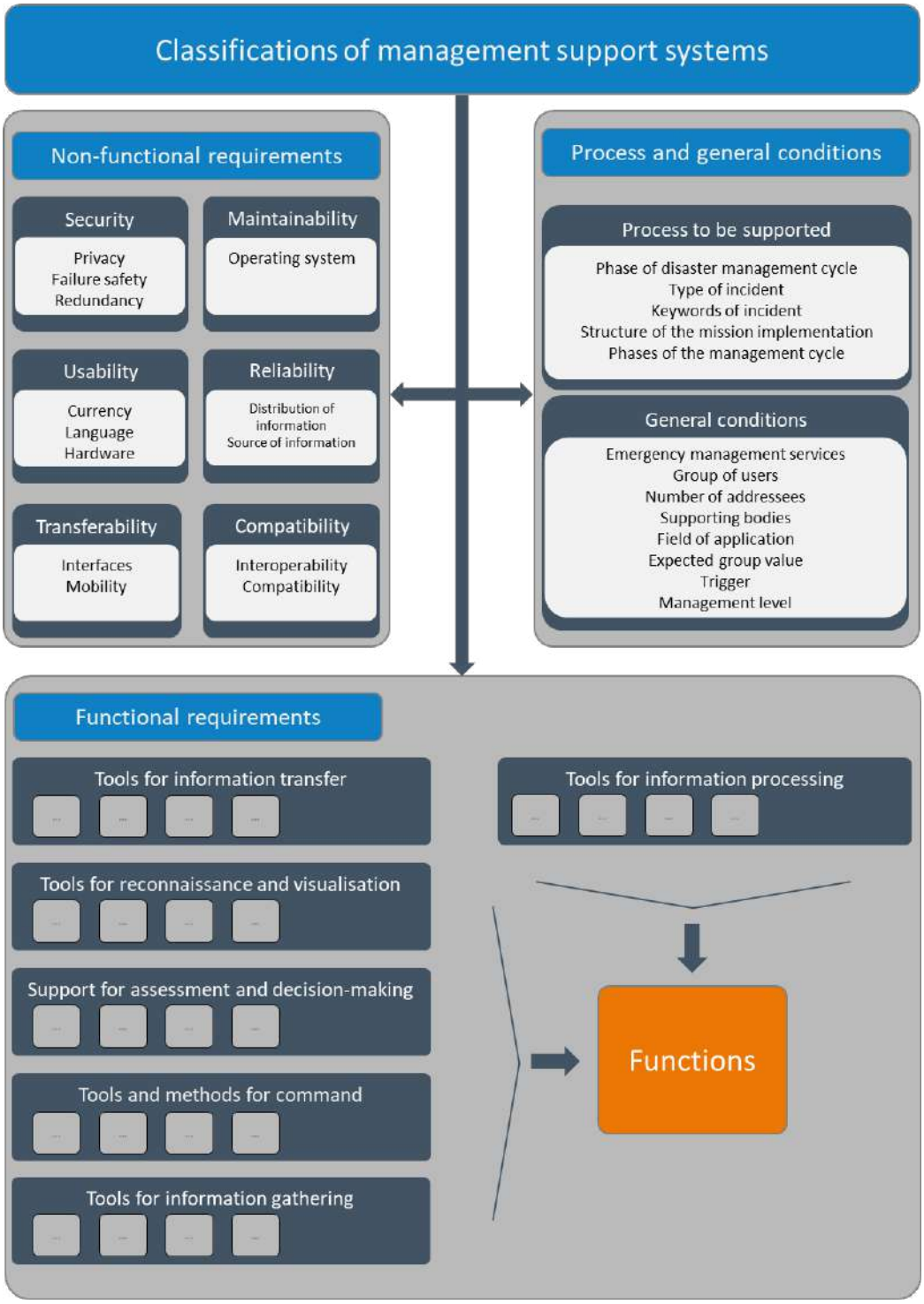
Figure 23: Classification Categories for Management Support Systems in the Disaster Management Environment



Source: Authors' adaption of (Rammert, 2020)

Rammert assesses IT-systems in a practice-oriented way. The concept can be called bottom-up (while O'Brien's classification is top-down). It was analysed which management procedures, actors and processes are present in disaster management and how these can be systematically described and classified. The categories shown cover a large part of the properties and possible uses of management systems but cannot be regarded as complete. For the development of the draft DCT-schema, some aspects from Rammert can be taken into account: First, a system is considered from four sides: the functional, non-functional requirements, the process, and the general conditions (whereby the last two are summarised in the Figure 23 for a better understanding). **The non-functional requirements** are based on the ISO/ICE 25010-standard which evaluate a software product quality with several characteristics (ISO/IEC, 2011). The criteria security, maintainability, transferability, and compatibility describe the technical and logical implementation of the tool. To be competitive, a minimum standard is required in these categories by the tool and should be verified, as it could already be an exclusion criterion for many organisations. In contrast to the criteria already mentioned, usability and reliability are to be assessed more subjectively and contain some very important aspects for the upcoming work. The currency and the source of information are indicators for evaluating the information obtained and will require attention. Another allocation criterion is the consideration of the **process** the system is used for. This is done on several levels: the most abstract level is the disaster management cycle (cf. Section 3.2); the most concrete level is the incident on site. The focus in the area of **general conditions** is made up of the user group and external influences. In this way, it is determined in which DMO the IT-system is used. It is also specified for how many user objects of the system class apply and who is specified within the organisations of a user group. The fourth category contains the **functional requirements** that the system offers for different purposes. A division into functions allows the user to select his system for certain tasks.

In summary, several aspects from Rammert's work can be adopted for the design and structure of the draft DCT-schema in Section 6. The separation into functional and non-functional functions as well as the positioning of the tool in the overall process are important and relevant features for the further categorisation.

4.4.3 For SMCS Analysis Technologies

As a next step the literature review was expanded on existing classification methods designed for SMCS analysis tools. Stavrakantonakis et al. developed a framework model for evaluating SMCS tools (Stavrakantonakis et al., 2012). The motivation was to provide a guide for enterprises to choose the right tool out of a rapidly increasing market. The evaluation criteria are divided into three perspectives: 1) the implemented concepts of the SMCS analysis tools, 2) the technologies

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and 3) the user interface. The applied criteria to evaluate ten tools that existed in the year 2012 can be found in Table 4 (the evaluation results can be found in in the Annex III in Table III).

Table 4: Evaluation Criteria for SMCS Analysis Tools

Concepts	Technology	User Interface
Analysis	Listening Grid Adjustment	Dashboard
Engagement	Near real-time processing	Export Results
Workflow Management	API	Visualisation
Influence / Social Profiles	Sentiment Analysis	
	Historical Data	

Source: (Stavrakantonakis et al., 2012)

Pohl takes a similar approach but analysing SMCS analysis tools primarily from the perspective of crisis management (Pohl, 2013). Studies and their analysis frameworks are summarised and based on the presented papers a categorisation was developed. The criteria are shown in Table 5 and the results can be found in the Annex III in Table IV.

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Table 5: Evaluation Criteria for SMCS Analysis Tools

Evaluation Criteria	Given Example
Multi-platform	Twitter, YouTube, Facebook
Crowdsourcing	
Org. Management (Routing etc.)	
Sentiment	
Visual Content	maps, timelines, tag clouds, etc.
Filtering	keywords, facets, location, time, etc.
Event/topic Detection	
Additional Techniques	classification, clustering, rules, named entity recognition (NER), etc.

Source: (Pohl, 2013)

A more extensive research and evaluation of SMCS analysis tools carried out in 2015 by the Trilateral Research & Consulting on behalf of the GDPC (Trilateral Research & Consulting, 2015). The purpose of the comparative review of SMCS analysis tools is to support disaster managers of humanitarian organisations in their selection of potential technologies for the phase before an upcoming disaster (disaster preparedness and disaster risk reduction). The more on ease of use-oriented approach of the examinations includes aspects such as costs and practical suitability. An overview of the criteria used to analyse 31 systems is given in Table 6.

Table 6: Evaluation Criteria for SMCS Analysis Tools

Evaluation Criteria	Additional Information
Key functions	range of functions, filtering, sentiment toning, visualisation etc.
Social media	Twitter, Facebook, YouTube etc.
Language of the tool's interface	
Language of the data that the tool can analyse	
Accessibility	free, limited use, demo, trial
Usability	scale of 1-5, 1=easy, 5=difficult
Instructions available on website	information and explanation
Online help (live) available	information and explanation
Website	

Source: (Trilateral Research & Consulting, 2015)

In another comparison, Kaufhold et al. investigated 45 SMCS analysis tools (Kaufhold et al., 2019). The research work is based on (Kaufhold et al., 2017) and has been updated and expanded by new tools and categories. It is important to emphasize that it is not only about fully developed business software, but also academic frameworks from research projects. A result of the comparative analysis and at the same time the reason for the research is the ascertained lack of capacity for handling large amounts of data and almost no existing approaches for assessing the quality of information. Kaufhold et al. present appropriate methods to overcome the mentioned challenges. Their categorisation distinguishes between intelligence, management, and special systems. Intelligence systems focus mainly on algorithmic-based analysis tasks to offer business or crisis-specific key figures to the user. Management systems also include organisational interaction and communication in cross media. The special systems are mostly designed for a specific purpose and contain special functions like crowdsourcing tools. The division of applications into the three systems is not always clear and can also change over time, as many systems are further developed with economic motivations (Kaufhold et al., 2019). The evaluation criteria are shown in Table 7 and the analysis results of the tools can be found in Table V in the Annex III.

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Table 7: Evaluation Criteria for SMCS Analysis Tools

Evaluation Criteria	Additional Information / Given Example
Crossmedia	addressing different channels for different purposes
Communication	live chats, direct messages etc.
Monitoring	tracking of content
Alert	detection of certain events or exceeding of threshold values
Event Detection	
Collaboration	planning and managing different tasks within and across organisations
Influencer	particularly motivated users
Sentiment	public mood
Topic	recognition of thematic structures
Quality	assessment framework/methods
Map	visualisation functions
Diagrams	
Filter	implementation of rules

Source: (Kaufhold et al., 2017) & (Kaufhold et al., 2019)

By comparing the presented approaches, it becomes clear that in the functional area certain key functions are represented in each source:

- Visualisation functions (diagrams, maps, dashboard)
- Sentiment analysis (public mood)
- Filtering
- Alerts / event detection
- Monitoring and aggregation of data
- Ways to collaborate

Furthermore Kaufhold et al. and Stavrakantonakis et al. also mention the detection of users with a high motivation and influence. Kaufhold and Pohl mainly consider the functional aspects, while the research work by Trilateral Research & Consulting and Stavrakantonakis et al. also include technical properties. These include the possibility of 'near real time processing', an Application Programming Interface (API) offered by the tool, the language of the tool's interface and the language of content that can be analysed.

The approach from Kaufhold et. al. is the only one that considers an assessment of the quality of information. As can be seen in their research paper, none of the tools they have analysed offers sufficient opportunities to make statements about the quality of information (Kaufhold et al., 2019).

The evaluation of SMCS analysis tools from Trilateral Research & Consulting is intended as a direct aid for practical implementation. This is the reason why they are the only using the criteria available assistance (e.g. help on website available) and usability (scale from one to five).

Overall, the described classification-systems for social media analysis tools provide a well-founded basis for an initial classification of the draft DCT-schema.

4.5 Consortium Survey

Under the leadership of WP3, a qualitative survey on the SMCS landscape in selected countries was conducted in the LINKS consortium in September 2020. The participants of the survey were the partners responsible for the five cases in the LINKS project, which are:

- Italy: Earthquake; participating partner: UNIFI and PDT
- The Netherlands: Industrial, participating partner: VU
- Germany: Drought and Terrorism, participating partner: SIC and DHPol
- Denmark: Flooding, participating partner: UCC and UCPH

The questionnaire was developed within WP2-4 and is thematically composed of questions about the current landscape of SMCS in the institutional landscape, already known technologies and the consideration of vulnerable groups.

The intention of the survey was to gather input from the consortium for the state-of-the-art analysis of the respective knowledge base. It should be ensured that interesting aspects mentioned by the consortium are taken into account and that the already existing competence is used for the creation of a knowledge base.

The whole survey can be found in Annex IV.

In the context of DCTs three questions were asked. These are presented below with a summary of the response.

- Do you know frameworks/guidelines/other documents/tools which specifically aim to promote/support/facilitate the use of SMCS?
    - Social media is mainly used by the police to search for missing persons, but less to deal with crises.
    - As a pioneer, the Red Cross has developed initiatives or platforms (e.g. ready2help) in several countries to encourage volunteers to help.
    - Some guidelines are known, e.g. from European projects, but in general there is a need for comprehensive guidance.
- Are you aware of any needs or challenges concerning the use of SMCS tools/technologies? (open question)
    - Five big challenges were mentioned:
        - Dealing with data protection (e.g. in the process of data collection).
        - Validation of information and dealing with rumours and false information.
        - Large variety of social media platforms used, which can lead to the problem of not being able to reach all relevant citizens.
        - Accounts and channels of DMOs do not get much attention.
        - Lack of replicable examples/good practices for establishing effective use of SMCS initiatives.
- Are you aware of methodologies to handle/identify/manage trustworthiness of data coming from SMCS?
    - No specific tools were mentioned that deal with the validation of SMCS data.

The responses within the consortium indicate at different points the need for a DCT knowledge base. Especially the challenges and problems mentioned (for the sake of completeness, it should be noted that the challenges are also covered in Section 4.2), make it clear that many DMOs lack a point of contact for advice on SMCS analyses in crisis management and miss good practice as examples. Furthermore, the market is unmanageable due to the mass of tools and can easily become overwhelming when it comes to identify a solution. The following sections present the results of the conducted business market analysis and the derived structure of the DCT-schema.

Key takeaways from Section 4

Literature concerning the following topics was analysed and presented.

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- Good practices of DCTs: The preparation to use SMCS and three strategies dependent on the level of engagement are presented:
    - The preparation to use SM:
        - Legal implications as well as human and financial resources need to be considered.
        - A social media strategy needs to be implemented into the organisation's strategy.
    - Information dissemination & data monitoring of social media in DMP:
        - Crisis-related information should be provided on the social media platforms.
    - Data monitoring & analysis: Introducing DCTs in DMP:
        - Social media data monitoring and analysis can be done to get a better situational awareness in particular.
    - Conversations & coordinated actions by crowdsourcing in DMP:
        - The crowd is very diverse and can achieve goals that DMOs would not be able to do on their own
- Negative impacts, challenges, and solution approaches when working with SMSC are presented:
    - The usual negative consequences of social media (e.g. intentional fake news, hate speech, rumours…) also affecting the work of DMOs.
    - A huge challenge is to overcome the negative impacts and especially, when monitoring social media, it is difficult to make sense out of the vast amount of data. Therefore, analysis tools can be used (e.g. filtering algorithms, authentication).
- Existing DCT related guidelines:
    - In addition to good practice instructions, they also contain technical input for the DCT analysis.
- Existing classifications of IT-systems and their importance for DCTs:
    - IT-systems in general:

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        - Based on O'Brien, DCTs might be divided into either 'expert systems', 'knowledge management systems' or 'strategic information systems', depending on the characteristics and focus of the DCT.
    - IT-systems in DMP:
        - A classification for DCTs could contain functional and non-functional requirements and process and general conditions.
    - SMCS analysis tools:
        - There already exists several approaches to classify SMCS analysis tools, which focus on different aspects, but largely agree in the key functions (visualisation, sentiment analysis, filtering, event detection, monitoring and aggregation of data, ways to collaborate).

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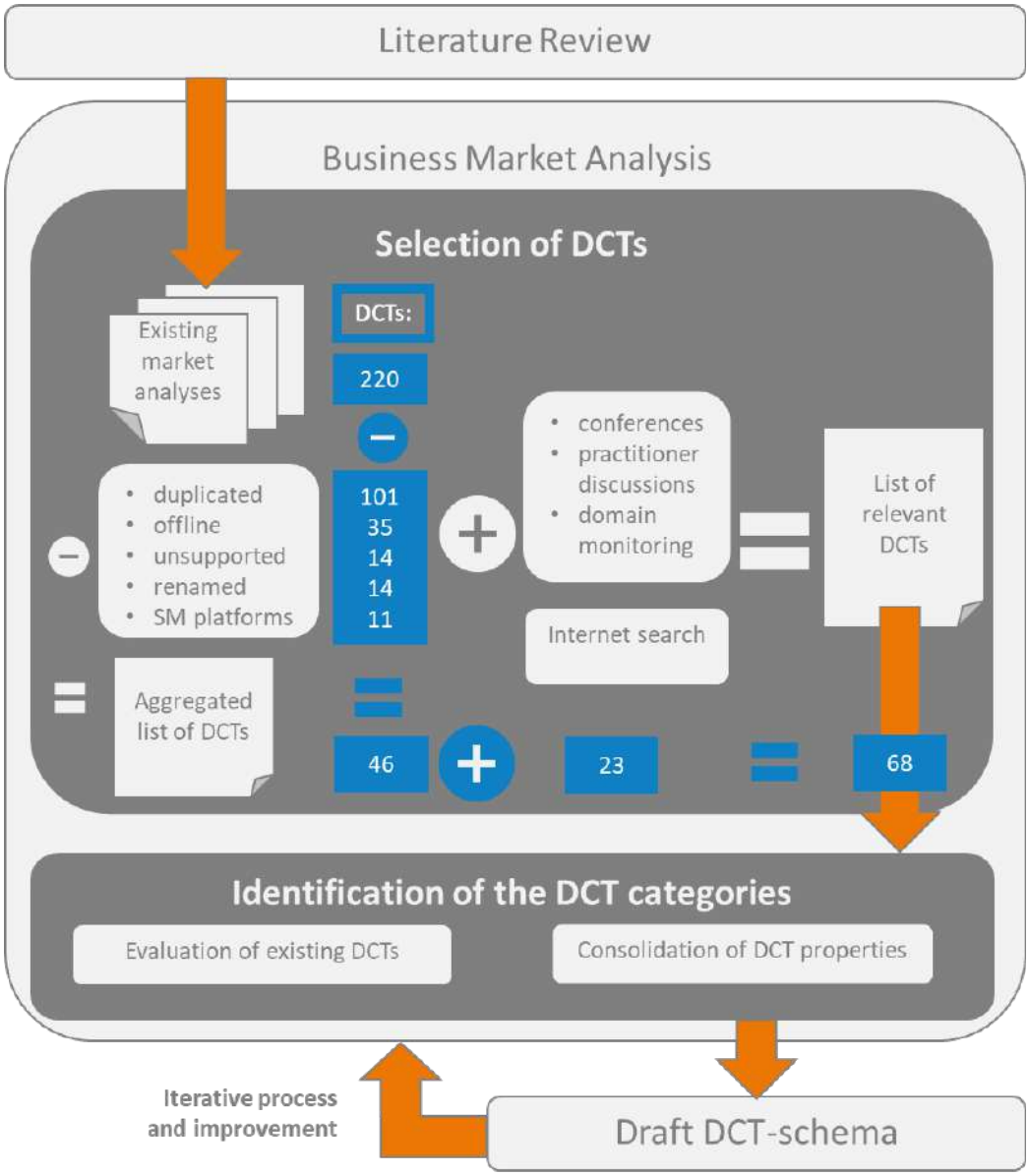
5. STATE-OF-THE-ART FROM BUSINESS MARKET ANALYSIS: DCT AND THEIR ROLE IN SMCS

This section provides the results of the business market analysis. The approach is previously explained in Section 2. In Figure 24 the quantities of DCTs for the different steps of the business market analysis are visualised in blue.

Figure 24: Business Market Analysis - Results



Source: Authors contribution

The six existing business market analyses originating from the literature review resulted in a list of 220 mentioned DCTs. Of those, the duplicated (101), offline (35), unsupported (14) and renamed (14) DCTs as well as the social media platforms themselves (11) were removed. An aggregated list of 46 DCTs remained. To this list 23 additional DCTs were added - identified through internet search as well as the input from conferences, practitioner discussions and general domain monitoring. Therefore, the current list of relevant DCTs contains 68 entries.

The current listed DCTs arised from 27 different countries. The USA (34) outweighs the United Kingdom (8) and Germany (6). This knowledge allows the assumption that it is worth digging deeper into e.g. the USA to evaluate their experiences with the technologies, but also to look for new(er) developments.

A further step besides the identification of the list of relevant DCTs is the evaluation of existing DCTs and the consolidation of DCT properties as described in Section 2. The preliminary results of that step are visualised exemplary in Table 9 and Table 10 (find the legend in Table 8). Besides the pure list of DCTs, the properties and assessment of these properties concerning a few example DCTs are shown. The current list of DCTs is presented in Table 11, the entire work status with the findings of the properties can be found in the Annex V.[28]

The generated excel file is stored on the LINKS collaborating platform 'SharePoint' and will be a living document within the consortium and over the runtime of LINKS. The number of identified DCTs will grow (at least assumed) and the information within the categories will be extended, refined, and updated. More details about the categories are given in the detailed explanation of the draft DCT-schema in Section 6.

Table 8: Legend for the Table of the DCT-list

Shortcut	Name	Description
y	yes	agreement to the request
n	no	disagreement to the request
tbd	to be done	will be done later
null	no information found	
*	comment	notification that a comment is set at the end of an entry

Source: Authors contribution

[28] Status: November 2020

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Table 9: Extract of the DCT-list with Consolidated Properties (1/2)

Name	General information							
	Website / URL	source country	description	operator / head of content	public supporter	target	users (authorities / public instances)	users (private coorporations)
AIDR	http://aidr.qcri.org/	Qatar		Crisis Computing team at QCRI	MicroMappers, Qatar Computing Research Institute, StandBy Task Force, United Nations Office for the Coordination of Humanitarian Affairs	Coordination of Humanitarian help by detecting disaster events using gathered information meta data from social media networks e.g. Twitter.	Unicef	
Scatterblogs	https://www.scatterblogs.com/	Germany		dpa, AFP GmbH	EU, Bundesministerium für Wirtschaft und Energie , eXist, Europäischer Sozialfonds für Deutschland (ESF)	Analyse and detect events of disaster by using gathered information and meta data from social networks i.e. Twitter.	police department Innsbruck	dpa (deutsche Presseagentur), afp
Ubermetrics Technologies	https://www.ubermetrics-technologies.com/de/	Germany		Ubermetrics Technologies GmbH (Berlin)		Cloud based real-time analysis of Social Media Data from various media sources and visualizing in dashboards and filtered graphics. Identification of opinion leaders in social groups and media segments of high communication rate.		Microsoft, TÜV Rheinland, Activision Blizzard, Randstad
awario	https://awario.com/	Belarus	Social Media Monitoring	Techfusion LTD,Republic of Cyprus	Null	Social media monitoring, analytics and answering		

Source: Authors contribution

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Table 10: Extract of the DCT-list with Consolidated Properties (2/2)

Name	Phase of DMC				Communi-cation Matrix				Range of functions																General technical properties									General properties									Data sources															Concrete use of social media (examples)					
	Prevention/mitigation	Preparedness	Response	Recovery	A2A - Authorities to Authorities	A2C - Authorities to Citizens	C2C - Citizens and Citizens	C2A - Citizens to Authorities	monitoring	real-time analytics	event detection	notification	location analysis	aggregation	clustering	general citizens warning	mapping	video and image source analysis	filter	diagrams	visual analysis	sentiment	quality	boolean search query	language selection	collaboration	CAP Format	multilanguage data processing	API	open source	standalone	authors meta data	location meta data	already used in disaster management	developed from research	commercial	currently active	demoversion available	Freeware	input information	output information	release date	blogs	commentary functions	websites	forums	microblogs	news pages	press releases	social media sites	video on demand / video websites	crisis warning softwares / apps	other analysis softwares	other monitoring softwares	instant messaging / chatting softwares	Twitter	Facebook	Instagram	Youtube	Pinterest	LinkedIn
AIDR			y	y			y		y	y			y	y	y	n	n							n					y	y	y		y	y	y		n	y	y			2015	n	n	n	n	y	n	n	n	n	n	n	n	n	y	n	n	n	n	n
Scatterblogs			y	y				y	y	y			y	y	y	y									GER, EN		y				y			y		y	y	y									y												y	y				
Ubermetrics Technologies			y	y				y	y	y			y	y	y										y	y		y	y					y		y	y	n	n	y	n	2020	y	y	y	y	y	y	y	y	y	n	y	y	n	y	y	y	y		
awario			y	y				y	y	y			y	y	y										y	y		y	y					y		y	y	n	n	y	y	nui	y	y	y	y	y	y	y	y	y	n	y	y	n	y	y	y	y		

Source: Authors contribution

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Table 11: Overview of Selected DCTs

Name	Website / URL	Source country
AIDR	http://aidr.qcri.org/	Qatar
awario	https://awario.com/	USA
Brandwatch Analytics	https://www.brandwatch.com/	UK
Buffer	https://buffer.com/	USA
Cision	https://www.cision.co.uk/	UK
ClaraBridge	https://www.clarabridge.com/	USA
Coosto	https://www.coosto.com/en/	Spain, Netherlands
Cogia	https://www.cogia.de/	Germany
CrowdControlHQ	https://www.crowdcontrolhq.com/sectors/emergency-services/	UK
Crisis Tracker	https://crisistracker.org/	USA
Cyfe	https://www.cyfe.com/	USA
DiscoverText	https://discovertext.com/	USA
Echosec	https://www.echosec.net/	Canada
ESA (Emergency Situation Awareness)	https://esa.csiro.au/aus/about-public.html	Australia
Esri	https://www.esri.de/de-de/home	USA, Germany
Evolve24	https://evolve24.com/	USA
Facebook Business	https://www.facebook.com/business/	USA
Facelift	https://www.facelift-bbt.com/de	Germany
Fanbooster	https://bytraject.com/software/social/	Qatar
Followerwonk	https://followerwonk.com/	USA
GeoFeedia	https://geofeedia.com/	USA
Gephi	https://gephi.org/	France
Google Analytics	https://marketingplatform.google.com/about/analytics/	USA
Hashtagify	https://hashtagify.me/	UK
Hashtracking	https://www.hashtracking.com/	USA
HootSuite	https://hootsuite.com/	Canada, Europe

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Hubspot	https://www.hubspot.com/	USA, Europe, Australia, Japan
IBM Intelligent Operations Center for Emergency Management	https://www.ibm.com/us-en/marketplace/	USA
JIXEL (Alerter and Aggregator)	https://www.jixel.eu/web/en/	Italy, England
Keyhole	https://keyhole.co/about-us/	Canada
Khoros	https://khoros.com/	USA, Europe
Lexalytics	https://www.lexalytics.com/	USA
Leximancer	https://info.leximancer.com/	Australia
Statistical Cybermetrics	http://lexiurl.wlv.ac.uk/	UK
Meltwater	https://www.meltwater.com/de	USA
Mention	https://mention.com/en/crisis-management/	France
Mitre	https://www.mitre.org/	USA
Mozdeh	http://mozdeh.wlv.ac.uk/	UK
ORA	http://www.casos.cs.cmu.edu/index.php	USA
Orlo (former SocialSignIn)	https://orlo.tech/	UK
publicSonar	https://publicsonar.com/	Netherlands
Pulsar	https://www.pulsarplatform.com/	UK
Quintly	https://www.quintly.com/	Germany, USA
Radarly (Linkfluence)	https://www.linkfluence.com/de/	France, Germany
Sahana	https://sahanafoundation.org/	USA
Salesforce	https://www.salesforce.com/	USA
Scatterblogs	https://www.scatterblogs.com/	Germany
Signal	http://www.getsignal.info	New Zealand
Simplify360	https://simplify360.com/	USA, India
Social Hub	https://socialhub.io/	Germany
SocialGist	https://socialgist.com/	USA
SocialMention	http://socialmention.com	nui
SocialSign.in	https://socialsignin.com/	USA, Belgium
Sparkcentral	https://sparkcentral.com/	USA
Sproutsocial	https://sproutsocial.com/	Austria
swat.io	https://swat.io/de/	USA

Synthesio	https://www.synthesio.com/	USA
Sysomos	https://sysomos.com/	Luxembourg
Talkwalker	https://www.talkwalker.com/	USA
Tint	https://www.tintup.com/	USA
TweetDeck	https://tweetdeck.twitter.com/	
Tweetreach	https://tweetreach.com/	USA
TweetTracker	http://tweettracker.fulton.asu.edu/	USA
Twitter	https://analytics.twitter.com/about	Germany
Ubermetrics Technologies	https://www.ubermetrics-technologies.com/de/	USA
Ushaidi	https://www.ushahidi.com/	Germany
Vico	https://vico-research.com/social-data-analytics/	USA
Viralwoot	https://viralwoot.com/	Austria
WebLyzard	https://www.weblyzard.com/	Belarus

Source: Authors contribution

Key takeaways for Section 5

- A business market analysis of DCTs was conducted resulting in a list of 68 DCTs, mainly originating in the USA or Europe;
- Common properties of the DCTs are consolidated in the areas of 'general information', 'Phase of the DMC', 'Crisis Communication Matrix', 'Range of functions', 'General technical properties', 'General properties', 'Data sources' and 'Concrete use of social media';
- The results migrate into the draft DCT-schema in Section 6.

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6. CONCEPTUALISING: DRAFT DCT-SCHEMA

The following sections describe the first-level categories for classifying DCTs (Section 6.1) and the summary of the individual categories is shown afterwards (Section 6.2). The developed overall draft DCT-schema is presented at the end of this section. The DCT-schema is evolved of the business market analysis with the property-consolidation of DCTs in combination with the literature review and the classification of DCTs based on it.

The DCT-schema is a living collection of DCTs, which will be kept up-to-date over the duration of the project (with the support of the consortium) and beyond.

6.1 First-Level Categories

The developed categorisation attempts to describe a DCT as precisely and differentiated as possible for a) comparison with each other and b) quick access to all relevant information. The categorisation in this section represent the draft DCT-schema as a solution to structure and collect identified DCTs but also to harvest relevant information about the DCTs.

The draft DCT-schema is divided into **categories** in order to provide some basic classifications. With the help of the existing classifications of IT-systems and systems used in the field of crisis management (cf. Section 4.4.2), the draft DCT-schema starts with '**first-level categories**'. These first-level categories contain sub-categories for further classification and description of DCTs (cf. in the following sections). The identified categories depict the current research status of this Task 4.1 and can be adjusted in the future if necessary. The decision to classify DCTs into these categories is based on the state-of-the-art as well as on empirical findings during the market analysis of existing DCTs.

Firstly, the category '**history**', which creates a change log of edits on a DCT's entry in the draft DCT-schema. The category '**general information**' is used to describe essential basic characteristics of a DCT. The '**disaster management cycle'** and the '**crisis communication matrix'** (cf. Section 3.2 & 3.3) are important categorisations within the disaster management. The division of the DCTs into the respective phases and directions of communication creates comparability and applicability to other concepts and are therefore included.

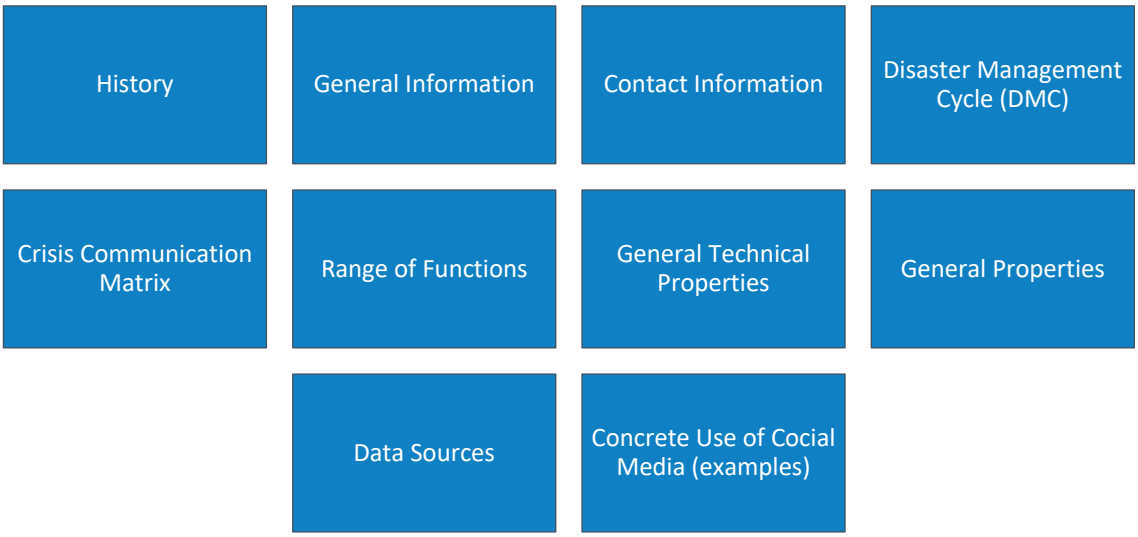
From a technical consideration of DCTs, these can be divided into '**general technical properties'** and their '**range of functions'**. The selection of the functions was made through the four already published examinations (see Table 4, Table 5, Table 6, and Table 7) of DCTs presented in Section 4.4.3. Certain functions such as visualisation or filtering are mentioned in all sources and are taken into account accordingly. The criteria of the general technical properties are a subset of the data

base scheme from the project SecInCoRe (cf. Figure 22 in Section 4.4.1) and the technology aspects from the research work from Stavrakantonakis et al. (Stavrakantonakis et al., 2012).

The data sources used by the DCT, which serve as input for the specific DCT, are categorically summarised in '**data sources**'. For a more detailed market overview, the social media platforms with the largest market share or the highest representation during the market analysis are specifically listed under the item '**concrete use of social media**'.

Within the following subsection all first-level categories, which are shown in Figure 25, are described with their sub-categories and explained in more detail.

Figure 25: First-level Categories of the Draft DCT-schema



Source: Authors contribution

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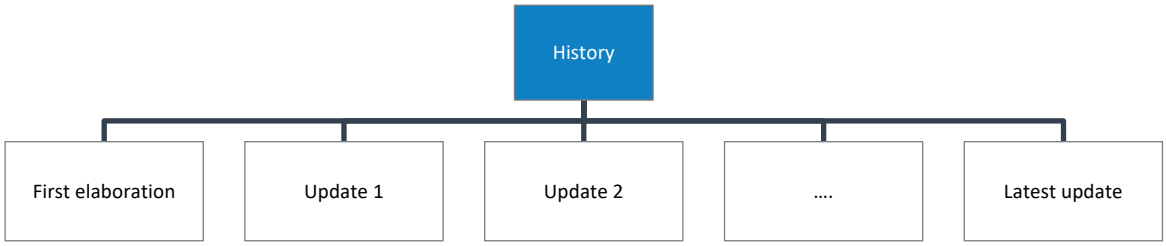
6.1.1 History

The category 'history' (Figure 26) covers change logs, which should keep all changes about a DCT in a timeline. This category is more organisational and therefore listed separately. In the current version of the draft DCT-schema the 'history' is not implemented yet as it emerged from the iterative development process as it needs to be transparent to evaluate the currency of an entry.

Figure 26: First-level Category 'History'

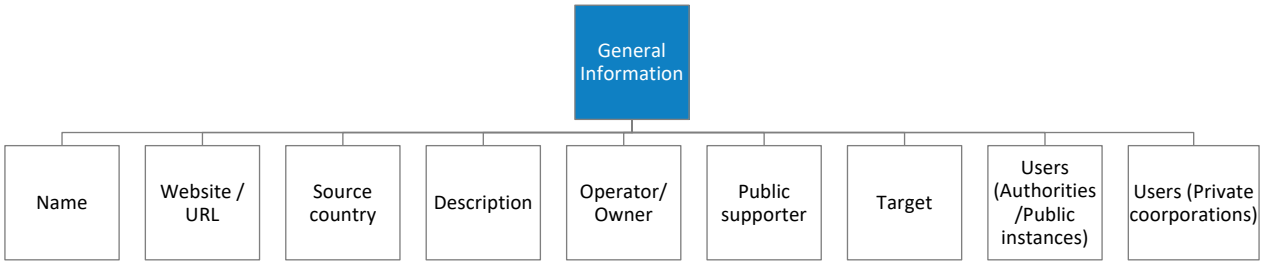


Source: Authors contribution

6.1.2 General Information

The 'general information' (Figure 27) contains the essential key data of a DCT and gives an overview of the application area and its users. General data are presented which do not yet require a more detailed subdivision. The contact information can be extended as required. The subcategories of 'general information' are explained in Table 12.

Figure 27: First-level Category 'General Information'



Source: Authors contribution

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Table 12: Sublevel Categories in First-level Category 'General Information'

Subcategory of 'General Information'	Description of the Subcategory
Name	official name/title
Website/URL	link to the website
Source country	seat of the company/developer
Description	short explanation
Operator/Owner	responsible operator/owner of DCT
Public supporter	public institutions who are supporting the development (in case they exist)
Target	main target of the DCT (in brief)
Users (Authorities / Public instances)	list of users and costumers from public authorities and institutions, who are using the DCT
Users (Private coorporations)	list of users and costumers, who are using the DCT (outside authorities)

Source: Authors contribution

6.1.3 Phase of Disaster Management Cycle

The DMC covers up all activities before, during or after a disaster in four phases: prevention, preparedness, response, and recovery. More detailed information are explained in Section 3.2.

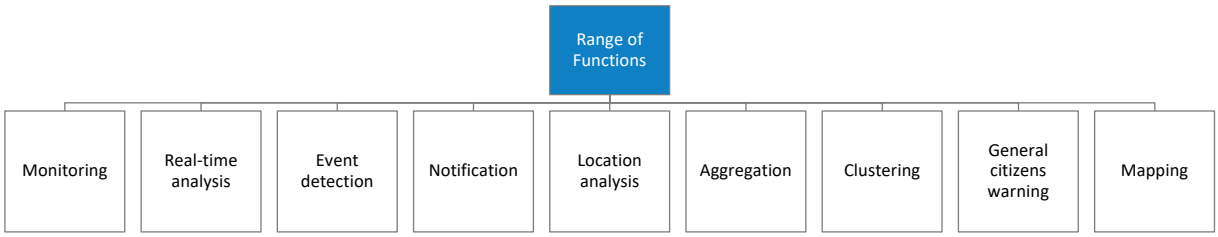
6.1.4 Crisis Communication Matrix Direction

The crisis communication matrix connects authorities and the general population (citizens) in the way and direction of communication in the context of disasters (A2C, A2A, C2A, C2C). The categorisation shows which communication channels are used by the DCT. For example, a crowdsourcing tool will often use the communication from the citizens to the public authorities (C2A). More detailed information about the crisis communication matrix are explained in Section 3.3.

6.1.5 Range of Functions

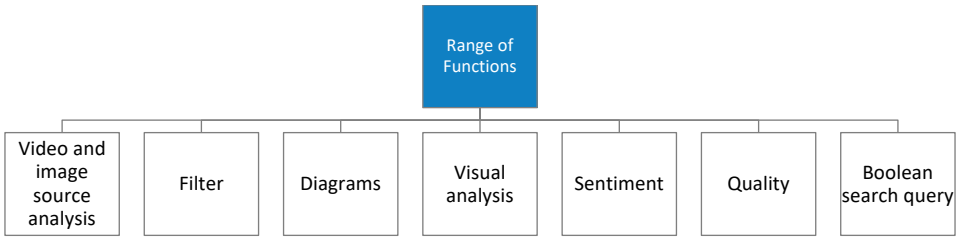
The 'range of functions' (Figure 28 and Figure 29) lists all functional properties of a DCT. The category is intended to divide the key data of the system relevant for the user of the DCT from the technical properties in Section 6.1.6. The more detailed explanation follows in Table 13.

Figure 28: First-level Category 'Range of Functions' (1/2)



Source: Authors contribution

Figure 29: First-level Category 'Range of Functions' (2/2)



Source: Authors contribution

Table 13: Sublevel Categories in First-level Category 'Range of Functions'

Subcategory of 'Range of Functions'	Description of the Subcategory
Monitoring	Social media monitoring means the observation of relevant topics and discussions for an organisation in social media. The observation takes place in (near) real time and can transmit collected information to analysis tools. Monitoring is a condition to perform real-time analytics and event detection (cf. next sub-categories).
Real-time analysis	The importance of real-time analytics is the ability to respond to data at the time you receive it from a monitoring system architecture. DCTs must respond to events and data in almost real-time. The definition of real time in the use case of SMCS in disaster management has yet to be precisely

	defined, since the definition of real time analysis always depends on the sampling rate of a system, i.e. the time interval between two data acquisitions. In this case, it must first be evaluated which temporal definition makes sense for this specific application.
Event detection	Online new event detection: identifying events from live streaming documents in real-time. Involving continuously monitoring of social media and algorithms to find out relevant events from social media posts and their behaviour.
Notification	The DCT has the ability to send automated notifications or messages to the user i.e. in case of an occurring event.
Location analysis	The DCT is using algorithms, meta data or content from a social media post to analyse to (exact) location of the creator of content.
Aggregation	The DCT collects and merges social media data from multiple platforms.
Clustering	Dealing with big amounts of data by using computer algorithms to classify content into groups ('clusters'). Thereby contents can be put into context. For example, a group of social media posts within similar signal words can be traced back to a type of event.
General citizens warning	The DCT supports functions of type A2C from the crisis communication matrix i.e. warning notifications.
Mapping	The DCT is collecting and visualising clustered data i.e. on a geographical map.
Video and image source analysis	The DCT analyses images and videos and uses an automatically detection to find out useful image-/ video properties and their content.
Filter	The DCT has the ability to filter analysed data by specified content or topics.
Diagrams	The DCT has a function to present the processed data in a graph, a dashboard or a visualised summary.
Visual analysis	Presents text-based data in special plots and diagrams for example a topic evolution over time to get more information than the size or importance of topics or contents. The user gets assist into analysing complex data with visual overviews.
Sentiment	The DCT analyses the mood (sentiment) of the citizen who are involved in an event.

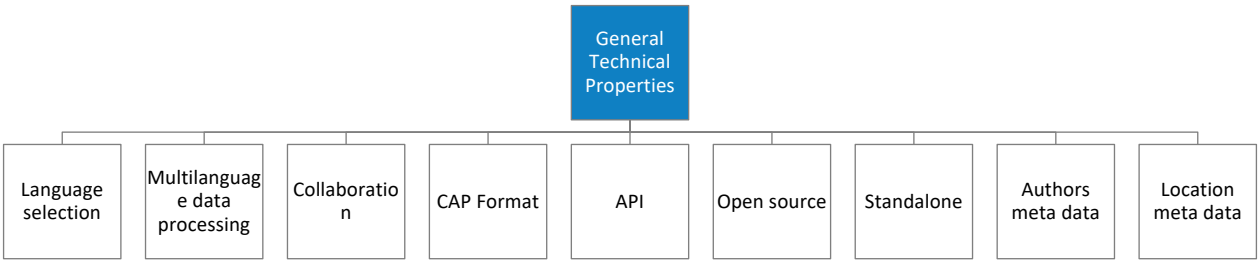
Quality	The DCT uses methods to evaluate the quality of the gathered data or is in the position to considers the quality of its own result. The definition of content quality is not defined similar in actual literature, so this category puts all types of quality analyses together. Quality is a diversified category and could be separated in some subcategories.
Boolean search query	Link search queries together with logical operators (Boolean functions 'and' and 'or'). For example, a search can be started with the condition that 'Word A' and 'Word B' must be included in the content.

Source: Authors contribution

6.1.6 General Technical Properties

The 'general technical properties' (Figure 30) covers all technical properties of a DCT that do not fall under the 'range of functions'. This category does not directly concern the user in terms of a functionality/feature but is relevant for the technical implementation when using DCTs. The subcategories are explained in Table 14.

Figure 30: First-level Category 'General Technical Properties'



Source: Authors contribution

Table 14: Sublevel Categories in First-level Category 'General Technical Properties'

Subcategory of 'General Technical Properties'	Description of the Subcategory
Language selection	The DCT has a function that changes the language.
Multilanguage data processing	The DCT is able to process multi-language content. A further consideration is to record which languages.
Collaboration	Synchronous interaction and cooperation of different organisations and their employees (or their volunteer helpers) while time and space restrictions can be disregarded.

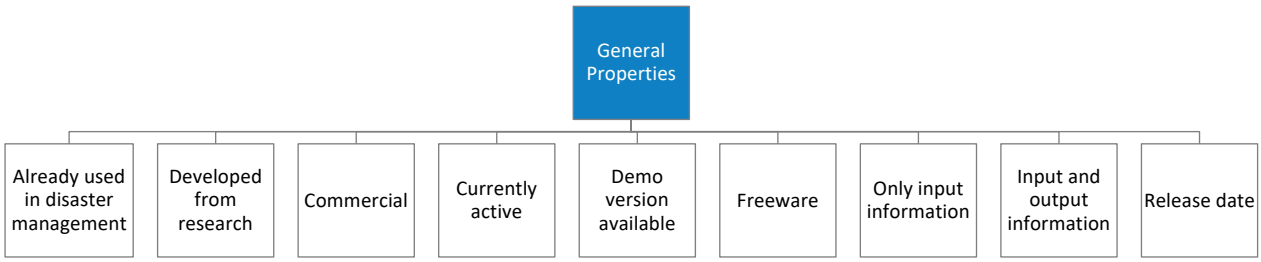
CAP Format	CAP (Common Alerting Protocol) is an international standard developed by OASIS (Organization for the Advancement of Structured Information Standards) to exchange warnings in XML-format for a widespread use.
API	Application Programming Interface: The DCT offers an open interface at source code level for the integration of the functions in other programs.
Open source	The source code is public and can be changed and edited by third parties.
Standalone	The DCT that does not require any external programs or dependencies to work, it is able to work independently.
Authors meta data	All available relevant meta data from the author/writer/user like name, profile picture, creation date of account, number of posts, etc. can be extracted.
Location meta data	Available location data where the post was created can be extracted.

Source: Authors contribution

6.1.7 General Properties

The category 'general properties' (Figure 31) covers all non-technical and more specific properties of a DCT. The subcategories are explained in Table 15.

Figure 31: First-level Category 'General Properties'



Source: Authors contribution

Table 15: Sublevel Categories in First-level Category 'General Properties'

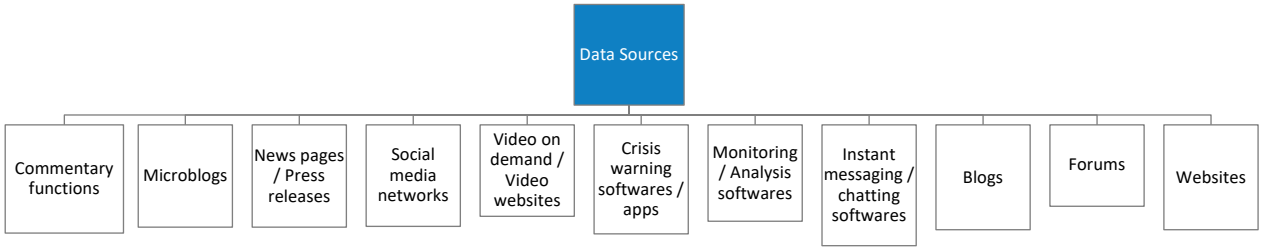
Subcategory of 'General Properties'	Description of the Subcategory
Already used in disaster management	DCT already used in disaster management
Developed from research	DCT derived from academic research
Commercial	DCT developed with commercial background
Currently active	still supported by the developer and available
Demo version available	free demo version available or can be requested
Freeware	free availability
Only input information	DCT analyses only incoming information from social media networks
Input and output information	DCT analyses of incoming information and offer to communicate information on different channels
Release date	latest release date of the DCT

Source: Authors contribution

6.1.8 Data Sources

To categorise the data sources used by DCTs, the first-level category 'data sources' is used. This category covers the sources discovered during the business market analysis, whereby only empirically recorded data is available. The subcategories used are shown in Figure 32. A currently ongoing discussion is to identify a further categorisation to classify those data sources into short- and long-term sources and specialised software.

Figure 32: First-level Category 'Data Sources'

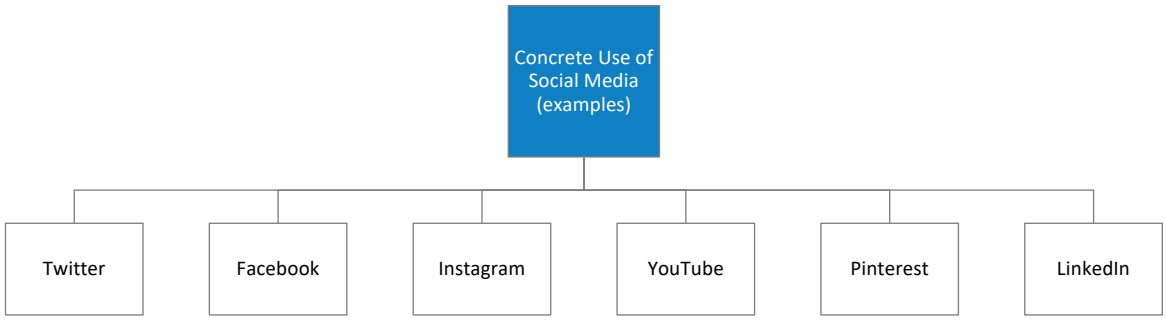


Source: Authors contribution

6.1.9 Concrete Use of Social Media (examples)

The 'concrete use of social media' (Figure 33) contains examples of social media networks and platforms[29]. A short description can be found in Table 16.

Figure 33: First-level Category 'Concrete Use of Social Media'



Source: Authors contribution

Table 16: Sublevel Categories in First-level Category 'Concrete Use of Social Media'

Subcategory of 'Concrete Use of Social Media'	Description of the Subcategory
Twitter	On Twitter registered users can distribute telegram-like short messages. URL: https://twitter.com/
Facebook	Facebook allows the creation of private profiles to represent oneself, company pages for business presence, and groups for private discussion of common interests. URL: https://www.facebook.com/
Instagram	Instagram is a mixture of microblog and audio-visual platform and enables the distribution of photos on other social networks. URL: https://www.instagram.com/
YouTube	On YouTube users can view, rate, comment on and upload video clips on the portal free of charge. All kinds of videos are available on YouTube,

[29] The selection needs further adjustments and verification.

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	including film and TV clips, music videos, trailers as well as self-made films and slideshows. URL: https://www.youtube.com
Pinterest	Pinterest is an online noticeboard for graphics and photographs with optional social network with visual search engine. URL: https://www.pinterest.com/
LinkedIn	LinkedIn is a web-based social network for maintaining existing business contacts and making new business connections. URL: https://www.linkedin.com/

Source: Authors contribution

6.2 Summary of Draft DCT-schema

The categories of the DCTs are filled in with yes/no answers, by listings (e.g. among the users of a DCT), by descriptions or key points. The collected data of a DCT is summarised in a schema, which will deliver input for further development within WP4. The current status of the developed and described draft DCT-schema is shown in Figure 34.

Key takeaways from Section 6

- The results of the literature review and the business market analysis are consolidated;
- Based on that, a draft DCT-schema is presented, which enables the classification and comparison of DCTs;
- Ten 'first-level categories' (nine shown in Figure 34, 'history' counts additionally) are presented and described, and also subcategories of those are introduced.

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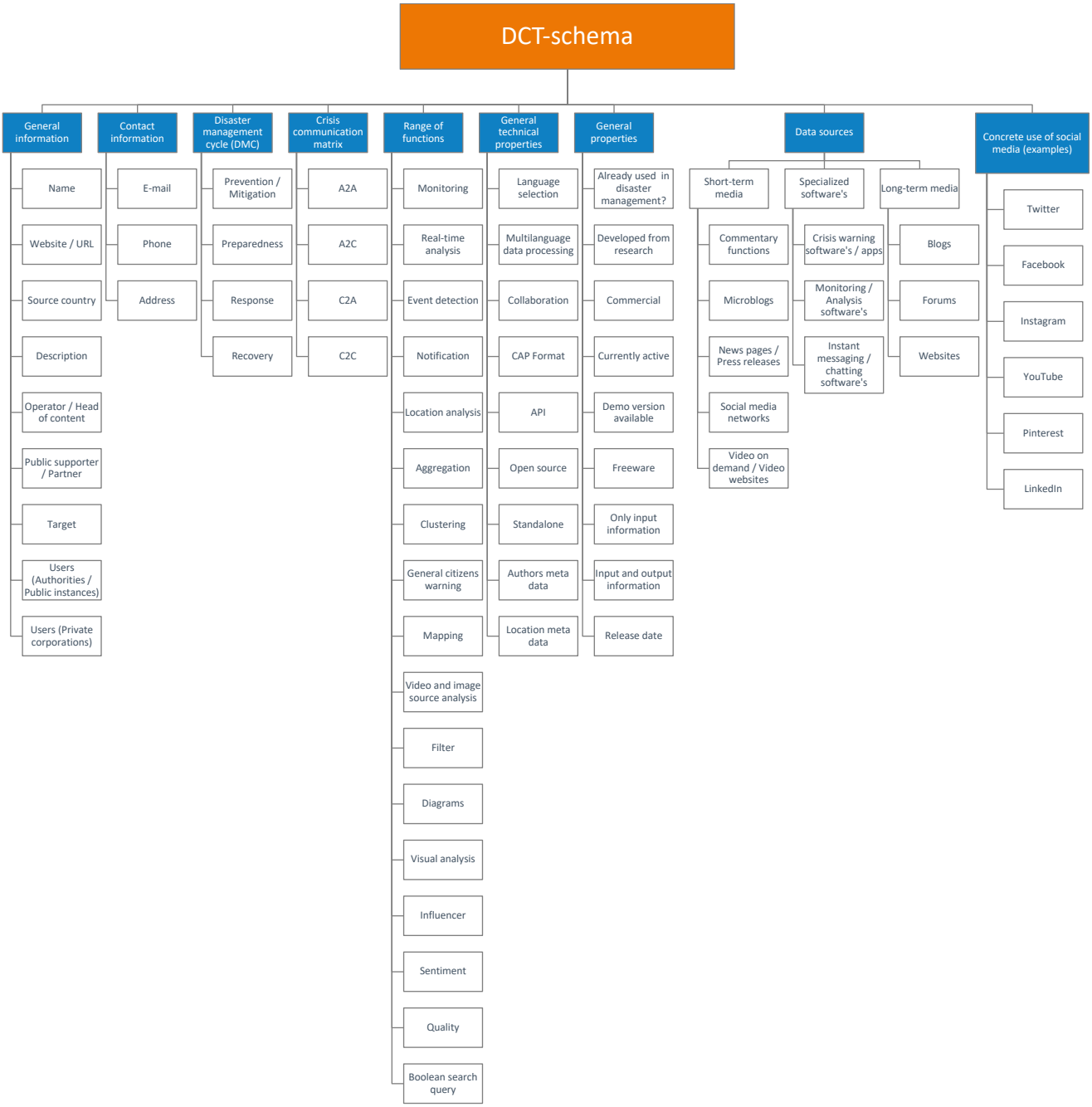
Figure 34: Structuring of Draft DCT-schema



Source: Authors contribution

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7. CONCLUSION

This section summarises the results of D4.1 and defines the gaps, future directions in the field of DCT and specifically within the LINKS project.

7.1 Summary

This deliverable provides a consolidated understanding of DCTs related to SMCS. DCTs are elaborated and analysed to achieve a consolidated understanding of these technologies and to prepare for the development of the LINKS Framework and the LCC, to achieve sustainable advanced learning on the effective use of SMCS in disasters, and ultimately to strengthen societal resilience.

To analyse and derive the DCT knowledge base, the state-of-the-art is developed by a **literature review** and a **business market analysis**. The literature review identifies significant existing scientific work concerning:

- Good practices when using DCTs in SMCS;
- Existing guidelines with a technological view;
- Existing IT-classification approaches for a) IT-system in general, b) IT-systems in DMP and c) SMCS analysis technologies;
- And negative impacts and challenges of DCT usage in Europe and beyond.

The business market analysis reveals a list of existing DCTs in use today and a first consolidation of DCT properties based on an intensive evaluation of these DCTs.

The results of both – the literature review as 'top down' approach as well as the business market analysis as 'bottom up' approach – are consolidated in the draft DCT-schema. The DCT-schema enables the classification and comparison of DCTs using an extensive set of categories.

7.2 Gaps and Future Directions

The state-of-the-art and the business market analysis provided the first steps of a consolidated understanding of DCTs in relation to SMCS as well as the basis for the development of the DCT-schema. The research also showed that there are several research gaps. One problem for a successful implementation of SMCS in disaster relates to the lack of an overview of existing DCTs. This gap includes not only the DCTs as such, but also their possible application scenarios as well as their functional scope. Furthermore, there is no consolidated and structured data on which DCTs are used in specific disaster situations and which DMOs have successfully implemented DCTs in their work. This information in a consolidated and well-structured form can provide valuable

information for DMOs in the successful implementation of DCTs. As a consequence, there is insufficient clarity in some DMOs about the advantages, disadvantages and benefits of SCMS in disaster situations.

Future directions outside of LINKS could be the integration of results and findings from other regional areas like the United States. As is clear from the current list of DCTs in this document, their market is quite broad and may offer more good practices and benefits for the European market. Another topic is the analysis of existing guidelines and recommendations, as there in no standard defined it might be possible to identify more (and less official) documents that might help other stakeholders as well. Also finished and on-going research projects are worth further analysis. Often the access to research results is difficult or nearly impossible which leads to the support open access initiative of the European Commission. A last area which is worth more analysis is the business market analysis, as it could be relevant to evaluate analysis software not only gathering data from SMCS to understand the potential of analysis algorithms. Those developments may contain interesting aspects and findings for technologies concerning SMCS in disasters as well. One of the challenges will be to keep the collection and knowledge about the DCTs up-to-date, especially because it is a fast-moving market. Approaches towards this could include the monitoring of the market and maintaining the database through crowdsourcing. In addition, the analysis of data from SMCS needs further attention. DMOs will face the problem of data overload and the questionable validity and trustworthiness of the data.

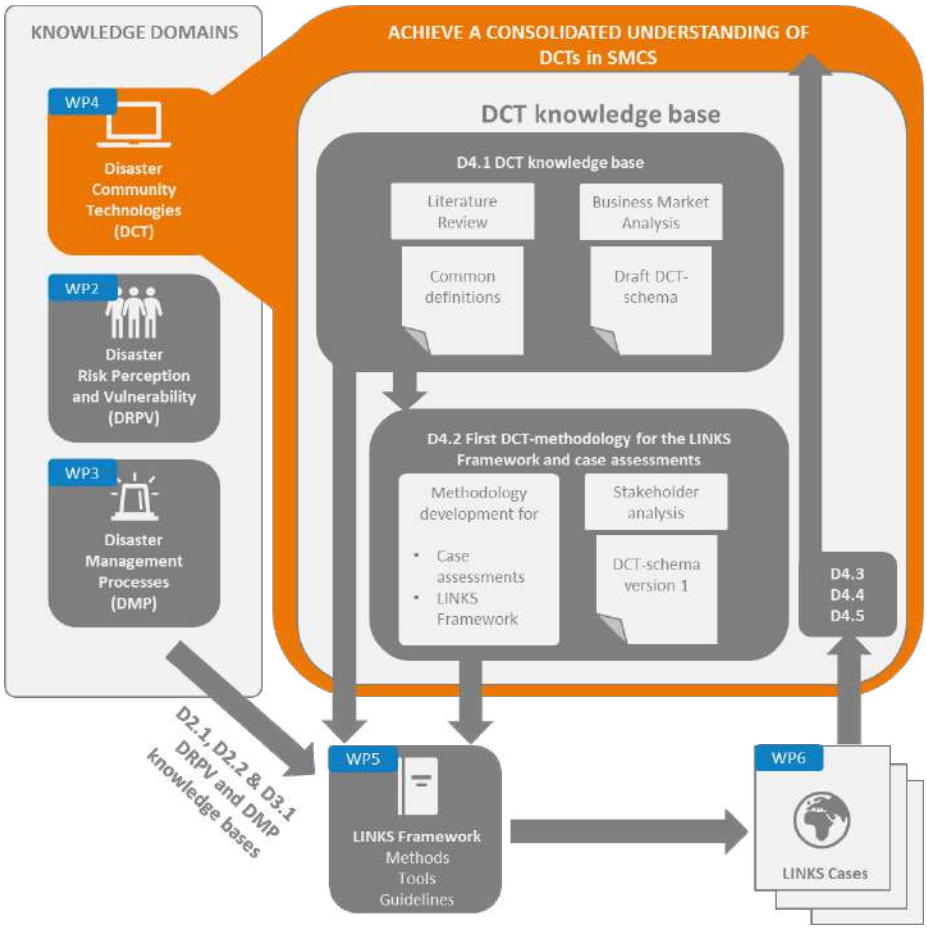
The results of this deliverable must also be further discussed and evaluated with practitioners to refine the outputs. Moreover, the definitions of, and especially the relations among, used concepts, terms, and available technologies in the area of DCTs have to be discussed and finalised in close exchange with the other knowledge domains of DRPV and DMP. This will also entail a more critical analysis of DCT in light of the other domains. After that consolidation of the three knowledge domains, the draft DCT-schema must be further developed to allow the comparison and classification of DCTs. Finally, the approach to foster the positive impacts as well as decrease the negative impacts have to be further evaluated and to be considered in the future work.

7.3 Next Steps in LINKS

Overall, the aim of D4.1 is to establish the DCT knowledge base in LINKS, by collecting data about current existing technologies for DMP with focus on SMCS (here: DCTs) and fostering a consolidated understanding about those technologies. In order to structure the collected data about existing DCTs and to make them more comparable, a categorisation and structuring is under development in WP4: the DCT-schema. Speaking more practical, this enables a structured analysis and collection of technologies (for SMCS) by focusing on relevant properties. In Figure 35

the D4.1 context and the future directions in LINKS are visualised. Future work in the field of DCT should be done in a threefold way: The draft DCT-schema has to be finalised and revised, stakeholders have to be involved to finalise the DCT-schema and the business market analysis must be kept up-to-date. The DCT-schema will then feed into the LINKS Framework and the case-based assessments.

Figure 35: Workflow for addressing the DCT Knowledge Domain within LINKS



Source: Authors contribution

Therefore, in task 4.2 (resulting in D4.2) a DCT focused methodology will be developed based on the DCT knowledge base. This will give guidance and support for the first assessment of the LINKS Framework in the cases (see D5.1 and D6.1). The methodology will also structure the research that will be conducted in all cases in cooperation with WP6. The first version of the DCT methodology is primarily aimed at addressing the gaps in the existing knowledge that is identified in this deliverable.

The methodology for the DCTs is developed in close consultation with stakeholders across cases – the LINKS Community Workshops and LCC will be utilized to this end. A possibility for developing the methodologies for the knowledge base is formed by user stories[30]. A user story is a method that is often used in software development to describe the requirements of a product or the need for a function from the user's point of view. It provides context for the development team and their work without using jargon. When a team has read a user story, they know why they are developing something and the value they are creating. From different stakeholder perspectives and based on the different cases, the respective requirements and needs for the methodologies for the application of the DCT knowledge base will be identified. This will require working closely with the consortium and the expertise it contains. The aim is to achieve an extended and improved knowledge base of DCT for the development of the LINKS Framework.

The aim of task 4.3 will be to inform and refine the DCT knowledge base and methodology, for the second round of case-based assessments of the Framework conducted in WP6. The 4.3 task is conducted as a reiterative process. The task will analyse the findings from the first round of assessments of the LINKS Framework (T6.2) and feed these findings into refining and extending the methodology and produce input for a revised version and assessment of the LINKS Framework focused on learning materials (see D5.1). This process is repeated for the second and final version of the LINKS Framework. The findings also serve to update the knowledge base developed in this Deliverable 4.1.

To monitor and improve the role of DCT in disasters in each of the cases, the cases are continuously monitored and assessed throughout the project in task 4.4. The goal is to provide timely identification of new knowledge and to facilitate a continuous discussion between stakeholders in each of the cases, as well as the wider LINKS Community. By adopting this approach, it is possible not only to identify knowledge that arises, but potentially integrate and monitor its effects through the DCT knowledge domain and the development of the LINKS Framework. The continuous assessment and monitoring of the case outputs further facilitates development of the LINKS Framework in WP5. As a result, a consolidated understanding of DCTs in SMCS will be achieved.

[30] More information about user stories can be found e.g.: https://www.visual-paradigm.com/guide/agile-software-development/what-is-user-story/

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8. NOTE TO ANNEXES

The following subsections of the annex (Annex I-V) present relevant information to the D4.1 for completion and comprehensibility of the subject areas worked on. The annexes comprise the following:

Annex I: Related European Projects (Horizon 2020 and FP7): This annex provides an overview of other European projects from the work programmes Horizon 2020 and FP7 that have intersections with regard to the topic. This is important for ensuring integration between EU funded research as well as to avoid re-inventing the wheel in terms of research questions and results. This list could be a useful basis for future works and EU projects that has a similar focus.

Annex II: Existing Guidelines: This table completes the guidelines for the use of SMCS in disaster management given in Section 4.3. The table is a useful base for policymakers and DMOs to familiarise themselves with current possibilities and what is considered best-practice. It is suitable for giving practitioners an understanding of how these technology platforms could be integrated into their services and what formal institutional arrangements they need to have in mind.

Annex III: Additional Information State-of-the-art: Annex III provides additional information on different aspects of the state-of-the-art analysis from Section 4.

Annex IV: Survey on the Country Profiles: This annex contains the survey that WP2-4 circulated to local partners to obtain knowledge of local policy and practices of SMCS use across the LINKS case countries.

Annex V: Current List of DCTs sorted into the Draft DCT-schema: This part of the appendix shows the current collection of DCTs and the previous entries of the properties in the schema.

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10. ANNEXES

10.1 Annex I: Related European Projects (Horizon 2020 and FP7)

Table I: Extract of related European Projects (H2020 and FP7)

Title	Project start	Project end	Project summary	Relevance to D4.1	URL
EmerGent	2014	2017	EmerGent regarded the positive and negative impacts and potentials of social media in emergencies for citizens and Emergency Management Services and how social media can be used during emergencies. Guidelines and tools were developed to achieve these goals.	D4.1 refers to the results, tools and guidelines produced in EmerGent. The results gathered in EmerGent regarding the use and potentials of SMCS in emergencies provide a useful basis for the identification of the knowledge bases in both DCT, DMP, DRPV.	http://www.fp7-emergent.eu/
SecInCoRe	2014	2017	The objective of SecInCoRe was to identify a knowledge base of data sets, processes, information systems and business models leading to a dynamic and secure cloud based 'common information space'.	The identified knowledge base of SecInCoRe is part of the DCT knowledge base concerning classifications of IT-systems.	http://www.secincore.eu
SOTERIA	2014	2017	SOTERIA aimed to research how social media communication may have a positive effect on disaster management	The findings of SOTERIA improves the understanding of the impact of social media.	http://soteria.i112.eu/
COSMIC	2013	2015	COSMIC aimed to identify the most effective ways to utilize new technologies for the protection of citizens by	The findings of COSMIC concerning IT-needs and usage (especially the guidelines) are an input	https://cordis.europa.eu/project/id/312737

			interlinking different stakeholders.	for the knowledge domain.	
IN-PREP	2017	2020	IN-PREP creates a Mixed Reality Preparedness Platform to facilitate interoperability, a 'at-a-glance' visualisation and integrate situational awareness with real time information.	LINKS builds in the DCT analysis on the findings concerning the usage of new technology of the IN-PREP project.	https://www.in-prep.eu/
DRIVER+	2014	2020	The main aim of DRIVER+ (Driving Innovation in Crisis Management for European Resilience) is to cope with current and future challenges due to increasingly severe consequences of natural disasters and terrorist threats, by the development and uptake of innovative solutions that are addressing the operational needs of practitioners dealing with Crisis Management	The project offer a lot of fundamental information in nearly all areas of LINKS, hence also about social media usage within disasters.	https://www.driver-project.eu/
ATHENA	2013	2016	ATHENA established a network of experts on social media and crisis management and created best practices and prototypes.	The best practices created by ATHENA were used as a basis for the DCT analysis.	https://cordis.europa.eu/project/id/313220
iSAR+	2013	2015	iSAR+ aimed to develop guidelines and a platform that enables citizens using new technologies to participate in response during emergencies.	The findings of iSAR+ are useful to analyse the understanding of innovative DCT processes.	https://cordis.europa.eu/project/id/312850/

SLANDAIL	2014	2017	SLANDAIL aimed to analyse and improve the ethical usage of social media in emergency management.	The best practices created were used as a basis for the DCT analysis.	https://cordis.europa.eu/project/id/607691
SUPER	2014	2017	SUPER aimed at leveraging social media for emergencies and security incidents. It included all relevant stakeholders, especially social network providers and authorities.	The results in SUPER about the Social Media usage servde as an important input for the work on DCTs.	http://super-fp7.eu/
I-REACT	2016	2019	The proposed system targets public administration authorities, private companies, as well as citizens in order to provide increased resilience to natural disasters though better analysis and anticipation, effective and fast emergency response, increased awareness and citizen engagement. I-REACT integrates existing services, both local and European, into a platform that supports the entire emergency management cycle.	LINKS will learn and benefit from the experiences and results of I-REACT. The results effectively improved the DCT analysis (cf. Section 4).	http://project.i-react.eu/

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10.2 Annex II: Existing Guidelines

Table II: Collection of existing Guidelines for Dealing with SMCS

Guideline No.	Title	Publishing Organisation / Author	Source
G1	EmerGent - Guidelines to increase the benefit of social media in emergencies	EmerGent	(EmerGent, 2017b)
G2	Framework recommendations for the use of social media in civil protection	Federal Office for Civil Protection and Disaster Assistance (BBK)	(BBK, 2017)
G3	The role of untied helpers in dealing with damaging events - Part 3: Recommendations for action and implementation for the use of untied helpers	German Red Cross (DRK)	(German Red Cross, 2013a, 2013b, 2013c)
G4	Operationalizing crowdsourcing through mobile applications for disaster management in India	R. Shaw; V. Sukhwani; Graduate School of Media and Governance, Keio University	(Sukhwani et al., 2019)
G5	Crisis Mapping and Crowdsourcing in Flood Management	Associated Programme on Flood Management (APFM)	(Associated Programme on Flood Management, 2017)
G6	Guidelines for the use of new media in crisis situations	COSMIC	(COSMIC, 2015)
G7	Warning and informing Scotland using social media in emergencies	Scottish Government	(Scottish Government, 2013)
G8	Social media for emergency management—a good practice guide	Wellington Region Emergency Management Office	(Pepperell & Neely, 2014)

G9	Crisis communications and social media: A best practice guide to communicating in an emergency	International Air Transport Association (IATA)	(IATA, 2014)
G10	Social Media in an emergency: Developing a Best Practice Guide Literature Review	Opus International Consultants Ltd.	(Opus International Consultants Ltd., 2012)
G11	Using Social Media in Emergencies: Smart Practices	Defense Science and Technology Laboratory (DSTL)	(Defence Science and Technology Laboratory UK, 2012)
G12	Social media use in emergency management	Wukich, Clayton; Cleveland State University	(Wukich, 2015)
G13	Using social media for emergency notifications—7 questions for emergency managers to consider	Twenty First Century Communications, Inc.	(Twenty First Century Communications, Inc.)
G14	Social Media in Emergencies—UNICEF Guidelines for Communication and Public Advocacy	United Nations Children's Fund (UNICEF)	(Social & Civic Media Section of UNICEF, 2012)
G15	Next Steps: Social Media for Emergency Response	Homeland Security, US	(Virtual Social Media Working Group, 2012)
G16	Civic Protection: Social Media	Federal Office of Civic Protection and Disaster Assistance (BBK)	(BBK, 2014)
G17	A guide to dealing with social media	German Red Cross Baden Württemberg	(German Red Cross, 2012)
G18	Social Media Guidelines and Best Practices	Centers for Disease Control and Prevention (CDC)	(Centers for Disease Control and Prevention, 2012)
G19	Lessons for Crisis Communication on Social Media: A Systematic	M. Eriksson in International Journal of Strategic Communication	(Eriksson, 2018)

	Review of What Research Tells the Practice		
G20	Innovative Uses of Social Media in Emergency Management	Homeland Security, US	(U.S. Department of Homeland Security, 2013)
G21	Social media and disasters	US Department of Health and Human Services	(US Department of Health and Human Services, 2020)
G22	ITU Guidelines for national emergency telecommunication plan	International Telecommunication Union (ITU)	(ITU, 2020)
G23	How to use social media to better engage people affected by crisis	International Committee of the Red Cross	(Lüge, 2017)
G24	Social media in emergencies in UNHCR's Emergency Handbook. Version 3.5.	United Nations High Commissioner for Refugees (UNHCR)	(UNHCR, 2020)
G25	Social Media and Disasters: Current Uses, Future Options, and Policy Consideration	B. Lindsay - Congressional Research Service	(Bruce R. Lindsay, 2011)
G26	Words into action guidelines: Citizens' Participation and Crowdsourcing	United Nations Office for Disaster Risk Reduction (UNDRR)	(United NationsOffice for Disaster Risk Reduction, 2017)
G27	Verification Handbook: An Ultimate Guideline on Digital Age Sourcing for Emergency Coverage	The European Journalism Centre	(The European Journalism Centre, 2013)
G28	How to Use Social Media for Crisis Communications and Emergency Management	Paige Cooper, Hootsuite	(Paige Cooper, 2020)

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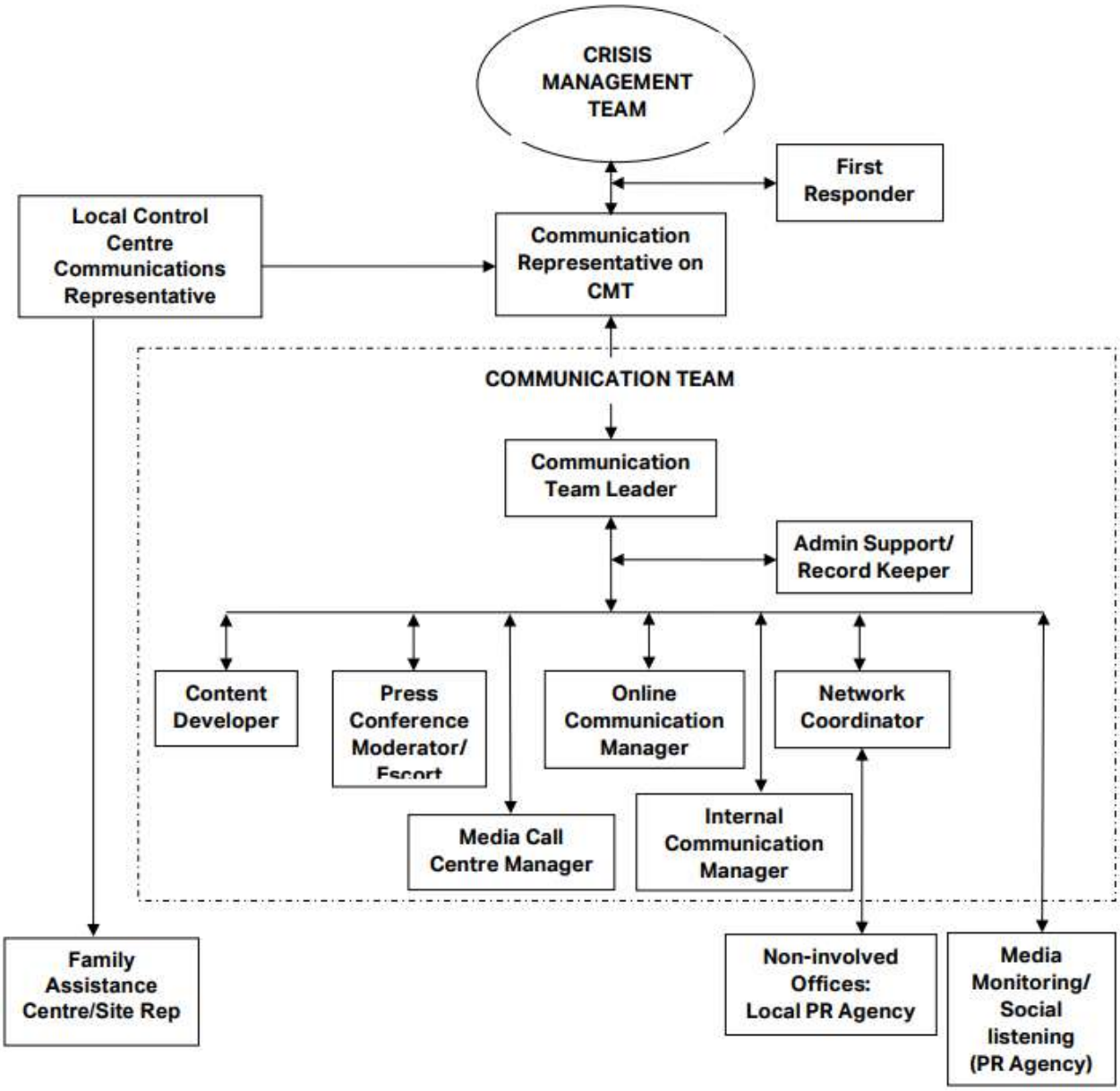
10.3 Annex III: Additional Information State-of-the-art

Figure I: Organisation Chart Example of a Crisis Communications Team



Source: (IATA, 2018)

Figure II: Visualisation of a Guideline for Citizens about the Use of Social Media in Emergencies

Source: (EmerGent, 2017a)

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Figure III: Possible Uses of Social Media in different Phases of the Disaster Management Cycle

	Prevention & preparedness phases			Response phase			Recovery phase		
	C2A	A2C	C2C	C2A	A2C	C2C	C2A	A2C	C2C
Dissemination of warnings		✓			✓				
Dissemination of recommendations for actions		✓			✓			✓	
Raise awareness of risks/promote prevention	✓	✓	✓				✓	✓	✓
Spread out status updates				✓	✓	✓			
Emergency calls (e.g. at overstrained telephone network)				✓					
Request of affected for help/offer help				✓	✓	✓	✓	✓	✓
Evaluation of the situation through authorities (by using information from social media				✓			✓		
Enabling/engaging a dialog between public authorities and citizens	✓	✓		✓	✓		✓	✓	
Aftercare for victims and relatives							✓	✓	✓
Maintain contact with family/friends						✓			✓
Search missing people								✓	✓
Coordination of volunteers					✓	✓		✓	✓
Mobilisation of volunteers					✓	✓		✓	✓
Search for witnesses								✓	
Building a relation and trust between authorities and the public		✓						✓	
Obtain and provide feedback							✓	✓	

Source: (EmerGent, 2017b)

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Figure IV: Overview of selected Cases and sample Studies in the Literature which Dealing with Social Media in Crisis Management (1/2)

References	Case	Contribution
Palen and Liu (2007)	2001 9/11	Use of wikis to collect information about missing people.
Harrald et al. (2002)		FEMA and the Red Cross used web-technologies to inform the public and to provide status report.
Liu et al. (2008)	2004 Indian Ocean tsunami	Citizens used photograph repository sites to exchange information.
Endsley, Wu, Eep, and Reep (2014)	2005 Hurricane Katrina, 2010 volcano Eyjafjallajökull in Iceland	Credibility of social media information is less than of printed, official online or televised news and information from family, relatives or friends.
Shklovski et al. (2008)	2007 Southern California wildfires	Citizens used photograph repository sites to exchange information.
Hughes and Palen (2009)	2008 Hurricanes Gustav and Ike	Highlights differences between the use of Twitter in crises and the general use.
Qu et al. (2009)	2008 Sichuan earthquake	Outlines that people gather and synthesize information.
Sutton (2010)	2008 Tennessee River technological failure	Outlines the phenomena of broadcasting emergency-relevant information via Twitter.
Heverin and Zach (2010)	2009 Lakewood attack on police officers	Shows the ability of Twitter to organize and disseminate crisis-related information.
Latonero and Shklovski (2011)	2009 Los Angeles fire Department	Public Information Officers highlight the importance of the information evangelist within organizations.
Starbird and Palen (2010)	2009 Oklahoma fires	Highlights the role of retweeting for information processing, especially filtering and recommendation.
Vieweg et al. (2010)	2009 Red River floods	Highlights broadcasting by people on the ground as well as activities of directing, relaying, synthesizing and redistributing.
Mendoza et al. (2010)	2010 earthquake in Chile	Shows that the propagation of tweets that correspond to rumours differs from tweets that spread news because rumours tend to be questioned more than news by the Twitter community.
Birkbak (2012)	2010 Bornholm blizzard	Two Facebook groups show that the geographical location and self-selection into groups create different views of a crisis.
Muralidharan, Dillistone, and Shin (2011)	2010 Deepwater Horizon oil spill disaster	BP's corrective action as the dominant image restoration strategy caused high presence of negative emotion.
Starbird and Palen (2011)	2010 Haiti earthquake	Analyses the earthquake with the help of translators and reveals the phenomenon of "digital volunteers."
Reuter et al. (2012)	2010 Love Parade mass panic in Germany, volcano Eyjafjallajökull in Iceland	Systematizes the communication between authorities and citizens during emergencies, outlining the need for duplex communication.
Nagy, Valley, and Stamberger (2012)	2010 San Bruno Californian gas explosion and fire disaster	Illustrates that sentiment analysis (analysis for identifying and extracting subjective information) with emotions performed 27% better than Bayesian Networks alone.
Helsloot and Groenendaal (2013)	2011 large-scale fire in Moerdijk, the Netherlands	Most tweets do not contain new relevant information for governments; tweets posted by governments got buried under an avalanche of citizen tweets.
Starbird and Palen (2012)	2011 Egyptian uprising	Shows how the crowd expresses solidarity and does the work of information processing through recommendation and filtering.
Wilensky (2014)	2011 Great East Japan earthquake	Emphasizes the use of Twitter to provide emotional support and mentions the problem of widely publishing obsolete or inaccurate information and the unequal distribution of useful information.
Perng et al. (2012)	2011 Norway attacks	The notion of peripheral response has been developed in relation to emergent forms of agile and dialogic emergency response.
Jennex (2012)	2011 San Diego/Southwest blackout	The availability of social media illustrates that "the cell phone system did not have the expected availability and users had a difficult time using social media to contact family and friends."
St. Denis and Hughes (2012)	2011 Shadow Lake fire	Shows the deployment of trusted digital volunteers as a virtual team to support an incident management team.
Reuter et al. (2013)	2011 Super Outbreak	Distinguishes groups of twitterers, such as helpers, reporters, retweeters and repeaters.

Source: (Reuter & Kaufhold, 2018)

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Figure V: Overview of selected Cases and sample Studies in the Literature which Dealing with Social Media in Crisis Management (2/2)

References	Case	Contribution
Wulf, Misaki, Atam, Randall, and Rohde (2013)	2011 Tunisian revolution	Social media linked the young activists with actors in other cities and stimulated the participation in weekly demonstrations.
Kuttschreuter et al. (2014)	2011 Escherichia coli contamination crisis	Social media can act as a complementary information channel for a particular segment, but it is neither a substitute for traditional nor for online media.
Yang, Chung, Lin, Lee, and Chen (2013)	2012 hurricane Isaac	Leads to knowledge, which classification algorithms work best in each phase of emergency.
Hughes et al. (2014)	2012 hurricane Sandy	Shows that few departments used online channels in their response efforts and that communication differed between fire and police departments and across media types.
Medina and Diaz (2016)	2012 Madrid Arena tragedy	Opportunities according to the main principles of the theory of Crisis Communication Management provided by Twitter.
White and Palen (2015)	2013 Colorado flood	Highlights the blending of online and offline expertise to evacuate horses from an isolated ranch.
Kaufhold and Reuter (2014)	2013 European flood in Germany	Identifies challenges of the public response among emergent groups and digital volunteers highlighting the role of moderators.
de Albuquerque et al. (2015)	2013 European flood in Germany	Messages near to severely flooded areas have a much higher probability of being relevant.
Burnap et al. (2014)	2013 Woolwich (London) terrorist attack	The sentiment expressed in tweets is significantly predictive of both size and survival of information flows.
Wan and Paris (2015)	2014 Sydney siege	System to analyse posts of a special topic and visualize the emotional pulse of a geographical region.
Chaturvedi, Simha, and Wang (2015)	2015 cyclone Pam 2014 Kashmir floods, Indonesia landslide	Data collection via Twitter for exploration of the ICT infrastructure for disaster management.
Fung, Tse, Cheung, Miu, and Fu (2014)	2014 Ebola fear in the USA	Examines the amplified fear of the imported Ebola virus through social media.
Fichet, Robinson, and Starbird (2015)	2015 Amtrak derailment, Baltimore protests, hurricane Joaquin floods	Examines the use of the live-streaming application Periscope by both citizens and journalists for information sharing, crisis coverage and commentary.
Soden and Palen (2016)	2015 Nepal earthquake	Investigates the work of mapmakers working and outlines factors contributing to the emergence of infrastructure.
Zipf (2016)	2015 Nepal earthquake, 2013 Philippines typhoon, 2011 Japan tsunami	Help of "Ambient Geographic Information" via social media (Twitter and Flickr) at crisis management.
An, Kwak, Mejova, and Oger (2016)	2015 Charlie Hebdo shooting	Examines sociological theories in terms of the social factors that contribute to online individual behaviour.
Zeng, Chan, and Fu (2016)	2015 Tianjin blasts	Clustering analysis and time-series analysis of social network Weibo's rumour management strategies.
Wiegand and Middleton (2016)	2015 Paris shootings	Examines the velocity of newsworthy content and its veracity with regard to trusted source attribution.
Sagar (2016)	2016 Roanu cyclone in Sri Lanka	Twitter and Facebook were used to help flood-affected victims with disaster warnings, relief information, and weather alerts.

Source: (Reuter & Kaufhold, 2018)

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Figure VI: Overview of Key Networks and Tools for Communicating in Emergencies

Name	Facebook	Twitter	YouTube
URL	www.facebook.com	www.twitter.com	www.youtube.com
Active users	800 million	100 million	490 million
Strength	Networking; content sharing; available in many countries and languages	Viral sharing of links and short facts; mobile phone usage	Video repository
Weakness	Closed network; most content can not be found through Google	Not widely used in many countries; limitation to 140 characters	None
Help page	www.facebook.com/help/	http://bit.ly/xMoCJI	http://bit.ly/yelYly

Name	Flickr	Google+
URL	www.flickr.com	http://plus.google.com
Active users	50 million	90 million
Strength	Photo repository	Networking; integration with other Google properties
Weakness	Usage declined in 2011	Still comparatively new and not heavily used, but further growth expected in 2012
Help page	www.flickr.com/help/	http://support.google.com/plus/

	Hootsuite	Soundcloud
URL	www.hootsuite.com	www.soundcloud.com
Active users	n/a	10 million
Strength	Managing and analyzing the impact of social media profiles	Repository for audio files; recordings via Smartphone possible
Weakness	Can be complex to use	Only the first 120 minutes of uploads and 100 downloads per track are free
Help page	http://hootsuite.com/help	http://help.soundcloud.com/

Source: (Social & Civic Media Section of UNICEF, 2012)

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Table III: Evaluation Results for Social Media Analysis Tools

Tool name	Analysis	Engagement	Workflow Management	Social Profiles	Listening Grid	Near real-time processing	API	Sentiment Analysis	Historical data	Dashboard	Export results
Alterian SM2	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓
Brandwatch	✓	×	✓	✓	✓	✓	✓	✓	✓	✓	✓
Converseon	✓	×	✓	✓	✓	✓	✓	✓		✓	✓
Cymfony Maestro	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
evolve24 Mirror	✓	✓	✓	✓	✓	✓		✓		✓	✓
Meltwater Buzz	✓	✓	✓	✓	✓	✓	×	✓	✓	✓	✓
NM Incite My BuzzMetrics	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Radian6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Sysomos	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Visible Technologies Intelligence	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Source: (Stavrakantonakis et al., 2012)

Table IV: Evaluation Results for Crisis and non-Crisis-related Research Works regarding Social Media Analysis

Crisis-Related Research Work	Multi-platform	Crowdsourcing	Orga. Management (Routing etc.)	Sentiment	Visual Content	Event/topic detection	Social Media Platforms	Visualization	Filtering	Add. Techniques
Twitcident [12], [13]	-	-	-	-	-	-	Twitter	map, stat. diagrams	keywords, facets	classification with handcrafted rules
WeKnowIt-System [15], [17]	X	-	-	-	-	X	Posts, Pictures, Videos	map, timeline	tags, time	text processing and clustering, trust
Tweak-the-Tweet [18], [19]	-	X	-	-	-	-	Twitter	map, timeline	layers (= predef. hashtags)	grammar definition and parsing
SensePlace2 [20]	-	-	-	-	-	-	Twitter	(heat-)map, timeline	time, tag cloud	named entity recognition (NER)
TEDAS [21]	-	-	-	-	-	X	Twitter	map, timeline	location, keyword, time	rules, classification
Twitris+ [22] [23]	X	-	-	-	-	X	Twitter, SMS	map, tag cloud	spatial-temporal-theme slices	event-descriptors for aggregation
Emergency Situation Awareness Platform [25], [24]	-	-	-	-	-	X	Twitter	map, tag clouds, timline	time, traffic, tag	text classification, bursty keywords
Crisees [26] [27]	X	-	-	-	-	-	YouTube, Twitter	map, lists	time, query	extension to sentiment
System for real and virtual volunteers [28]	X	-	X	-	-	-	Facebook, Twitter	overviews on groups, activities, tasks	group related information	group management, linked to existing emergency sys.
Classification System for Microblogs [29]	-	-	X	-	-	-	Microblogs	-	-	Naive Bayes classifier
SocialSensor Systems [30], [31]	X	-	-	X	X	X	Facebook, Flickr, YouTube Tumblr, Google+, Instagram, Twitter	map, timeline, lists, etc.	zooming, sorting (e.g., recency) verification info. etc.	Clustering of geo-data and visual descriptors, sentiment, indexing, etc.
Non Crisis-Related Research Work										
Eddi [32]	-	-	-	-	-	X	Twitter	list, timeline	tag cloud, time	keyword summarization
Twitinfo [33], [34]	-	-	-	X	-	X	Twitter	map, time, traffic	peak selection	peak/event detection, sentiment
MediaFinder [35]	X	-	-	-	X	-	substantial list (Twitter, Instagram etc.)	grid, timeline, graph	entities, topics, time etc.	facets, NER, image retrieval
TwitterBeat [36]	X	-	-	X	-	X	Twitter (any textual information)	(heat-)map	zooming	sentiment on topic and location
TweetMotif [37]	-	-	-	-	-	X	Twitter	list	topic	aggregation of near-duplicate messages

Source: (Pohl, 2013)

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Table V: Evaluation Results for Social Media Analysis Tools

Systems		Crossmedia	Communication	Monitoring	Alert	Event Detection	Collaboration	Influencer	Sentiment	Topic	Quality	Map	Filter	Diagrams
Intelligence Systems	*Adobe Social*	✓	X	X	X	X	✓	✓	✓	✓	X	✓	✓	✓
	Mention	✓	X	X	X	X	X	✓	✓	✓	X	X	✓	✓
	BrandWatch	✓	X	✓	✓	X	✓	✓	✓	✓	X	X	✓	✓
	Cogia	✓	✓	✓	✓	X	✓	✓	✓	✓	X	✓	✓	✓
	Evolve24	✓	X	✓	X	✓	✓	X	✓	✓	X	✓	✓	✓
	GeoFeedia[a]	✓	X	✓	X	✓	✓	✓	✓	✓	X	✓	✓	✓
	Meltwater	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	✓	✓	✓
	PublicSonar	✓	X	✓	✓	✓	X	✓	✓	✓	X	✓	✓	✓
	Signals	✓	✓	✓	✓	X	X	✓	✓	✓	X	✓	✓	✓
	Socialmention	✓	X	X	X	X	X	X	✓	✓	X	X	✓	✓
	Quintly	✓	✓	✓	X	X	✓	X	X	X	X	X	✓	✓
	Trackur	✓	X	✓	X	X	X	✓	✓	✓	X	X	✓	X
	TweetTracker	X	X	X	X	✓	X	✓	X	✓	X	✓	✓	✓
	ubermetrics	✓	X	✓	✓	X	✓	✓	✓	✓	X	X	✓	✓
	VicoAnalytics	✓	✓	✓	✓	X	✓	✓	✓	✓	X	X	✓	✓
	Dataminr	✓	X	X	✓	✓	X	X	X	✓	X	✓	✓	X
Management Systems	*Coosto*	✓	✓	✓	X	X	X	✓	✓	✓	X	X	✓	✓
	Crowdbooster	✓	✓	X	X	X	✓	✓	X	X	X	X	✓	✓
	Lithium	✓	✓	X	X	X	✓	✓	✓	✓	X	X	✓	✓
	HootSuite	✓	✓	✓	X	X	✓	✓	✓	✓	X	X	✓	✓
	Salesforce	✓	✓	✓	X	X	✓	✓	✓	✓	X	X	✓	✓
	Simplify360	✓	✓	✓	X	X	✓	✓	✓	✓	X	X	✓	✓
	Facelift	✓	✓	X	✓	X	✓	✓	X	✓	X	X	✓	✓
	SproutSocial	✓	✓	✓	✓	X	✓	✓	X	✓	X	X	✓	✓
	TweetDeck	X	✓	✓	X	X	X	✓	X	X	X	X	✓	X
	CrowdControlHQ	✓	✓	✓	✓	X	✓	✓	✓	X	X	✓	✓	✓
	Orlo	✓	✓	✓	✓	X	✓	✓	✓	✓	X	X	✓	✓
	MusterPoint	✓	✓	✓	✓	X	✓	✓	✓	X	X	X	✓	✓
	TalkWalker	✓	✓	✓	✓	X	✓	✓	✓	✓	X	✓	✓	✓
Special Systems	*AIDR*	X	X	X	X	✓	X	X	X	✓	X	✓	✓	X
	CircleCount[a]	X	X	X	X	X	X	X	X	X	X	X	X	✓
	CrisisTracker[a]	X	X	X	X	✓	X	✓	X	✓	X	✓	✓	✓
	SensePlace2	X	X	X	X	✓	X	X	X	✓	X	✓	✓	X
	Tweedr	X	X	X	X	✓	X	X	X	✓	X	X	X	X
	TwitInfo	X	X	X	X	✓	X	✓	✓	✓	X	✓	✓	✓
	Twitris	✓	X	X	X	X	X	✓	✓	✓	X	✓	✓	✓
	Ushahidi	✓	X	✓	✓	✓	✓	✓	✓	X	X	✓	✓	✓
	SMART-C[b]	✓	✓	X	✓	✓	X	X	X	✓	X	X	X	X
	EARS[b]	X	✓	X	✓	✓	X	X	X	✓	X	✓	✓	X
	Leadline[b]	✓	X	X	X	✓	X	X	X	✓	X	✓	✓	✓
	Alert4All[a,b]	X	✓	X	✓	X	✓	X	✓	X	X	✓	✓	✓
	ESA-AWTM	X	✓	✓	X	✓	X	X	X	✓	X	✓	✓	X
	RSOE EDIS	✓	✓	X	✓	✓	✓	X	X	X	X	✓	✓	X
	Vox Civitas[a]	X	X	X	X	✓	X	X	✓	✓	X	X	✓	✓
	Visual Backchannel[b]	X	X	✓	X	X	X	X	X	X	X	X	✓	✓

[a]de facto non-operating systems.
[b]Architecture but no implemented system.

Source: (Kaufhold et al., 2019)

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10.4 Annex IV: Survey on the Country Profiles

Country profile for:

Author:

Please answer the following questions by providing a qualitative description of the processes.

Questions	Answers
Briefly describe the institutional landscape of disaster risk reduction frameworks and guidelines in your country (beyond those that deal with SMSC). - What are the main global/national/subnational frameworks/guidelines governing DRR in your country? - What are the main authorities responsible for DRR and what level of government do they represent? - Do you know of specific disaster guidelines/frameworks/other documents/tools adopted which consider vulnerable people*? - Do you know of specific disaster guidelines/frameworks/other documents/tools adopted which consider gender perspectives?	
How are disaster frameworks/guidelines/other documents/tools generally communicated by governments/subnational governments? Are vulnerable groups considered?	

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Describe the overall role of SMCS in guiding disaster management processes in your country.	
Do you know frameworks/ guidelines/ other documents/tools which specifically aim to promote/support/facilitate the use of SMCS? Maybe do they consider the most vulnerable groups, in your country?	
Are you aware of any needs or challenges concerning the use of SMCS tools/technologies? (open question)	
Are you aware of methodologies to handle/identify/manage trustworthiness of data coming from SMCS?	
Other comments/reflections/remarks	

*The list of most vulnerable people includes vulnerable social groups like elderly people, minors, women, homeless, migrants/refugees, indigenous communities, low-income people, chronically ill people, people with disabilities, but also temporary vulnerable people like tourists, volunteers and first responders/practitioners.

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10.5 Annex V: Current List of DCTs sorted into the Draft DCT-schema

The tables in this subsection cover snapshots of the list that has been collected over the last time and will be extend further. The sorting is in an alphabetical order.

The tables below show the status of the collection of DCT on November 2020. The draft DCT-schema has not been analysed and filled out for all collected DCTs yet as this is also part of the methodology to refine the schema further.

Table VI: Draft DCT-schema - General Information (1/3)

General information (1/3)			
Name	**Website / URL**	**source country**	**description**
AIDR	http://aidr.qcri.org/	AIDR	
Brandwatch Analytics	https://www.brandwatch.com/	Brandwatch Analytics	
Buffer	https://buffer.com/	Buffer	
Cision	https://www.cision.co.uk/	Cision	
ClaraBridge	https://www.clarabridge.com/	ClaraBridge	
Coosto	https://www.coosto.com/en/	Coosto	
Cogia	https://www.cogia.de/	Cogia	
CrowdControlHQ	https://www.crowdcontrolhq.com/sectors/emergency-services/	CrowdControlHQ	
Crisis Tracker	https://crisistracker.org/	Crisis Tracker	
Cyfe	https://www.cyfe.com/	Cyfe	
DiscoverText	https://discovertext.com/	DiscoverText	
Echosec	https://www.echosec.net/	Echosec	
ESA (Emergency Situation Awareness)	https://esa.csiro.au/aus/about-public.html	ESA (Emergency Situation Awareness)	Social Media Analysis for all-Hazards
Esri	https://www.esri.de/de-de/home	Esri	
Evolve24	https://evolve24.com/	Evolve24	
Facebook Business	https://www.facebook.com/business/	Facebook Business	
Facelift	https://www.facelift-bbt.com/de	Facelift	

Followerwonk	https://followerwonk.com/	Followerwonk	
GeoFeedia	https://geofeedia.com/	GeoFeedia	
Gephi	https://gephi.org/	Gephi	
Google Analytics	https://marketingplatform.google.com/about/analytics/	Google Analytics	
Hashtagify	https://hashtagify.me/	Hashtagify	
Hashtracking	https://www.hashtracking.com/	Hashtracking	
HootSuite	https://hootsuite.com/	HootSuite	
Hubspot	https://www.hubspot.com/	Hubspot	
IBM Intelligent Operations Center for Emergency Management	https://www.ibm.com/us-en/marketplace/ emergency-management/details	IBM Intelligent Operations Center for Emergency Management	
JIXEL (Alerter und Aggregator)	https://www.jixel.eu/web/en/	JIXEL (Alerter und Aggregator)	
Keyhole	https://keyhole.co/about-us/	Keyhole	
Khoros	https://khoros.com/	Khoros	
Lexalytics	https://www.lexalytics.com/	Lexalytics	
Leximancer	https://info.leximancer.com/	Leximancer	
Statistical Cybermetrics	http://lexiurl.wlv.ac.uk/	Statistical Cybermetrics	
Meltwater	https://www.meltwater.com/de	Meltwater	
Mention	https://mention.com/en/crisis-management/	Mention	
Mitre	https://www.mitre.org/	Mitre	
Mozdeh	http://mozdeh.wlv.ac.uk/	Mozdeh (wie Statistical Cybermetrics)	
ORA	http://www.casos.cs.cmu.edu/index.php	ORA	
Orlo (vormals SocialSignIn)	https://orlo.tech/	Orlo (vormals SocialSignIn)	
publicSonar	https://publicsonar.com/	publicSonar	
Pulsar	https://www.pulsarplatform.com/	Pulsar	
Quintly	https://www.quintly.com/	Quintly	
Radarly (Linkfluence)	https://www.linkfluence.com/de/	Radarly (Linkfluence)	
Sahana	https://sahanafoundation.org/	Sahana	
Salesforce	https://www.salesforce.com/	Salesforce	

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Scatterblogs	https://www.scatterblogs.com/	Scatterblogs	
Signal	http://www.getsignal.info	Signal	
Simplify360	https://simplify360.com/	Simplify360	
Social Hub	https://socialhub.io/	Social Hub	
SocialGist	https://socialgist.com/	SocialGist	
SocialMention	http://socialmention.com	SocialMention	
SocialSign.in	https://socialsignin.com/	Sparkcentral	
Sparkcentral	https://sparkcentral.com/	Sproutsocial	
Sproutsocial	https://sproutsocial.com/	swat.io	
swat.io	https://swat.io/de/	Synthesio	
Synthesio	https://www.synthesio.com/	Sysomos (now Meltwater Social)	
Sysomos	https://sysomos.com/	Talkwalker	
Talkwalker	https://www.talkwalker.com/	Tint	
Tint	https://www.tintup.com/	TweetDeck	
TweetDeck	https://tweetdeck.twitter.com/	Tweetreach	The most powerful Twitter tool for real-time tracking, organising, and engagement. Reach your audiences and discover the best of Twitter.
Tweetreach	https://tweetreach.com/	TweetTracker	
TweetTracker	http://tweettracker.fulton.asu.edu/	Twitter	TweetTracker is a **powerful** tool from Arizona State University that can help you **track**, **analyse**, and **understand** activity on Twitter.
Twitter	https://analytics.twitter.com/about	Ubermetrics Technologies	

Ubermetrics Technologies	https://www.ubermetrics-technologies.com/de/	Ushaidi	
Ushaidi	https://www.ushahidi.com/	Vico	
Vico	https://vico-research.com/social-data-analytics/	Viralwoot	
Viralwoot	https://viralwoot.com/	WebLyzard	
WebLyzard	https://www.weblyzard.com/	awario	
awario	https://awario.com/	Fanbooster	Social Media Monitoring
Fanbooster	https://bytraject.com/software/social/	AIDR	Social media management software for agencies that work with their client

Table VII: Draft DCT-schema - General Information (2/3)

General information (2/3)			
Name	**operator / head of content**	**public supporter**	**target**
AIDR	*Crisis Computing team at QCRI*	MicroMappers, Qatar Computing Research Institute, StandBy Task Force, United Nations Office for the Coordination of Humanitarian Affairs	Coordination of Humanitarian help by detecting disaster events using gathered information meta data from social media networks e.g. Twitter.
Brandwatch Analytics		null	Brand management for corporate businesses
Buffer			Brand management + analytics
Cision			Brand management + analytics
ClaraBridge			Brand management + analytics
Coosto			Brand management + analytics
Cogia			Brand management + analytics
CrowdControlHQ			engage your audience, manage your activity, and analyse your social media performance
Crisis Tracker		USAID, Invisible Children	Track and reoprt armed conflicts incidents in parts of Africa

Cyfe			
DiscoverText			
Echosec			
ESA (Emergency Situation Awareness)			Social Media Analysis for All-Hazards
Esri			Geospatial Analysis
Evolve24			
Facebook Business			
Facelift			
Followerwonk			
GeoFeedia		Ubermetrics, brandwatch, Talkwalker	
Gephi			
Google Analytics			
Hashtagify			
Hashtracking			
HootSuite			
Hubspot			
IBM Intelligent Operations Center for Emergency Management			
JIXEL (Alerter und Aggregator)			
Keyhole	Assetize Inc.		Brand management + analytics
Khoros			
Lexalytics			
Leximancer			
Statistical Cybermetrics			
Meltwater			
Mention			
Mitre			
Mozdeh			
ORA			
Orlo (vormals SocialSignIn)			
publicSonar			
Pulsar			
Quintly			

Radarly (Linkfluence)			
Sahana			
Salesforce			
Scatterblogs	dpa, AFP GmbH	EU, Bundesministerium für Wirtschaft und Energie , eXist, Europäischer Sozialfonds für Deutschland (ESF)	Analyse and detect events of disaster by using gathered information and meta data from social networks i.e. Twitter.
Signal	Intergen		
Simplify360			
Social Hub	maloon GmbH		Increasing the user's impact access to multiple social media platforms in a single software application.
SocialGist			
SocialMention			
SocialSign.in			
Sparkcentral			
Sproutsocial			
swat.io	Swat.io GmbH	Messsenger People	Social Media marketing, Social Listening, Community Management
Synthesio			
Sysomos			
Talkwalker			
Tint			
TweetDeck	Twitter		Twitter Real time dashboard
Tweetreach			
TweetTracker	Arizona State University	Quicknets	Twitter Real time search and visualization
Twitter			
Ubermetrics Technologies	Ubermetrics Technologies GmbH (Berlin)		Cloud based real-time analysis of Social Media Data from various media sources and visualizing in dashboards and filtered graphics. Identification of opinion leaders in social groups and media segments of high communication rate.
Ushaidi			
Vico			
Viralwoot			
WebLyzard			

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awario	Techfusion LTD,Republic of Cyprus	null	Social media monitoring, analytics and answering
Fanbooster	Traject	null	Social Media management, sheduling and analytics

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Table VIII: Draft DCT-schema - General Information (3/3)

General information (3/3)		
Name	**users (authorities / public instances)**	**users (private coorporations)**
AIDR	Unicef	
Brandwatch Analytics	British Red Cross	Walmart, The Guardian, Sparkassen-Finanzgruppe
Buffer	null	GitHub, Spotify, Stripe, Basecamp
Cision		Kellogs
ClaraBridge		
Coosto		
Cogia	Saarland	BMW, Continental
CrowdControlHQ	Wiltshire Police, Notthingham City Council	
Crisis Tracker		
Cyfe		
DiscoverText		
Echosec		
ESA (Emergency Situation Awareness)	Queensland	
Esri		
Evolve24		
Facebook Business		
Facelift		VaPiano, Ikea,
Followerwonk		
GeoFeedia		Microsoft, Allianz, Alibaba, Lamborghini
Gephi		
Google Analytics		
Hashtagify		
Hashtracking		
HootSuite	City of Boston, New York, Barcelona City Council, Fairfax County	
Hubspot		

IBM Intelligent Operations Center for Emergency Management	Department of Science and Technology of the Republic of the Philippines (Case study)	
JIXEL (Alerter und Aggregator)	GECoS (Gestione Emergenze e Comunicazione Sicilia – Emergencies and Communication Management Sicily, Calabria	
Keyhole		
Khoros		
Lexalytics		
Leximancer		
Statistical Cybermetrics		
Meltwater		
Mention		
Mitre		
Mozdeh		
ORA		
Orlo (vormals SocialSignIn)	Fire, Staffordshire Police	
publicSonar	Pilot phase with a Safety Region in the Netherlands	
Pulsar		
Quintly		
Radarly (Linkfluence)	european institutions	luxury brands
Sahana		
Salesforce		
Scatterblogs	police department Innsbruck	dpa (deutsche Presseagentur), afp
Signal		
Simplify360		
Social Hub	police department Stuttgart, Frankfurt	Deutsche Bahn, Rossmann, elbdudler, DIe Welt, Bundeswehr
SocialGist		
SocialMention		
SocialSign.in		
Sparkcentral		
Sproutsocial		
swat.io		
Synthesio		

Sysomos		
Talkwalker		
Tint		
TweetDeck		part of Twitter
Tweetreach		
TweetTracker	Humanity Road Inc.	
Twitter		
Ubermetrics Technologies		Microsoft, TÜV Rheinland, Activision Blizzard, Randstad
Ushaidi		
Vico		
Viralwoot		
WebLyzard		
awario		
Fanbooster	null	null

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Table IX: Draft DCT-schema - Phases of DMC, Directions of Crisis Communication Matrix

	Phase of disaster management cycle				Crisis Communication Matrix communication direction			
Name	**Prevention/Mitigation**	**Preparedness**	**Response**	**Recovery**	**A2A - Authorities to Authorities**	**A2C - Authorities to Citizens**	**C2C - Citizens and Citizens**	**C2A - Citizens to Authorities**
AIDR			y	y			y	
Brandwatch Analytics							y	y
Buffer	y	y	y	y		y		
Cision								
ClaraBridge								
Coosto								
Cogia								
CrowdControlHQ								
Crisis Tracker								
Cyfe								
DiscoverText								
Echosec								
ESA (Emergency Situation Awareness)			x	x				
Esri			x	x				
Evolve24								
Facebook Business								
Facelift								
Followerwonk								
GeoFeedia								
Gephi								
Google Analytics								
Hashtagify								

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Hashtracking								
HootSuite								
Hubspot								
IBM Intelligent Operations Center for Emergency Management								
JIXEL (Alerter und Aggregator)								
Keyhole								
Khoros								
Lexalytics								
Leximancer								
Statistical Cybermetrics								
Meltwater								
Mention								
Mitre								
Mozdeh								
ORA								
Orlo (vormals SocialSignIn)								
publicSonar								
Pulsar								
Quintly								
Radarly (Linkfluence)								
Sahana								
Salesforce								
Scatterblogs			y	y				y
Signal								
Simplify360								
Social Hub			y	y				y
SocialGist								
SocialMention								
SocialSign.in								
Sparkcentral								
Sproutsocial								
swat.io								
Synthesio								

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Sysomos								
Talkwalker								
Tint								
TweetDeck					y	y	y	y
Tweetreach								
TweetTracker			y	y				y
Twitter								
Ubermetrics Technologies			y	y				y
Ushaidi								
Vico								
Viralwoot								
WebLyzard								
awario			y	y				y
Fanbooster						y		y

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Table X: Draft DCT-schema - Range of Functions

	Range of functions															
Name	**monitoring**	**real-time analytics**	**event detection**	**notification**	**location analysis**	**aggregation**	**clustering**	**general citizens warning**	**mapping**	**video and image source analysis**	**filter**	**diagrams**	**visual analysis**	**sentiment**	**quality**	**boolean search query**
AIDR	y	y			y	y	y	n	n							n
Brandwatch Analytics	y	y		y				n	n							n
Buffer	y			y		y										
Cision						y										
ClaraBridge						y										
Coosto						y										
Cogia	y	y		y		y										
CrowdControlHQ	y	y		y	y	y										
Crisis Tracker	y															
Cyfe																
DiscoverText																
Echosec																
ESA (Emergency Situation Awareness)	y	y	y		y	y	y									
Esri	y	y							y							
Evolve24																
Facebook Business																
Facelift	y	y				y										
Followerwonk																
GeoFeedia																
Gephi																
Google Analytics																
Hashtagify																

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Hashtracking																
HootSuite	y	y			y	y										
Hubspot																
IBM Intelligent Operations Center for Emergency Management	y	y			y											
JIXEL (Alerter und Aggregator)	y	y			y	y		y								
Keyhole																
Khoros																
Lexalytics																
Leximancer																
Statistical Cybermetrics																
Meltwater																
Mention	y	y			y	y										
Mitre																
Mozdeh																
ORA																
Orlo (vormals SocialSignIn)	y	y				y										
publicSonar	y	y	y		y	y										
Pulsar																
Quintly																
Radarly (Linkfluence)	y	y			y	y	y									
Sahana					y			y								
Salesforce																
Scatterblogs	y	y			y	y	y	y								
Signal	y	y			y	y										
Simplify360																
Social Hub	y	y				y	y									
SocialGist	y	y				y	y									
SocialMention	y	y														
SocialSign.in																
Sparkcentral																
Sproutsocial																
swat.io																
Synthesio	y	y				y										

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Sysomos																
Talkwalker	y	y			y	y	y									
Tint																
TweetDeck	y	y	n	y	y	y	n	n	n	n	y	n	n	n	n	n
Tweetreach																
TweetTracker	y	y	n	n	y	y	y									
Twitter																
Ubermetrics Technologies	y	y			y	y	y									
Ushaidi																
Vico																
Viralwoot																
WebLyzard																
awario	y	y			y	y	y									
Fanbooster	y	y	null	y	null	y	y	n	null	null	y	y	y	y	null	null

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Table XI: Draft DCT-schema - General Technical Properties, General Properties

	General technical properties									General properties								
Name	**language selection**	**collaboration**	**CAP Format**	**multilanguage data processing**	**API**	**open source**	**standalone**	**authors meta data**	**location meta data**	**already used in disaster management**	**developed from research**	**commercial**	**currently active**	**demoversion available**	**Freeware**	**input information**	**output information**	**release date**
AIDR					y	y	y		y	y	y		n	y	y			2015
Brandwatch Analytics		y	n			n		y	y	n		y	y	y	n			
Buffer		y	n		n	n				n		y	y	y	n			
Cision			n							n								
ClaraBridge	y	y	n		n	n	y		Y	n								
Coosto										n								
Cogia										n				y	n			
CrowdControlHQ										y			y					
Crisis Tracker										y				y	y			
Cyfe										n								
DiscoverText										n								
Echosec										y								
ESA (Emergency Situation Awareness)							y			y		y						
Esri																		
Evolve24										n				y	n			
Facebook Business										n								
Facelift		y								n								
Followerwonk										n								
GeoFeedia										n			n		n			
Gephi										n				y	y			
Google Analytics										n					n			
Hashtagify										n				y	n			

Hashtracking										n				n	n			
HootSuite		y			y					n		y	y					
Hubspot										n				y	n			
IBM Intelligent Operations Center for Emergency Management		y					y			y		y	y					
JIXEL (Alerter und Aggregator)			y		y		y			n		y	y					
Keyhole										n								
Khoros										n				y	n			
Lexalytics										n				y	n			
Leximancer										n				y	n			
Statistical Cybermetrics										n				y	y			
Meltwater										n				y	n			
Mention		y			y					y								
Mitre										y				n	n			
Mozdeh										n				y	y			
ORA										y				y	y			
Orlo (vormals SocialSignIn)										n		y	y	y	n			
publicSonar		y					y			n		y		y	n			
Pulsar										n				n	n			
Quintly										n				n	n			
Radarly (Linkfluence)				y	y					n		y	y	y	n			
Sahana			y			y				y								
Salesforce										n				y	n			
Scatterblogs	GER, EN		y				y			y		y	y	y				
Signal										n		y		y				
Simplify360										n				y	n			
Social Hub	GER, EN				y					n		y						
SocialGist		y			y					n		y	y					
SocialMention										n		tbd	tbd					
SocialSign.in										n				n	n			
Sparkcentral										n				y	n			
Sproutsocial										n				y	n			
swat.io										n				y	n			

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Synthesio				y						n		y	y	y	n			
Sysomos										n				y	n			
Talkwalker				y	y					n		y		y	n			
Tint										n				y	n			
TweetDeck	n	n	n	y	n	n	y	y	y	n	n	y	y	y	y	y	y	2020
Tweetreach										n				y	n			
TweetTracker				y						y			n	y	n			
Twitter										n				y	n			
Ubermetrics Technologies	y	y		y	y					y		y	y	n	n	y	n	2020
Ushaidi										y								
Vico										n				n	n			
Viralwoot										n				n	n			
WebLyzard										n				n	n			
awario	y	y		y	y					y		y	y	n	n	y	y	null
Fanbooster	null	null	n	null	y	n	y	null	null	n	n	y	y	y	n	y	y	null

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Table XII: Draft DCT-schema - Data Sources, Concrete Use of Social Media

	Data sources													Concrete use of social media (examples)					
Name	**blogs**	**commentary functions**	**websites**	**forums**	**microblogs**	**news pages**	**press releases**	**social media sites**	**video on demand / video websites**	**crisis warning softwares / apps**	**other analysis softwares**	**other monitoring softwares**	**instant messaging / chatting softwares**	**Twitter**	**Facebook**	**Instagram**	**Youtube**	**Pinterest**	**LinkedIn**
AIDR	n	n	n	n	y	n	n	n	n	n	n	n	n	y	n	n	n	n	n
Brandwatch Analytics																			
Buffer														y	y	y			
Cision														y					
ClaraBridge					y	y	y	y						y	y	y			
Coosto																			
Cogia																			
CrowdControlHQ														y	y				y
Crisis Tracker																			
Cyfe																			
DiscoverText																			
Echosec																			
ESA (Emergency Situation Awareness)														y					
Esri																			
Evolve24																			
Facebook Business																			
Facelift													y	y	y	y			
Followerwonk																			
GeoFeedia																			
Gephi																			
Google Analytics																			
Hashtagify																			
Hashtracking																			

HootSuite														y	y	y	y	y	y
Hubspot																			
IBM Intelligent Operations Center for Emergency Management																			
JIXEL (Alerter und Aggregator)														y	y				
Keyhole														y	y	y	y		
Khoros																			
Lexalytics																			
Leximancer																			
Statistical Cybermetrics																			
Meltwater																			
Mention	y			y										y	y	y		y	y
Mitre																			
Mozdeh																			
ORA																			
Orlo (vormals SocialSignIn)														y	y	y			y
publicSonar														y	y		y		
Pulsar																			
Quintly																			
Radarly (Linkfluence)	y			y										y	y	y	y	y	y
Sahana																			
Salesforce																			
Scatterblogs					y									y	y				
Signal	y			y															
Simplify360																			
Social Hub	y																		
SocialGist	y			y										y	y	y	y		
SocialMention														y	y		y		
SocialSign.in																			
Sparkcentral																			
Sproutsocial																			
swat.io																			
Synthesio																y			

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Sysomos																			
Talkwalker	y			y										y	?	?	?	?	?
Tint																			
TweetDeck	n	n	n	n	n	n	n	y	n	n	n	n	n	y	n	n	n	n	n
Tweetreach																			
TweetTracker														y					
Twitter																			
Ubermetrics Technologies	y	y	y	y	y	y	y	y	y	n	y	y	n	y	y	y	y		
Ushaidi																			
Vico																			
Viralwoot																			
WebLyzard																			
awario	y	y	y	y	y	y	y	y	y	n	y	y	n	y	y	y	y		
Fanbooster	n	n	n	y	n	n	n	y	y	n	n	n	n	y	y	y	y	y	y