DISASTER WASTE MANAGEMENT AND COMMUNITY ENGAGEMENT

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Lund 2024

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Number of pages: 64
Wordcount: 15 096
Keywords: disaster waste management, debris, community, engagement, participation
Abstract:

Disasters can generate up to fifteen times the annual rates of waste generated by the impacted communities and overwhelm the capacities of waste management systems. Disaster waste influences almost every aspect of response and recovery, is risky, and can be time-consuming and costly to clean-up. Disaster waste management (DWM) is, therefore, a key, and often neglected step for response and recovery. Research gaps show that DWM, particularly its social and organisational aspects, remains a largely unexplored topic. This research aims to fill these gaps by exploring the potential of engaging the affected communities in DWM for better efficiency. By conducting a scoping study of the existing DWM and comparing the theoretical results to the practice using data from 9 semi-structured interviews, information was collected, analysed and interpreted. The complexity of DWM is portrayed through state-of-the-art findings and the many determinants of DWM, dilemmas present in the field and current debates in academia and practice. This serves as a base for exploring the potential of community engagement and its role in DWM. Based on the results, communities play a diverse role, from affecting how regular pre-disaster waste is treated, thus preventing the piling up of the mixed waste that aggravates the DWM, to participating in planning, decision-making, information sharing and trainings. The study contributes to the general knowledge in this emergent field, provides a base for further localised research and offers practical implications for policy-makers and organisations working with communities as to how to best involve them in DWM.

Avdelningen för Riskhantering och samhällssäkerhet, Lunds tekniska högskola, Lunds universitet,

Lund 2024.

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Acknowledgements

First and foremost, I want to '*tack*' myself; for dedication, endurance, ability to overcome the lows and all the hardships I encountered on this interesting and enriching two-year journey at Lund University. This would have not happened without the sincere and constructive help and guidance of Mo Hamza – thank you for all your time, effort but especially patience to navigate me through this research and writing process. Your kind advice and understanding of the way I work and think have always brought me back on track when I was flying way too high.

My big '*thank you*' goes to the interviewees who made this thesis possible to happen by sharing their knowledge, and expertise and for finding time even under crazy time-zone differences.

I also want to thank my DRMCCA peers – what a journey this was! I have never met such a supportive and sincere batch, dedicated to the cause and excellence – I have learnt so much from each and single one of you. Thank you for this.

My gratitude extends to all the amazing lecturers and staff of LTH who make this programme so unique and well-structured and share their wisdom and experience with us. You are an inspiration to all of us!

I want to thank Pernille and Thijs – for their constructive criticism that added the last touch to this thesis and for all the fun in the group projects and beyond.

My deepest gratitude goes to dear Sofia, for her infinite support, comfort, help and for always standing by my side during these two difficult but amazing years, being there when I needed it and making this all such a wonderful experience.

Most importantly, I want to thank my partner Marek – without you, your patience and support, I would have never joined this programme and none of this would have ever happened. Thank you for believing in me.

Summary

Disaster waste management (DWM) is a crucial step in returning back to “normal” after hazardous events, particularly earthquakes, hurricanes, typhoons, tsunamis and cyclones (Genc, 2023). Response and recovery are dependent on prompt and timely DWM (Domingo & Luo, 2017), as disasters can generate large amounts of waste that pose health and environmental risks and overwhelm the capacities of waste management systems (Brown et al., 2011a). This topic is an emergent one – whether in academia or practice, therefore research gaps persist, calling for wider engagement and attention (Zhang et al., 2019). One such aspect is the social and organisational, especially when it comes to the role of the public in DWM (Brown et al., 2011; Zhang et al., 2019; Tajima et al., 2023). This thesis explores the role of the community in the DWM and its potential for enhancing the efficiency of this system, in different phases of the DRM cycle. An inductive research strategy is applied; therefore, no theoretical frameworks are included, and space is given to conceptual clarifications for a better understanding of the complexity of this topic. This thesis benefits from data collected by two methods – a review of the literature in a scoping study and semi-structured interviews with 9 experts from academia and practice. Due to the exploratory approach, various codes and themes emerged from the collected data. These were structured and combined based on the two research questions, reflecting the overall objective of the thesis, i.e. exploring, how can community engagement supports effective DWM.

State-of-the-art of DWM is presented, with four main themes emerging from the analysis and constituting a base for the overarching objective. Firstly, hard and soft determinants of DWM are highlighted along with and the important regular “peace-time” solid waste management as one of the major determinants influencing the DWM (Ahmed et al., 2022; Karunasena et al., 2012). Second, a dilemma in DWM between the urgent removal of disaster waste or adherence to environmental standards was highlighted by several authors. Under this dilemma, recycling and temporary storing of the disaster waste was often referred to as potential and preferred ways of treating the waste, whether as a final solution (recycling) (Atchue & Morse, 2023; Modica et al., 2021) or an interim one (temporary storage sites) (Crowley, 2017; Memon, 2016; Mori & Tajima, 2020), therefore these are analysed more in-depth. Thirdly, debris can present itself not just as a problem but also an opportunity for some (Brinton et al., 2022; de Magalhães et al., 2020; Guerrero-Miranda & Luque González, 2021). In this regard, the informal waste sector appears as a stakeholder with the potential of influencing DWM (Dugar et al., 2020). Disaster-affected community that suffers losses in livelihood and shelter can benefit from the cash-for-work programs that provide necessary income to the community members while disposing of the debris without the need to hire external services (Guerrero-Miranda & Luque González, 2021). Hence, these two topics constitute an important part that is discussed closely under this theme. Fourth, and a recurrent topic within the DWM state-of-the-art, is the need for mainstreaming DWM into disaster risk management – policies, frameworks, programmes but also budgets and funding at all the administrative levels – local, regional, national and international for enhancing its efficiency (Pradhan & Xu, 2018; Srinivas & Helmy, 2015).

The second part of the results chapter is dedicated to answering RQ2, i.e. the community engagement and seeking answers to what roles a community can have in DWM, in which disaster risk management (DRM) phases can the community be engaged and what could be hinder to this engagement. To understand DWM processes in each phase of the DRM cycle and the potential to include people in them, first, the context for community engagement is laid out. Social, cultural, economic and other factors are analysed and the importance of coordination of stakeholders in DWM is highlighted (Tajima et al., 2023; Trivedi et al., 2015). DWM processes in each DRM phase are outlined based on the collected data from theory and practice, and the potential for intersections with community engagement is scrutinised. The role of the community in DWM is diverse and affected by many determinants that need to be taken into consideration during planning and developing a DWM system. The community can affect DWM by influencing the composition and quantity of the disaster waste beforehand by adopting a 3R attitude – recycle, reuse and reduce the waste where possible, already as a part of the solid waste management process in the pre-disaster time. Participation in the clean-up requires adequate preparedness, trainings and information. Barriers such as lack of skills, resources, and protective equipment can be tackled relatively easily, depending on the context. Other barriers are more complex, requiring a systemic approach to economic and social development, working with people's attitudes and understanding of the matter. A sensitive approach is necessary, especially when trauma and loss affect survivors, and acknowledging the uniqueness of each community and specific features of the setting.

This research provides understanding as to how the situation with this field looks like in academia and practice and suggests ways to improve practices, efficiency and effectiveness of DWM by outlining how and when communities could be involved in the DWM. Additionally, it offers some baseline for further localised research that could stimulate the development of this field.

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Abbreviations

DRM	Disaster risk management
DWM	Disaster waste management
IGOs	Inter-governmental organisations
LTH	Faculty of Engineering, Lund University (*Lunds Tekniska Högskola*)
MSB	Swedish Civil Contingencies Agency (*Myndigheten för samhällsskydd och beredskaps*)
NGOs	Non-governmental organisations
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
RQ	Research question
TDS	Temporary disposal site
TSS	Temporary storage sites
UK	United Kingdom
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNEP	United Nations Environment Programme
US	United States
USD	United States dollar

1. Introduction

After the devastating earthquakes in 2023 that hit Türkiye and Syria, and the following aftershocks, 280,000 buildings collapsed or were damaged to the point that they had to be demolished, with a total cost of the debris clean-up estimated up to 1.6 billion USD, as the recent assessments shows (Türkiye Earthquakes Recovery and Reconstruction Assessment, 2023). The volume of debris generated by a single hazard can pile up to about fifteen times the annual rates of waste generated by impacted communities and can significantly overwhelm the capacities of the waste management system (Brown et al., 2011a). The 2011 Great East Japan Earthquake resulted in approximately 31 million tons of disaster waste, summing up to a total annual waste amount of the whole Japan (Wakabayashi et al., 2017).

Disaster waste management (DWM) becomes an inevitable step after hazardous events, particularly earthquakes, hurricanes, typhoons, tsunamis, and cyclones. However, uncoordinated and chaotic response, and poor recovery, further complicated by large amounts of waste hindering the emergency response, leads to failures of the search and rescue activities (Genc, 2023). Disaster-generated waste is composed of a variety of materials: from construction and demolition waste, vegetation, soil, hazardous waste from households, industrial waste, and pre-existing waste to bodies of victims and dead animals (Brown et al., 2011a; Dugar et al., 2020). Such a mixture of material, and the associated poor handling of the waste, poses risks leading to environmental pollution and health and safety hazards, including vermin and vector breeding (Brown et al., 2011a). Thus, even though often overlooked and not prioritised (Karunasena et al., 2012), DWM constitutes an integral element of response and recovery (Domingo & Luo, 2017).

1.1 Research Gap and Motivation

The notion that “disasters are not natural” (O’Keefe et al., 1976) has been an accepted concept in disaster research and further established by a UNDRR campaign[1]. The role of vulnerability, inequalities, poor urban planning, and insufficient policy implementation in hazardous events turning into disasters is undisputed. Hence, managing the risks that hazards pose to humans and everything they value became imperative (Puttick et al., 2018).

Disaster waste influences almost every aspect of the response and recovery activities. It is risky and can be very time-consuming and costly to clean-up. Often, solid waste cleaning programs and services are not in place even in regular situations, implying that waste management is not high on the list of priorities (Brown et al., 2011a). This can become problematic when all societal functions are suddenly compromised by an earthquake, tsunami or typhoon. Therefore, setting up an effective DWM, especially in countries prone to hazards, is a major step in securing a resilient and sustainable future (Tajima et al., 2023).

In practice, DWM has been largely neglected in the policies and the planning phase (Zawawi et al., 2018) and is often ad-hoc and uncoordinated (Ahmed et al., 2022). Although some

[1] #NoNaturalDisasters Campaign, see more at: https://www.undrr.org/our-impact/campaigns/no-natural-disasters#:~:text=Hazards%20are%20natural%2C%20disasters%20are,%2Drisk%2Fdisaster%2Drisk%E2%80%A6

gaps have been covered in recent years in DWM research, it still remains an emerging and largely unexplored topic within the DRM research (Gupta et al., 2016; Zhang et al., 2019; Brown et al., 2011; Modica et al., 2021). Most literature includes single case studies, and technical management aspects of DWM and does not focus on organisational, legal, social, and financial frameworks and impacts of the "peace-time" waste management transition to DWM (Brown et al., 2011a; Zhang et al., 2019). Moreover, cross-case studies with more diverse examples beyond the US context are also missing (Zhang et al., 2019) and the planning phase of the DWM lacks more academic attention. The relationship between communities' recovery and DWM is not well-researched and understood (Brown et al., 2011a).

Tajima (2023) considers coordination among public, private, and civil society actors as a key factor for successful DWM. Despite the participation of disaster-affected communities in the clean-ups has proved to be a key element in effective DWM (Trivedi et al., 2015) and social capital and leadership are essential components for fast and efficient recovery (Kawamoto & Kim, 2016), no in-depth research of social or organisational aspects have been conducted (Brown et al., 2011; Zhang et al., 2019; Tajima et al., 2023;). Similarly, adequate guidance on how to efficiently include people in waste decision-making processes in a disaster context is missing (Brown et al., 2011a). This guides the motivation for this thesis and encourages further exploration of understanding the potential of engaging communities in DWM.

1.2 Purpose and Research Questions

The purpose of the thesis is to fill an existing research gap by investigating how the current academic literature covers the DWM topic and where the research and practice meet. This exploration focuses mostly on the organisational and social aspects of DWM and the correlations with community engagement, as these belong to the under-researched areas. Exploration is guided by the following overarching objective and two research questions (RQs):

How can community engagement support effective and efficient disaster waste management (DWM)?

a) What is the state-of-the-art on DWM in theory and practice?
b) What role does the community play in DWM; in which phases of DRM; and what are the known barriers to community engagement in DWM?

1.3 Limitations of the Study

An important limitation of this research is its focus on hydro-meteorological- and geological-hazards-generated waste, excluding waste accumulated during pandemics, terrorist attacks, industrial accidents, and others. Moreover, this research solely covers the waste generated by hazards and not by relief and humanitarian aid. Another significant limitation of this study is that despite its focus, no actual communities were consulted during the research, despite the effort to contact and include civic society and community-based organisations in different hazard-prone countries with experience with DWM. This, too, might have affected the general objectivity of the data.

2. Conceptual Framework

This chapter introduces concepts and frameworks that serve as bases for the research and provide a backbone for the analysis. Based on the exploratory approach and inductive strategy of this study, no theoretical frameworks have been defined. However, to better comprehend the findings and to structure the results, the disaster risk management cycle and its various phases as defined below, are used throughout this thesis.

2.1 Disaster as a Social Phenomenon

One of the most prominent and widely accepted definitions of disaster comes from the United Nations Office for Disaster Risk Reduction (UNDRR). UNDRR's terminological dictionary defines a disaster as 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*" (UNDRR, 2016).

As Coppola (2020b) outlines, not all events become disasters, only those that overburden response capacities. Disasters are not time-bound; they can be sudden or slow and creeping. Often, they are not restricted to a single hazard but can occur as compound disasters, whether independent of each other or as a result of secondary hazards triggered by the first one (Coppola, 2020b, 2020a).

2.2 Disaster Risk Management

Disaster risk management (DRM) is understood as "(…) the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk and manage residual risk" (UNDRR, 2016). Different scholars categorize the measures or actions necessary for managing the risk of disasters into four (Coppola, 2020b), or five phases (Alexander, 2002). In this thesis, a combination of definitions that best suits the DWM context is used, dividing DRM into the following steps of the DRM cycle:

- Prevention and Mitigation
- Preparedness and Planning
- Response
- Recovery

2.3 Disaster Waste Management

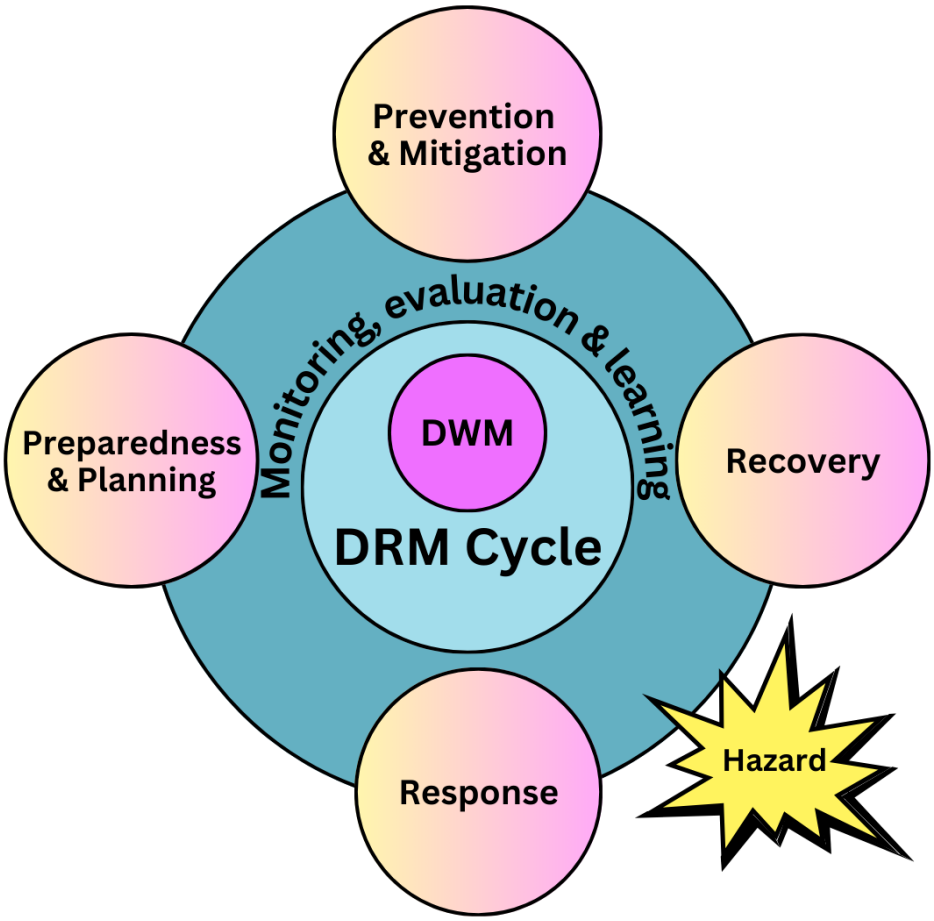
The field of DWM is still emerging, thus a universal or academically respected definition is yet to be elaborated and agreed upon. United Nations Environment Program (UNEP) in collaboration with the Office for the Coordination of Humanitarian Affairs (OCHA) and the Swedish Civil Contingencies Agency (MSB) has described DWM as the "sorting, collection, handling, transportation, and treatment of disaster waste" (MSB/UNEP/OCHA, 2013, p.41). Dugar et al. (2020) further elaborates, calling DWM a mechanism used for "handling, treatment, reuse,

and recycling of disaster-generated debris that must comply" both with "the standard technical practices in solid waste management as well as the emergency response and recovery system" (2020, p. 466). It is not specified what is deemed to be "standard" technical practice in DWM.

Disaster waste or post-disaster waste is considered to be a waste mix "generated by the impact of a disaster, both as a direct effect of a disaster as well as in the post-disaster phase" due to inefficient waste management (UNEP/OCHA, 2013, p. 41). Part of the disaster waste is also debris - remains generated by broken buildings, and parts of infrastructure mixed with vegetative material caused by different types of hazards (Brown et al., 2011a; Dugar et al., 2020).

Despite the main narrative and significant ratio of studies being oriented on the response and recovery phase (Brown et al., 2011a), DWM is positioned as an integral part of the whole DRM cycle and as one of the key elements or (thematic) activities. Positioning DWM within all stages of the DRM cycle allows for a more comprehensive and holistic analysis, looking into its different phases while searching overlaps and community engagement potential in each phase.

Figure 1: Positioning of DWM within DRM cycle



Source: Author's adaptation of DRM cycle, combined from Coppola (2020b) and Alexander (2002)

2.4 Community Engagement

2.4.1 Community

The concept of community is a particularly slippery one (Mathie & Cunningham, 2003) and has been developing and changing over time (Rodríguez et al., 2018). Thorns (in Vallance & Carlton, 2015) identified ninety-four different definitions of community. The conditions of what constitutes a community are very time-and-context dependent. McMillan and Chavis (1986) (in Van Niekerk et al., 2018) describe four elements of community:

- Membership or the feeling of belonging,
- influence – of the group towards individuals, of individuals towards the group and of the group towards its environment,
- fulfilment of the needs of the members by the application of the resources available in the group for such purposes,
- shared emotional connections.

Although the concept of community has been evolving and has moved away from strictly geographically based, within DRM and especially DWM, the connection of community with the physical location remains important due to the exposure to particular hazards in a certain environment (Rodríguez et al., 2018).

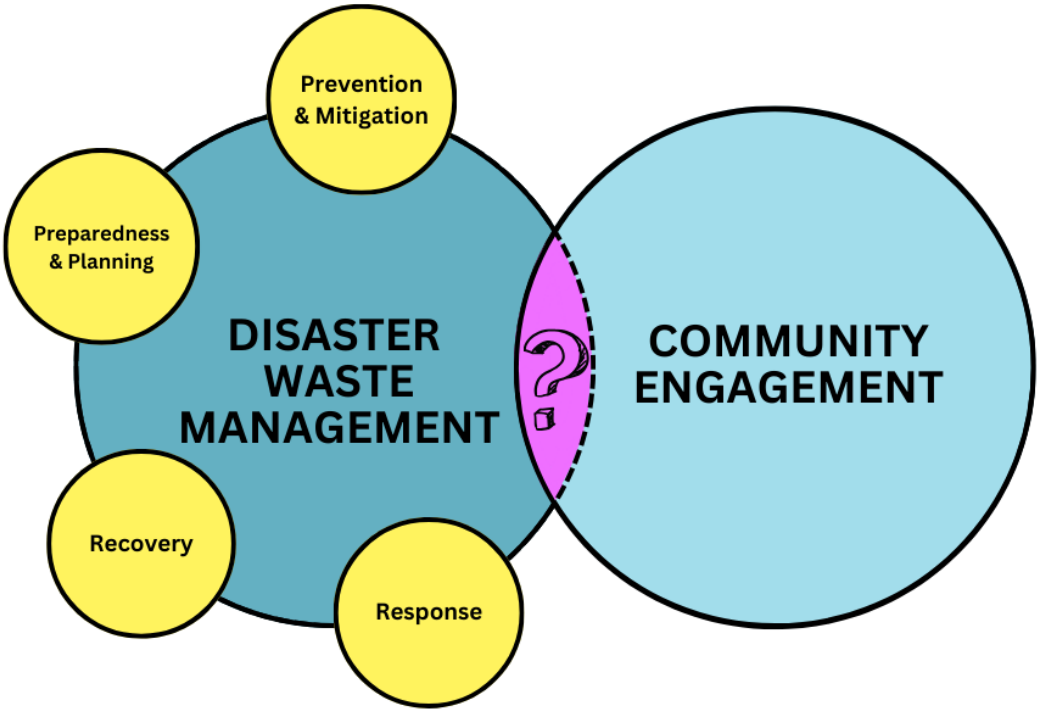
2.4.2 Community Engagement in DWM and DRM

Many policy documents, handbooks, and guidelines call for "systematic community engagement" or "community involvement" (e.g. Sphere Handbook, 2018; Sendai framework, 2015). Community engagement can indeed link the existing social capital community possesses with the necessary actions and solutions for responding and recovering after a hazardous event (Parsons et al., 2016).

Similar applies to DWM; community engagement seems to be considered as an important element that influences the effectiveness of the response and recovery phase. Although the available literature often highlights the necessity for participatory processes in the policies guiding the DWM (e.g. participatory contingency planning) the social and organisational aspects of DWM particularly in other than the response and recovery phase are under-researched (Brown et al., 2011a) and thus the call for a participatory approach often remains more of a token than a real and functional practice.

In this thesis, community engagement is not limited to the actual involvement of multiple members of a tightly knitted group, but rather the notion is broadened to any non-private and non-authority involvement and participation in DWM. This includes the actions of individual members of communities, the public and volunteers from the affected areas and beyond. Engagement is understood as any form of activity with the intention to influence any part of the process of DWM, its partial activities or stakeholders (Head, 2007). For simplification, *involvement* and *participation* are used interchangeably in this thesis as fit for the context, although the nuances of both exist and are not to be omitted. Limitations of community engagement and potential drawbacks are not a subject of this thesis, thus not discussed.

Figure 2: Conceptual framing of community engagement and DWM



Source: Author's visualisation

3. Methodology

The following section introduces the methodology used in this thesis and outlines the selected methods. This thesis builds on qualitative research and on the idea that the nature of reality is co-constructed by researchers, practitioners and communities and dependent on subjective views (Creswell, 2013). Evidence of such realities is explored and studied under chosen methods to try to gain an understanding of the variety of 'knowledges' available out there. The collection of qualitative data was guided by an inductive research strategy, which is best suited to answer exploratory and descriptive questions (Blaikie, 2009). The chosen methods were purposefully combined to answer both research questions and provide robustness to the data collected. In line with the inductive strategy, this research builds on data collection and triangulation, followed by analysis, trying to describe and interpret the "nature of regularities or networks (…) in social life" (Blaikie, 2009). Limitations of the methodology are also outlined at the end of the chapter.

3.1 Data Collection and Sampling

Data collection was conducted by using two methods: **a scoping study** and **semi-structured interviews**.

3.1.1 Scoping Study

According to Arksey and O'Malley (2005, p.21) a scoping study "aims to map rapidly the key concepts underpinning a research area and the main sources and types of evidence available". This approach can be particularly beneficial in emerging and not yet extensively researched fields (Mays in Pham et al.,2014) which DWM still is (Gupta et al., 2016; Zhang et al., 2019). The purpose of this scoping study is to map the "extent, range and nature of the research activity" (Arksey & O'Malley,2005, p. 21) within DWM.

The scoping study was carried out in line with the framework suggested by Arksey and O'Malley, and documented in such details, so it would allow other researchers to replicate it (Arksey & O'Malley, 2005). The following steps were included:

I. Identifying the research question,
II. Identifying relevant studies,
III. Study selection,
IV. Charting the data,
V. Collating, summarizing and reporting the results.

I. Research Question for the Scoping Study

How can community engagement support effective and efficient DWM?

a) What is the state-of-the-art on DWM in theory and practice?
b) What role does the community play in DWM; in which phases of DRM; and what are the known barriers to community engagement in DWM?

II. Identifying the Relevant Literature

For this research, the Elsevier's Scopus database was selected for primary search inquiry, covering a wide range of research in different study fields (Beerens & Tehler, 2016, p. 415) utilising the Boolean search operators. Results were limited based on the following general criteria:

- English language,
- Published between 2009 and 2023 for recent development.

The search itself was not limited strictly to academic articles but also widened to grey literature, books, book chapters, conference papers and similar, in an effort to widen the scope in this emergent field. To add robustness to the identification process, additional literature was mapped by secondary search inquiry using Google Scholar, a web-based academic search engine that serves as a source for finding relevant grey literature (Haddaway, 2015).

III. Study Selection

The search process proved to be a dynamic and iterative one, requiring flexibility and reflexivity, running several test searches and repetitions and revisiting the results, to make sure the literature was scoped in a complex, relevant and comprehensive manner (Arksey & O'Malley, 2005).

a) Primary Search Inquiry - Scopus

Given the emergent nature of the topic, the primary search inquiry included search strings consisting of different yet general word combinations to ensure greater variability of the potentially relevant literature. The first search string was constructed broadly, basing it on "TITLE-ABS-KEY":

("disaster waste management").

Applying the **criteria,** the search produced **100 papers** (including articles, book chapters, reviews, editorials, conference papers, and lectures). This search was exported to **.csv** format for further analysis. Title analysis, abstract analysis, and quick skimming narrowed the search down to **32 articles for full reading**, out of which **28** were included in the final analysis. The selection process is depicted in Figure 3. To ensure that the most common synonym (i.e. debris) is covered, a second search string was conducted, based on "TITLE-ABS-KEY":

("disaster debris management")[2].

This search found **26** papers, however, only **three articles** were identified as relevant for the analysis for this thesis.

b) Additional Search Inquiry – Google Scholar

[2] This key word combination had to be used instead of "disaster" AND "debris" AND "management", as among the 951 results at first, too many irrelevant articles were found.

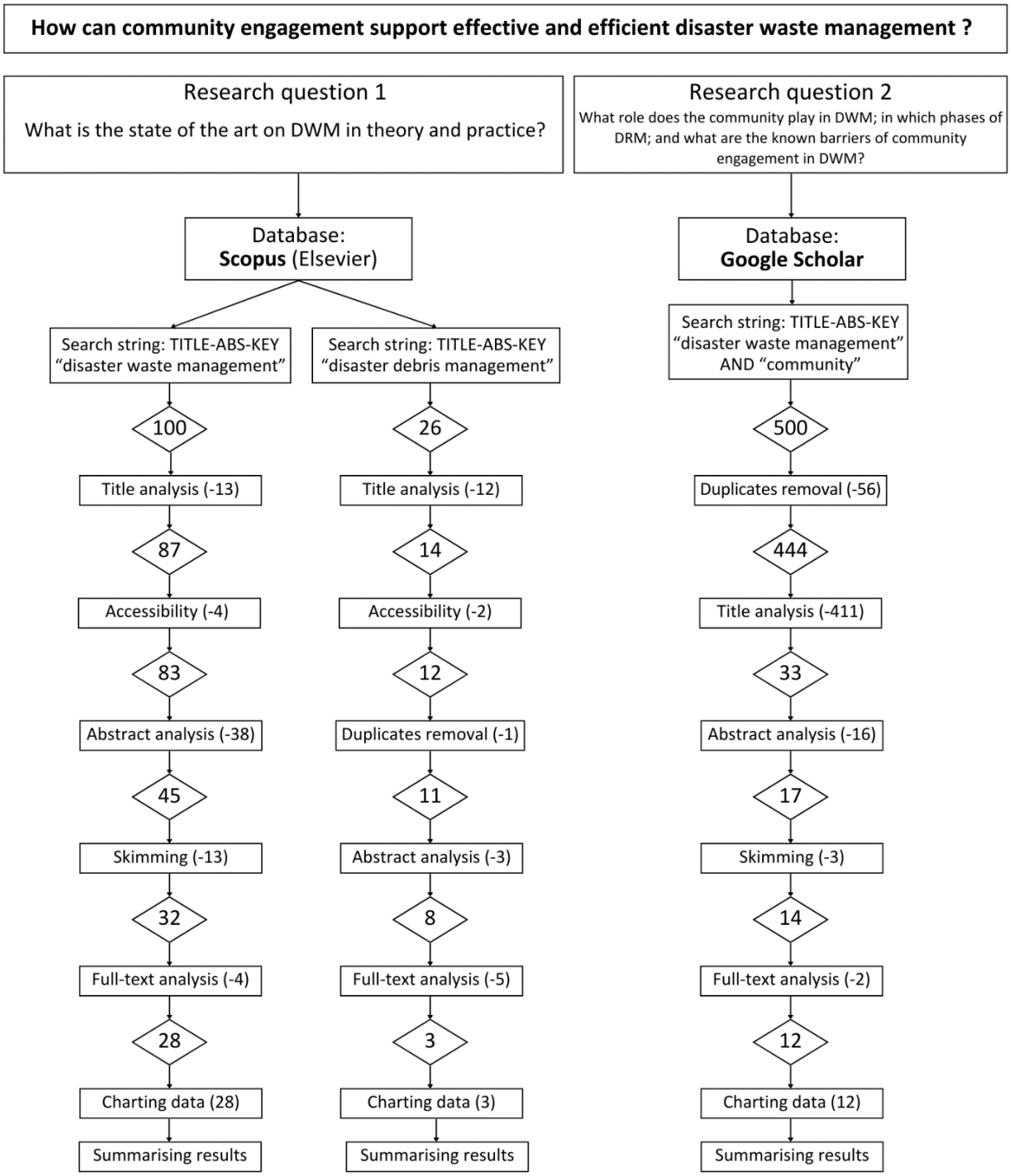
To add robustness to data, Google Scholar was used. The same criteria were applied but the search string was adjusted to ensure only the most relevant articles for this thesis were found. Search inquiry under TITLE-ABS-KEY format included the following keywords:

("disaster waste management" AND "community").

Google Scholar results gave **831** articles in English from 2009 until 2023 but only the first 500 were selected for further scrutiny. Publish or Perish software by Harzing was used to export the 500 results to .csv file for easier sorting. The selection process is described in

Figure 3. Out of these, **12** were used for the analysis.

Figure 3: Scoping study selection process – Research question 1, Research question 2



IV. Charting the Data

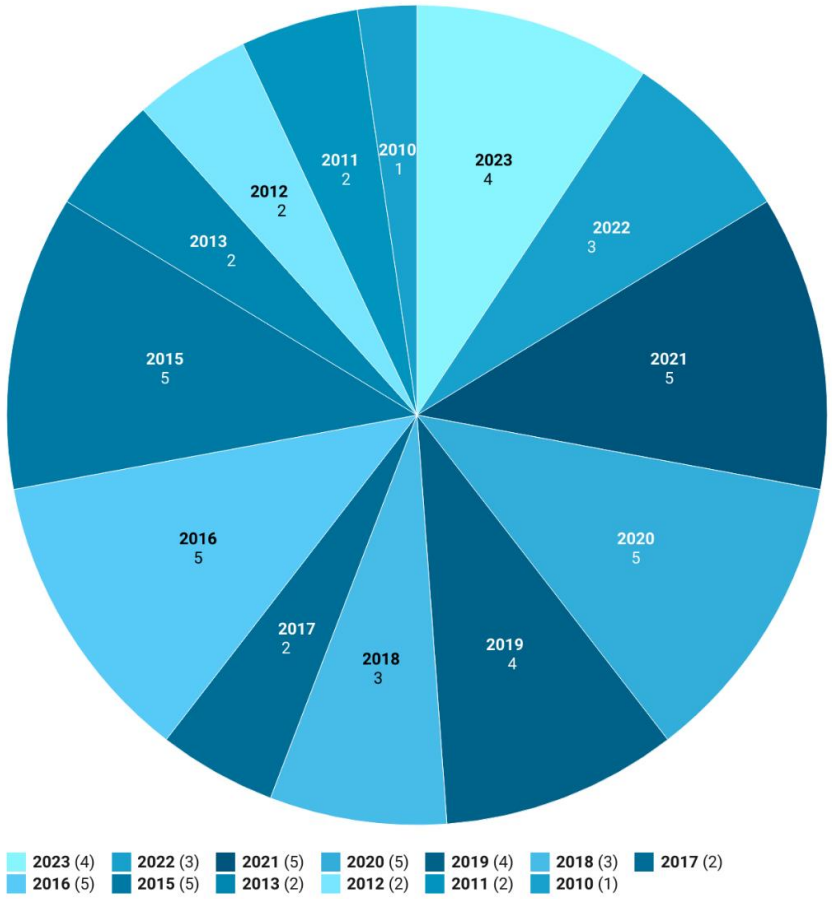
Ritchie and Spencer's (in Daudt et al., 2013, p. 2) describe the data charting process as a technique for "synthesizing and interpreting qualitative data by sifting, charting and sorting material according to key issues and themes" similar to "data extraction" in the systematic review process (Arksey & O'Malley, 2005). In line with this, broadly set key themes were chosen to keep the focus while reading the papers and ensure comparability of the data extracted. Open coding was utilised. In total, **54** papers were read in full, out of which only **43** were included in the analysis. Despite the effort to include grey literature, after the selection process and the charting, only scholarly articles ended up being included in the analysis.

V. Collating, Summarising and Reporting the Results

Data were collated and summarised based on the charted data identified through codes relevant to the RQs. No analytical or theoretical framework was set before the research. At first, colour-coding was used for highlighting repeating themes. Later, topics were collated in an excel sheet for assessment. The weight of evidence or quality of the studies was not assessed (Daudt et al., 2013). Data were also triangulated by semi-structured interviews, in line with the suggestions of Daudt et al. (2013) to engage in a consultation exercise for the findings' validation.

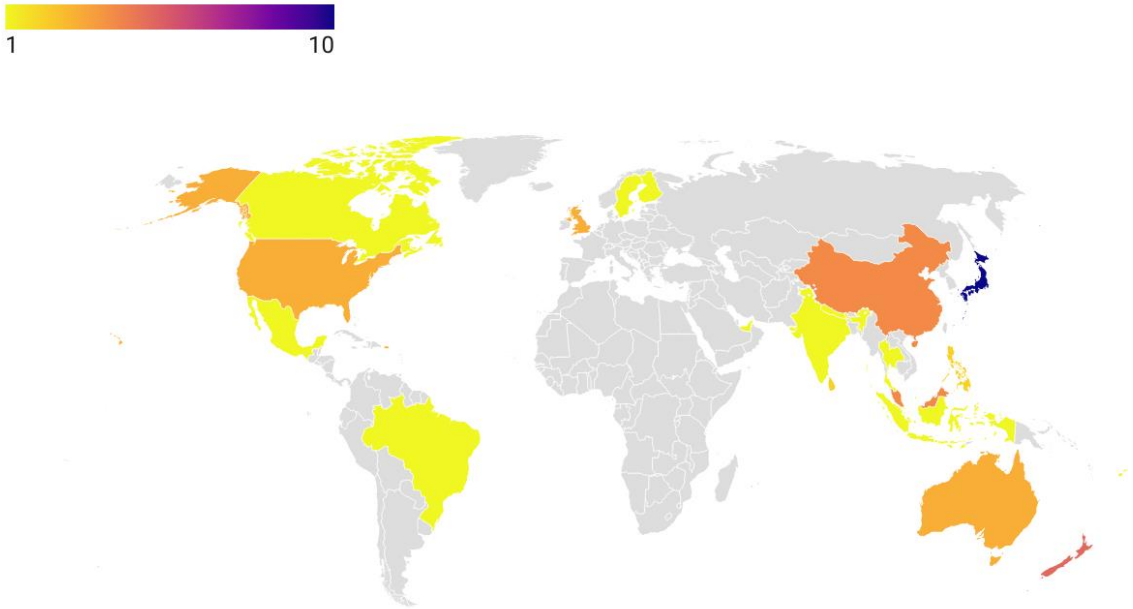
Based on the year of publication of the analysed studies, a steady growth can be observed from around 2015 in exploring the DWM topic by researchers. However, due to a limited number of articles, it is impossible to derive any conclusions about the entire field. The map of the main authors' affiliation shows Japan, the USA, New Zealand, Australia, and Malaysia dominating the research. Japan's highest number of articles can be attributed to high capacity and knowledge combined with research interest and prioritisation of the DWM topic.

Figure 4: Number of articles published by year



Source: Author's data, visualisation by Datawrapper

Figure 5: Papers published by author's affiliation



Source: Author's data, visualisation by Datawrapper

3.1.2 Semi-structured Interviews

The scoping study method was complemented by subsequent semi-structured interviews with key informants. Semi-structured interviews provide a flexible and versatile tool to research how realities are constructed and viewed according to different interviewees (Kallio et al., 2016). Identifying the interviewees was influenced by the limitation of conducting the interviews online and within a short time.

I. Interview Sampling

Using a purposeful sampling strategy as a tool to "inform an understanding of the research problem and central phenomenon" (Creswell, 2013, p. 300), key informants were located either through contacts known to the Risk Division of LTH or by purposeful online search targeting a diverse portfolio of actors, i.e. international organisations, national, regional and local authorities, non-governmental organisations and academia. Although often questioned for lack of sample diversity, a snowball sampling, suitable for studying social networks and connections, was also included to help mitigate the issues with lack of responsiveness (Kirchherr & Charles, 2018). In total, 35 key informants were contacted from 15 countries (namely *Sweden, Japan, Nepal, Sri Lanka, the Philippines, Indonesia, Thailand, Australia, New Zealand, Samoa, Fiji, the US, the UK, Italy* and *Türkiye*). For the exact response rate see Table 1.

Interviewees were either consultants/independent experts in the field of DWM/solid waste management/disaster risk management, or representatives of national authorities, private companies, and international organisations (IGOs and NGOs) working with the topic of DWM. Local community organisations and NGOs residing in the countries mentioned above were contacted, however, no response was obtained. Out of 35 contacted, 8 experts were interviewed. One additional expert sent their answer to the interview questions as an audio message by email, using the same interview guide, therefore was regarded as an equally valuable source. Five of the 9 interviewees were recruited through snowball sampling.

Table 1: Interviewees' response rates

Response	**Individuals**
Participated in an online interview	8
Other form of consultation – audio message	1
Declined	5
Nil response	19
Agreed but did not participate	2
Total	35

Source: Author

II. Data Collection

Online interviews were conducted through Zoom. On average the interviews took 48 minutes (from 41 minutes up to 1 hour 4 minutes). Interviews were conducted based on an interview guide (see Annex 3), recorded and transcribed for further analysis.

III. Data Analysis

The analysis of the data was conducted in line with the open coding process of data analysis spiral, as suggested by Creswell (2013), using the NVivo software, version 14. After transcribing, reading, classifying, memoing, and organising the data, links between the codes emerged in line with the inductive coding strategy (Creswell, 2013). Hence, codes were classified into themes which were then aggregated and interpreted based on the RQs to provide a backbone for the results section. This iterative process allowed for revisiting the codes and themes several times, editing and aggregating them.

IV. Ethical Considerations of Semi-structured Interviews

To tackle the potential problem of confidentiality and data protection of interviewees, written informed consent (see *Annex 2*) was sent out to their email addresses before the interviews to ensure no language barrier, time pressure or connection issues would hinder their understanding of the matter to which they are consenting. Additionally, information about the recording of the interviews for research purposes and transcription was included. The possibility to withdraw the consent at any point was emphasized. All data were depersonalised, and anonymity was ensured throughout the whole process by keeping the document matching names with labels separately, offline and safely. No incentives were offered to interviewees. (Social Research Association, 2021). Whether conducting a scoping study or interviews, it was kept in mind not to feed any existing stereotypes or biases that would lead to stigmatisation of any groups or the spreading of misinformation. The physical integrity of the interviewees was not violated.

3.2 Data Analysis

Overarching themes that emerged were coded separately for each method in an inductive logic to enhance the robustness of data. They were clustered into several categories based on their relevance to the topic, frequency of appearance or accent given to them by the authors/interviewees. Results from the thematic analysis of the articles and interviews are interpreted, analysed and presented in Chapter 4.

3.3 Methodological Limitations

I. Scoping study

Among the main limitations of scoping studies is that the quality of the selected studies or their importance is not assessed, thus they alone cannot serve as a base for data generalisation (Arksey & O'Malley, 2005). Furthermore, scoping studies are also criticised due to their lack of completeness (Hagelsteen, 2024) often caused by either language limitations, time constraints, or researcher's biases or "publication bias" (Sargeant & O'Connor, 2020). Publication bias appears when publication is dominated by favourable research, causing the researcher conducting the scoping study to report on certain matters with greater emphasis (Sargeant & O'Connor, 2020). Additionally, since decolonisation of research is taking place too slowly, another limitation can be the predominance of Western-centric views, frameworks, approaches, and

concepts in the research, which can negatively influence the inclusivity of epistemologies and global balance (Gray & Fook in Gobena et al., 2023). Besides publication bias, the subjectivity of the researchers about which studies to include when doing title and abstract analysis poses another limitation of the scoping study. This could have potentially affected the results of the data collection.

II. Semi-structured interviews

Contacting people without a gatekeeper based on the researcher's best but perhaps limited knowledge of the networks might have affected how relevant their roles and expertise were for this research. On the other hand, a successful purposeful sampling and snowball sampling that took place in the second stage might have affected the diversity of the interviewees, while increasing the relevance of the data for this study. Additionally, since the majority of the contacted experts come from countries where English is not the first language, this could have affected the response rate significantly and posed a shortcoming in the quality of data acquired through interviews (Kakilla, 2021).

4. Results and Discussion

This chapter presents the results of the scoping study and interviews in an integrated manner that combines analysis and discussion, due to its suitability for the subject and qualitative research. Interviewees are referred to by abbreviations E1, E2[3], etc.

The chapter is divided into two main parts, each providing a baseline for answering the respective RQ. The first part discusses the variety of determinants that emerged as decisive factors influencing DWM, outlining the state-of-the-art in DWM in theory (scoping study) and practice (interviews). All the themes in the first part (RQ1) are connected to the second part (RQ2). Hence, references are being made to how a particular theme is relevant to a community's role in DWM (RQ2).

The second part focuses on the communities' role in DWM in each of the DRM phases to demonstrate the logic behind mainstreaming DWM into DRM and the context under which communities' approach DWM. All these themes reflect the complexity of the topic, and the most recent and/or persisting debate in academia and are supplemented by information from the practice and experience of the interviewees working in the DWM/DRM field, to compare and contrast the knowledge and provide a foundation for answering the overarching objective and two RQs:

How can community engagement support effective and efficient DWM?

a) What is the state-of-the-art on DWM in theory and practice?

b) What role does the community play in DWM; in which phases of DRM; and what are the known barriers to community engagement in DWM?

[3] E (for an expert) is used instead of I (interviewee) in order to minimise the visual confusion (e.g. I1, I5)

4.1 State-of-the-art and Trends in DWM

There appeared to be a consensus between the reviewed literature and the interviews on describing effective DWM in terms of its components, main features, activities, and outcomes. DWM's resilience depends on the "speed at which a system can initiate a clean-up response in order to reduce, reuse, recycle and reproduce for recovery and then discharge the remaining material in an environmentally manner" (Nakayama & Shimaoka, 2015, p. 80). Although resilience is not a centre of the focus of this thesis and was not defined in the conceptual framework, this research widens and refines this framing by focusing and applying this view to effectiveness and efficiency of DWM, thus making it more tangible. Most interviewees also adopted a similar utilitarian perspective on DWM. They usually referred to the aspect of **timely removal of debris** simultaneously with **proper, safe and environmentally friendly disposal**, referring to recycling as a preferred method. According to E5, without a proper DWM, no reconstruction or restoration of the affected areas can be achieved. Maximising the reuse of the material (E8) and potential livelihood restoration through DWM (E6) was mentioned as important features of DWM. This descriptive definition will be further analysed in 4.1.2.

4.1.1 DWM and its Determinants: Critical Issues that Impact the DWM

DWM is influenced by a range of determinants and factors that have, to a varying degree, the potential to facilitate or complicate the process and need to be taken into consideration during planning. This complexity had to be limited for the scope of this thesis and so the issues affecting DWM that emerged from the research were briefly clustered into two groups: **hard** and **soft** determinants.

I. The "Hard" Determinants of DWM

Among the most commonly referred to as "hard" determinants and decisive factors in planning that influence DWM are **geography**, **terrain**, **type of hazard** and **composition and quantity** of the waste (Trivedi et al., 2015; Sakai et al., 2019). Three interviewees mentioned the **size** and **remoteness** of certain locations such as the Indonesian archipelago or Pacific Islands as influencing factors of DWM. E7 stated that because of remoteness, complicated terrain or affected infrastructure, donors, organisations and authorities have often difficulties reaching the area. Similarly, E3 mentioned that remoteness can be a barrier, especially given the transportation and bringing in resources (e.g. heavy machinery). E5 expressed:

> *"Pacific islands are very small, (…) in case of Samoa, there are only 200,000 people living here and there is no municipality, only the central government and (…) more than 300 traditional communities. (…) In Japan, the local governments are in charge of waste collection and disaster response. However, in this country, (…) the central government has to do (…) the planning as well as implementation. It's too much for them, so involving the community is very important." (E5)*

Size of the country, terrain, and remoteness may be a referencing value for inaccessibility during a disaster, however, this is only part of the picture. **Composition** and **quantity** of disaster waste are another important determinant. Disaster waste differs from regular and relatively

predictable municipal waste due to its unstable characteristics (Karunasena, 2010). The composition and quantity of disaster waste are influenced by economic development, urbanisation (Trivedi et al., 2015) built environment and **different types of hazards** (Brown et al., 2011a; Pradhan & Xu, 2018). In earthquakes, most debris consist of construction and demolition waste, whereas the main constituent of disaster waste in hurricanes or typhoons is usually vegetative and green waste (Zhang et al., 2019).

De Magalhães et al. (2020) highlight that waste quantity and composition estimations should be a base for every community's planning for disasters, organisation of work and equipment for DWM. However, Hernández-Padilla & Anglés (2021) argue, that developing a methodology for estimating the waste composition and quantity often becomes difficult due to missing post-disaster data. Importantly, waste composition and quantity can influence whether the public is able to participate in the clean-up, as a large amount of construction and demolition must be removed by heavy machinery (Brown et al., 2011a).

All these factors should be considered by practitioners and decision-makers. Waste quantity and composition estimations must be prioritised in planning for DWM (Brown et al., 2011a; Modica et al., 2021; Trivedi et al., 2015). Hard determinants are significantly **context-dependent** (Brown et al., 2011a) and in some cases difficult to influence (e.g. terrain, geography). In other cases, a systematic approach is required (e.g. to composition and quantity). Nevertheless, these factors need to be considered in DWM planning as well as response and recovery through localised lenses.

II. The "Soft" Determinants of DWM

The soft factors determining the DWM are even more complex, interrelated and difficult to dissect and analyse in isolation. A few, however, emerged as more impactful than others. As mentioned above, DWM as well as disaster waste are very **context-specific** (Sakai et al., 2019; Trivedi et al., 2015) and **country-dependent** (Asari et al., 2013; Brown et al., 2011; Zhang et al., 2019). **Political situation** and/or **leadership** (de Magalhães et al., 2020; Hatcher et al., 2012; Hernández-Padilla & Anglés, 2021; Karunasena et al., 2012; López & Hooper, 2020; Memon, 2016; Pradhananga et al., 2021; Sakai et al., 2019; Zawawi et al., 2018), **social context** (Brown et al., 2011a; Sakai et al., 2019), **institutional arrangement** (Tajima et al., 2023), **cultural factors** (Karunasena, 2010), **funding opportunities**, **management system** (Asari et al., 2013), **awareness of the community** (Sakai et al., 2019), **values** and **accepted common ideas** about waste (Asari et al., 2013) are just a few important determinants to name.

Awareness about DWM and disaster waste has been highlighted in the interviews: both awareness of the politicians and the community. Awareness of the risks by the leaders often plays a role in (non)prioritisation of DWM. Authors refer to **(non)prioritisation of DWM** (despite consuming a large part of the recovery budget) as a barrier (Atchue & Morse, 2023; Pradhan & Xu, 2018). Two interviewees confirmed this, adding that not prioritising preparedness and planning in DWM is particularly problematic (E7), especially given the limited resources (E3). This is often accompanied by unclear roles and responsibilities, so waste ends up being "nobody's responsibility" (E7).

Similarly to the lack of awareness, (non)prioritisation, can be attributed to different factors. According to E2, the **novelty of the topic** of waste management in Nepal impacts the awareness and capacity of the municipalities that acquired new responsibilities after institutional changes and decentralisation (E2). This resulted in low prioritisation compared to their other responsibilities. The capacity as well as the power of the local authorities to enforce the regulations was also stressed by E6:

> *"(…) the most room for improvement is supporting municipalities to build their resilience and strength to respond to debris and solid waste."*

According to the interviewees, some progress in awareness of DWM, although slow, is evident in some countries. E8 stated that DWM is starting to be more acknowledged as a topic in several Asian countries:

> *"I think they're [Philippines] only realising the importance of the DWM very recently. (…). So maybe around 2019, they started their training [of government officials], so only since that time, (…) those who were able to participate in training they are now creating plans at the local government level."*

Five interviewees mentioned the **disaster experience** of a community or a country as a factor relevant to awareness, capacity development and learning. However, the impact of this experience is diverse. According to E4, in Japan, the capacities are often strengthened with every hazard and awareness is significantly improved. An example of Higashi Matsushima city shows that previous experience with the 2003 earthquake compelled the small local communities to consolidate and discuss preparedness, build partnerships and designate a location of a temporary storage site. Thus, after the 2011 tsunami, up to 97% of the large amounts of generated debris were recycled (E4). Similarly, E9 praised the gradually improving capacities of the Philippines and their focus on trainings and strong leadership. This contrasts with Haiti, where, despite recurring hazards, awareness is not present, possibly also due to weak governance and living in a constant survival mode (E9):

> *"You can start thinking about the preparedness [for DWM] if you don't need to think about the survival. (…) So, you start with somewhere and then eventually get to the preparedness for the disasters. (…) Otherwise, you just wait and hope something nothing is going to happen."*

An interconnectedness of all these aspects related to awareness, prioritisation, resource mobilisation (especially when scarce), systematisation and coordination of DWM can be identified. All these factors (size, experience, novelty of the topic) circulate back to a commonly known issue in DRM (and DWM) – **capacity**. Among the main challenges developing countries are facing are the **lack of capacities** (Brown et al., 2011a; Pradhananga et al., 2021), limitation of resources (Brown et al., 2011a; Pradhananga et al., 2021) and technical equipment (e.g. heavy machinery) (Brown et al., 2011a). Seven interviewees also mentioned capacity as an important DWM contributing factor. In Japan, despite the assigned responsibility to develop DWM plans[4],

[4] Ministry of Environment of Japan - Guidelines on DMW

many prefectures lack the human resources to do so (E1). Size, remoteness but mostly limited capacity of Pacific Islands was mentioned by E5 in terms of response but also landfilling potential. E3 adds the level of development as one of the main contributors to lower capacity (budget, human resources, facilities and equipment) to deal with DWM and DRM in the Pacific Islands. E9 elaborated:

> *"It is also about education. I mean, there are no people that want to start a company doing this because they really don't know how to do it. So, it is about training and education. I think you need to start there."*

This is in line with another determining factor according to Brown et al. (2011a) and Nakayama & Shimaoka (2015) - whether disaster waste is managed in **developing** or **developed**[5] countries. Some authors highlight this distinction stating that countries face different problems in this regard (Brown et al., 2011a; Zawawi et al., 2018). Legal frameworks play an important role, too (Kazemi et al., 2022). However, Yusof et al. (2016) state that it is often the implementation that is more problematic, especially in developing countries. Additionally, DWM regulations and existing guidelines have often been created in the Global North with little attention to the context of developing countries (Brown et al., 2011a; Crowley, 2017; Fernandez et al., 2023; Kazemi et al., 2022). All these determinants paint a complex and highly contextual picture of DWM that constitutes the first part of the answer on the current state-of-the-art of the DWM debate and practice. These determinants can pose barriers to DWM and thus influence the effectiveness of the clean-up.

III. "Regular" Solid Waste Management as a Pre-condition to DWM

Another determining issue worth highlighting in a separate subchapter is solid waste management during regular times. Many authors consider the pre-disaster "peace-time" **solid waste management system** to be key, if not the main determining factor of how disaster waste will be managed (Ahmed et al., 2022, 2022; Atchue & Morse, 2023; Dugar et al., 2020; Hernández-Padilla & Anglés, 2021; Ismail et al., 2023; Karunasena et al., 2012; Kazemi et al., 2022; Memon, 2016; Nakayama & Shimaoka, 2015; Parura & Rahardyan, 2020; Tajima et al., 2023; Trivedi et al., 2015; Zawawi et al., 2018). Tajima et al. (2023, p. 4) highlighted the importance of the "cyclic relationship of the pre- and post-disaster actions" in DWM. Karunasena et al. (2012) add that problems with solid waste management, such as dumping contaminated waste randomly, magnifies with disasters. It is fair to assume, that this cyclic relationship tends to be ignored in practice. Consequently, poor management of solid waste management often leads to a high degree of mixing of waste, which E4 considers to be a significant barrier in DWM. Seven interviewees mentioned solid waste management as an important contributing factor to DWM. According to E1, DWM is not an isolated topic, but it needs to be considered in relation to proper solid waste management. Both solid waste management and DWM have environmental impacts

[5] These terms are being used based on the references made by authors of the literature used in scoping study. As majority of the articles used these terms without defining them, it is not possible to make an exact distinction between these two groups or comparison with whether these strictly correspond to high-income/low-income categories or distinctions based on Human Development Index. Therefore, throughout the thesis, they are being used simply as a reference to particular arguments of scoped literature.

and affect pollution, as plastic and other waste are often released into the ocean after disasters (E1).

Having a functional and effective solid waste management is regarded as a mitigation measure (Tajima et al., 2023) or a prevention strategy (Memon, 2016) of DWM, that can influence waste control and decrease the potential quantity of disaster waste (Yusof et al., 2016). Yadav & Barve (2016) found out that having sustainable solid waste management is the third most important (out of ten[6]) enablers of DWM that, however, depends on other factors such as government support, awareness, and building partnerships. Tajima et al. (2023) add institutional arrangement, pro-active policies, stakeholder engagement and other factors (e.g. the level of decentralisation, the capacity of the responsible actor(s), regulations and their implementation, finance). One such example is decentralisation in Nepal, leading to insufficiently defined solid waste management responsibilities of municipalities, resulting in lacking services (E7). Therefore, waste is often being dealt with on an individual basis (e.g. by open burning) (E7). In the Philippines, "the day-to-day waste management is already inadequate thus scaling up after a big disaster is a real challenge for the local governments" (E8). This corresponds with the findings of Ismail et al. (2023), who note that solid waste management in developing countries is likely to be neglected and non-prioritised, which negatively affects introducing DWM programmes and promoting preparedness (Nakayama & Shimaoka, 2015).

Solid waste management is an especially challenging endeavour for small island states such as Vanuatu with no public waste service and dispersed locations of different islands (Ahmed et al., 2022). According to E5, management of the solid waste is a problem and the capacity in the Pacific Islands is quite limited; in Samoa, there is only one landfill site per island. Although recycling is encouraged, nothing else has much value due to expensive transport, besides aluminium, that can be exported to the Asian market (E5). Additionally, legal frameworks for solid waste management are often outdated and awareness is quite low (E8).

Solid waste management is an important pre-condition to DWM and how it is managed often determines the situation with disaster waste later. Capacities and facilities, legal frameworks, institutional arrangements and people's mindsets and attitudes play a major role. A community can influence (to a degree) how solid waste is managed and thus how DWM will be affected.

4.1.2 DWM Dilemma of Time vs Environment

Another emergent theme, derived from the utilitarian approach to efficient DWM definitions is portrayed through an existing dilemma in the following section. DWM is often pictured in the literature as a "tension" between time-pressure to remove the waste for fast recovery, to have as little impact on health and keeping the processing of the waste up to high environmental standards (Brinton et al., 2022; Brown & Milke, 2016; Brown et al., 2021; Modica

[6] Ten enablers being: partnership and coordination, lesson learnt from previous events (Information sharing), development of sustainable waste management systems, commitment and support of government and donors, disaster waste management planning along with disaster preparedness, availability of temporary disposal sites in vulnerable regions, trained manpower, community involvement, advance arrangement of physical capacity, selection of suitable contractors.

et al., 2021; Nakayama & Shimaoka, 2015, 2015; Tajima et al., 2023; Zhang et al., 2019). Two main topics emerged under this umbrella that can be relevant for community participation in DWM.

I. Recycling of the Disaster Waste

One frequently referenced topic and often a preferred way of processing disaster waste is recycling (Asari et al., 2013; Atchue & Morse, 2023; Brinton et al., 2022; Crowley, 2017; Guerrero-Miranda & Luque González, 2021; Karunasena, 2010; Kazemi et al., 2022; Modica et al., 2021; Srinivas & Helmy, 2015). As a large portion of the disaster waste consists of construction and demolition waste (e.g. concrete and asphalt) from buildings, and vegetation (e.g. coconut trees), it often needs to be first separated into recyclable and non-recyclables (Asari et al., 2013). However, time pressure often forces waste managers into poor decision-making regarding recycling and thus waste (even the hazardous) ends up being landfilled (Atchue & Morse, 2023). Further complications appear with a large degree of mixing of waste (E4).

Recycling as such, and its success rate, depends on many factors beyond the time constraints, such as the amount of waste generated, available technology (Guerrero-Miranda & Luque-González, 2021), priorities of the community, existing legislation, or available resources (Brown & Milke, 2016) but also recycling market's availability to absorb the waste. As a key success factor of recycling, Ismail et al. (2018) list the effectiveness of technologies and facilities and the participation of the public.

Recycling is a complex and context-specific operation that is often overlooked either due to urgency or simply because of non-existent pre-disaster recycling practices, which circles back to poor solid waste management. Lack of recycling facilities and capacities, as well as poor people's attitudes/knowledge, affect the subsequent difficulty of recycling disaster waste. Additionally, the absence of private waste management companies (E9) provides an additional complication to disaster waste recycling. Similar to solid waste management, in recycling, the potential of community engagement can be leveraged for the improvement of DWM effectiveness.

II. Temporary Storage Sites

To tackle the urgency of removing waste quickly while keeping environmental standards high, many authors refer to establishing temporary storage sites (TSS) or temporary disposal sites (TDS), as an interim solution (Brown et al., 2011a; Brown & Milke, 2016; Crowley, 2017; de Magalhães et al., 2020; Dugar et al., 2020; Ismail et al., 2018; Memon, 2016; Milton & Mateo-Babiano, 2016; Modica et al., 2021; Mori & Tajima, 2020, 2020; Nakayama et al., 2013; Parura & Rahardyan, 2020; Trivedi et al., 2015; Yadav & Barve, 2016).

According to Brown et al. (2011a) TSS/TDS are commonly used tools for DWM that allow for temporary placement of the waste to selected areas for sorting, recycling and properly disposing of waste, thus gaining additional time for the waste managers in the recovery process. In Christchurch (New Zealand) using a TSS helped to accelerate the re-opening of affected streets and expedited the search and rescue operations after the 2011 earthquake (Crowley, 2017). Selection of the potential locations for TSS before the disaster as a part of the planning activities is highly advocated for (Brown et al., 2011a; Crowley, 2017; Mori & Tajima, 2020; Parura &

Rahardyan, 2020; Trivedi et al., 2015). Five interviewees mentioned TSS and its pre-disaster establishment as an important step in DWM. E1 described, that Japanese municipalities are recommended by the authorities to identify locations of TSS beforehand. The main conditions for the locations are to avoid proximity to residential areas and water sources (E1). However, TSS still needs to be accessible for people to bring disaster waste (Japan). On the other hand, security concerns can arise from improper management of the TSS. In the Philippines, fire brigades had to come daily to extinguish fires resulting from burning cables to get rid of the plastic and uncover the copper (E3).

Yadav & Barve (2016, p. 190) consider having a TSS available as a DWM enabler that depends on a variety of factors such as "planning, community involvement, government support and partnership for effective results". The location of TSS as well as recycling emerged in the research as important themes with the potential to affect and be affected by the community.

4.1.3 Debris as an "Opportunity"

In connection to the previous section, and as a separate theme emerging from research, disaster waste is often perceived not simply as a problem but an **opportunity** by many authors (Atchue & Morse, 2023; Brinton et al., 2022; Brown et al., 2011; Guerrero-Miranda & Luque-González, 2021; Leiras et al., 2020; Memon, 2016; Nakayama & Shimaoka, 2015), particularly for the 3R principle (reuse, reduce, recycle) (Brown & Milke, 2016). This is due to its potential to reduce space for landfills and create economic opportunities for locals (Brown & Milke, 2016; Dugar, 2020). De Magalhães et al. (2020) provide an argument about how recycling creates opportunities in places, where communities already have a hard time coping with disasters. Similarly, E7 sees a potential for profitable business in, for example, glass recycling in Nepal, as there is already an ongoing effort of the informal waste sector to recycle metal and other valuable materials.

Despite positioning this section as a part of the RQ1 answer (state-of-the-art of DWM), the following themes appeared separately during the coding and the analysis of the data. Therefore, it can be assumed that this only further underlines the importance that the community and the public play in "regular" solid waste management as well as DWM.

I. Emergence of Informal Waste Sector

When formal systems are not in place and/or gaps exist, it is common that waste presents itself as an opportunity for individuals seeking livelihood opportunities. Tajima et al. (2023) describe the informal waste sector as beneficial for DWM, particularly in the context of developing countries. They also note that further empirical research is still missing. Trivedi (2015) considers the informal waste sector as an important stakeholder which must be included in the planning processes. The precarious situation of informality can often result in people's vulnerability, stemming from the lack of formalised employment and workers' protection. Additionally, Wilson in Hernández-Padilla & Anglés (2021) note that this way of "recycling" usually "attracts" poor and marginalised people from socially disadvantaged groups. When minors are involved, they tend to skip education which hinders their possibilities of participating in the formal labour market. It can be assumed that this can create a cycle of perpetual vulnerability

and poverty. Moreover, the lack of skills and necessary tools can result in lower efficiency of the work and questionable results. Job loss and damage after the 2016 Manabí Earthquake in Ecuador led to the emergence of the informal waste sector. People who lacked technical skills were faced with an enormous amount of debris and only managed to salvage a fraction of the recyclable materials for sale (Guerrero-Miranda & Luque-González, 2021). In contrast, after the 2011 Bangkok floods, waste pickers salvaged left-over furniture and material of value that was still possible to reuse (Nakayama et al., 2013). The rest of the waste ended up being mostly landfilled, as no recycling was introduced. Without the work of the informal sector, all the valuable material would be lost and landfilled. Thus, it is possible to assume that the informal sector is filling up the recycling gaps where systems are not in place and waste is mixed with reusable material. E3 described that a few weeks after the 2004 Indonesian tsunami, all the metal was recovered by scavengers. Based on E3's experience, they would usually not sell the material right away but would wait until the market has recovered. According to E7, during normal times in Nepal, the informal sector takes care of glass and iron at the local level, but the rest of the waste is landfilled, and progress is slow, especially with plastic and household waste and other not-so-valuable materials.

It can be assumed that the informal sector plays a role and should be part of DWM decision-making. Additionally, support, protection, and training on DWM provision should be prioritised where possible and steps made towards the development of proper formal and functional solid waste management systems with higher rates of recycling than what the informal sector can provide.

II. Cash-for-work Programmes

One way to tackle both large amounts of accumulated debris and loss of livelihood in the aftermath of disasters is through "cash-for-work" projects. These projects include the "provision of wage payments in exchange for labour through various short-term activities" (Guerrero-Miranda & Luque-González, 2021, p. 2). Such programs, which help individual home-owners who would anyway attempt to demolish the remains of their homes and reuse the material are organised by a variety of NGOs and other actors, especially in countries with post-earthquake conditions such as Haiti (Karunasena et al., 2012) or in post-tsunami conditions in Banda Aceh (Indonesia) to encourage community involvement (Nakayama & Shimaoka, 2015) and provide the necessary human power (Tajima et al., 2023).

Six interviewees mentioned cash-for-work programmes as a beneficial strategy. Most agreed that these programmes are favourable to the municipality, which gets to have the debris cleaned and the locals who get basic livelihood opportunities instead of contracting "outsiders" to clean the debris (E7). These programmes are usually funded by international donors (E7). However, E3 elucidated, why caution is in place when doing cash-for-work programmes, and understanding the local context is crucial:

> "*In Indonesia, we have the term what we call "Gotong royong" (GR). GR is like voluntary activities (…) or communal work (…) to clean the village, or sometimes even to build the house for the poor. (…) after Indonesian tsunami, many people claim that the response (…)*

has killed the spirit of people to do GR because every time the agency [i.e. international organisation] comes, they pay (…). So, at a certain level it has spoilt the spirit of the GR and make people not to do anything for free (…). You have to be careful about that also."

4.1.4 Mainstreaming of DWM into DRM

The fourth theme that appeared during the research of the state-of-the-art in DWM is the (lack of) alignment of DWM and DRM, particularly in practice. Four interviewees consider mainstreaming DWM into DRM as crucial. According to E1, one of the main reasons is financial. Dedicated DWM budgets are often missing, so other resources (e.g. resilience, sustainability, climate change adaptation or solid waste management funds) should be explored. E5 and E8 see the importance of mainstreaming DWM into preparedness and contingency plans and aligning with DRM legislation. According to E2, links should be made also between DWM and climate change and nuances of the two should be highlighted for people to understand interlinkages of their actions, such as open waste burning. E1 and E8 believe that the issue of mainstreaming DWM is a matter of DWM awareness among politicians, leaders, and the public.

Several authors agree that mainstreaming DWM into DRM plans and practices at the national and local levels should be treated as a priority and the two should be closely aligned (Ahmed et al., 2022; Dugar et al., 2020; Modica et al., 2021; Pradhan & Xu, 2018; Srinivas & Helmy, 2015; Tajima et al., 2023; Yadav & Barve, 2016; Yusof et al., 2016; Zawawi et al., 2018). Out of all DRM phases, DWM should especially be mainstreamed into DRM preparedness (Zawawi et al., 2018) and incorporated at national and local levels (Pradhan & Xu, 2018; Srinivas & Helmy, 2015). DWM contingency plans should be included in overall solid waste management planning and governance (Pradhan & Xu, 2018). Ahmed et al., (2022) even recommend full alignment of the DRM and DWM to ensure the integration of the national plans and overall coordination.

4.2 "Disaster Community" and DWM

Many authors deem participation of the disaster-affected community in DWM as critical (Alfa, 2016; Brown et al., 2011b, 2011a; Karunasena et al., 2012; Pradhananga et al., 2021; Trivedi et al., 2015; Zhang et al., 2019). Kawamoto & Kim (2016) highlight that community participation in DWM becomes especially important when the resources are limited, and using social capital as a resource could be a way to stretch them. Interviewees agreed that participation of the community is crucial, as they are the ones impacted the hardest and are present in the affected area before anyone else (E7). Most importantly, their involvement facilitates the prompt recovery process (E5). Community engagement in DWM is a complex phenomenon that depends on a plethora of factors. The following section describes these contextual issues and provides an analysis of how communities can affect DWM in each DRM phase and what can hinder these activities.

4.2.1 Community Context and DWM Pre-conditions

I. Community Awareness and Understanding of DWM

Community awareness of disaster waste risks and understanding of the DWM processes has resonated significantly throughout the literature as being the essence of effective and efficient DWM (Alfa, 2016; Karunasena et al., 2012; Milton & Mateo-Babiano, 2016; Mori & Tajima, 2020; Tajima et al., 2023; Trivedi et al., 2015). Similarly to the awareness of authorities about the DWM, it plays an important role and combined with capacity (technical, financial), it has a major impact on successful recovery and reuse of the disaster waste (Memon, 2016; Sakai et al., 2019). Community perception of the risks of the disaster waste and awareness of its impacts influences their preparedness (Nakayama et al., 2013). Increasing the knowledge about the DWM influences stakeholders' will to promote preparedness (Trivedi et al., 2015). Therefore, it can be assumed that preparedness is directly impacted by both increased knowledge and awareness of the stakeholders but also community. From their experience, E6 observed little awareness of the disaster waste risks, particularly of the hazardous waste. Given the health risks disaster waste lying around the affected areas poses, the importance of awareness and information sharing on DWM cannot be understated.

II. Social and Economic Factors

Karunasena (2010) elaborates that DWM is affected not only by political, legal and economic but also by social and cultural factors. Asari et al. (2013, p. 291) highlight the importance of acknowledging that each community is guided by its own "commonly accepted waste disposal ideas and roles". Four interviewees mentioned the uniqueness of each community and high context-dependency as an important factor to consider when working with communities. E7 also acknowledged that:

> "*engaging the community is very contextual and differs from place to place, therefore just raising awareness is not going to solve the issue because they have other pressing challenges that they face on a regular basis. So, engaging the community should be a more often localised mechanism*". (E7)

It is fair to assume that specific conditions of the community (legal, social, political, financial) can affect its possibility to participate in DWM, regardless of their awareness. This needs to be taken into consideration and ways to tackle this potential barrier need to be explored.

According to Kawamoto & Kim (2016) **social capital** was important for the efficiency of DWM in the context of the clean-up effort after the 2011 Great East Japan Earthquake. According to E4, the size of the municipality matters for social capital. In Japan, smaller municipalities tend to exhibit stronger ties, sometimes organising community events. Thus, after the disaster, strong relationships keep the activity high during recovery and the clean-up. In large municipalities, people are often supported by volunteers instead of neighbours/members of the community (E4). E2 and E8 referred to the importance of social capital but also resources as an even more decisive factor. In Nepal, despite high social capital, the low income per capita causes that when a hazard strikes in remote and rural areas, where people mainly do subsistence farming, they lack resources to mobilise (E2). This corresponds to the limitation of resources and economic barriers and the level of development of the country as a soft determinant that poses a potential barrier to community engagement. Cash-for-work programmes and more systemic development of economic opportunities can help address this issue.

Other contextual social factors such as age or gender also seem to have an impact on DWM. E3 and E5 highlighted the important but often neglected role of women in recovery. Women's active involvement in DWM decision-making processes can facilitate reaching a consensus and ensure that there are no arising issues in operationalising these decisions (E3). According to E5, an aging population affects DWM in Japan in several ways. In rural areas, some community activities decline with fewer people present, which complicates maintaining the services, affecting the daily needs of communities. During a disaster, a community cannot respond without outer support (E5). Additionally, according to E4, bulky waste and non-functional equipment tend to be stored in abandoned houses and the houses of elderly people due to difficulties of carrying it to the recycling station or costly service. This leads to a higher degree of waste mixing and potentially hazardous waste in disaster waste.

Other important contextual factors can hinder or facilitate the DWM process and affect community engagement. Therefore, no blueprint solutions and one-size-fits-all approach should be applied without proper knowledge and understanding of the situation, the dynamics in the society, financial and economic factors, and social considerations.

III. Clarification of Roles and Coordination

To facilitate community engagement in DWM in all DRM phases, clarification of the roles and responsibilities of stakeholders[7] involved is crucial. **Coordination of stakeholders** happens to be a decisive factor, particularly in response (Tajima et al., 2023). According to Tajima et al. (2023) dealing with disasters solely in a command-and-control manner does not always bring the expected outcomes. Horizontal collaboration is needed, particularly when actors of the network are diverse, and resources are spread, such as in DWM. Tajima et al. (2023) suggest the **network**

[7] i.e. government on all levels (national, regional, local), private sector, NGOs, communities, international donors, experts and volunteers.

governance[8] as particularly useful in settings "where insufficient government capacity leads to the presence of diverse international organizations (donors) and domestic NGOs" (Tajima et al., 2023, p. 5). It provides explanations on how the tension between actors impedes successful response. This way of governance is also called 'heterarchy', as opposed to hierarchy, and is characterised as "governing with and through networks" (Tajima et al., 2023, p. 5). It is fair to assume that the community is or should be a part of this potential heterarchy and possesses resources and capacities that the state does not (e.g. being present in the affected area right after a disaster, social capital or ability to affect solid waste management, as well as recycling of the disaster waste where heavy machinery could damage the material), therefore making a valuable contribution.

The uncoordinated response of stakeholders is presented as a common barrier, particularly in developing countries (Brown & Milke, 2016), with tons of debris being left behind after the response is "finished" (Atchue & Morse, 2023). Debris management often becomes a competition between organisations, even among UN agencies (E3). After the 2018 Palu (Indonesia) tsunami, unlike in Banda Aceh, the government limited access to only several agencies to operate in the response phase (E3). Dugar et al. (2020) described how the government of Nepal, during the 2015 earthquake, took the lead in the DWM and response activities and coordinated the volunteers from various IGOs and NGOs which provided technical and financial assistance. E7 confirmed that the 2015 earthquake in Nepal was indeed a learning experience for the government, which introduced a functional one-door policy to address the previously unsystematic response (E7). Similarly, E9 added that the responsibility for waste is often scattered [in Pakistan] and there is no single organisation taking care of waste. In such cases, the government should act as a coordinator (Tajima et al., 2023). To prevent such chaos and miscoordination (Domingo & Luo, 2017; Karunasena, 2010; Karunasena et al., 2012) and for clarity of communication, a single point responsibility is required (Karunasena et al., 2012). In line with this, E8 considers it necessary to clarify and appoint the leading entity for the DWM efforts.

Tajima et al. (2023) suggest that a combination of hierarchical (with a single point of entry) and heterarchical networks is the most efficient governance approach to DWM. To successfully involve the community, it can be expected that some level of coordination and structure is necessary, to also make the most of their capacities. One such example is Japanese JISHUBO[9] organisations, which started to grow in numbers after the 2011 Great East Japan Earthquake as disaster preparedness community organisations, particularly in the rural areas (E5). Such a level of community organisation can be viewed as beneficial for systematic trainings, storing of know-how and better organisation of response and recovery while at the same time having appointed/elected representatives in decision-making processes. JISHUBOs are also affected by an aging Japanese population (E5).

[8] Network governance, according to Klijn in Tajima (2023, p. 5) "public policy making and implementation through a web of relationships between government, business, and civil society actors".

[9] Jishu-bosai-soshiki, or Jishubo, meaning ''autonomous organization for disaster reduction''

4.2.2 Community Involvement in the DWM Process

The division of the whole DWM process in line with DRM stages follows the logic presented in the conceptual framework. However, DWM activities are not restricted to each phase separately but are conducted in a fluid manner.

I. Prevention and Mitigation

Prevention and **mitigation** in DWM are often neglected stages that require more attention (Ahmed et al., 2022; Kazemi et al., 2022; Manami & Misuzu, 2020; Modica et al., 2021). Prevention and mitigation in DWM have been referred to mainly in the context of quantity and composition of the DW, i.e. reducing the amount of potentially generated disaster waste, the presence of hazardous waste and the degree of mixing (Tajima et al., 2023), enacting proper building regulations to prevent the collapse of buildings, maintaining the pipes to prevent their blockages, or caring for vegetation to minimise the potential of green waste (Memon, 2016; Modica et al., 2021). As previously outlined, solid waste management is considered as one of the determining factors of disaster waste composition and quantity, thus a mitigation measure. For efficient solid waste management, local authorities play an essential role (Zawawi et al., 2018), but community participation and their perception and awareness are key factors (Brown et al., 2011a; Trivedi et al., 2015). Thus, communication about waste separation and reduction (Crowley, 2017) as well as developing capacities in the communities is crucial (Crowley, 2017; Trivedi et al., 2015). However, many countries face difficulties in disposing of the waste in an environmentally friendly way (Nakayama & Shimaoka, 2015) particularly in remote rural areas (Ismail et al., 2018). When responsibilities are unclear, and capacities or experience are lacking, communities often end up using open-burning or dumping the waste as the only available method (Ismail et al., 2018). It is fair to assume that the community and the public generally play an important role in the mitigation and prevention phase. This role can include reducing their household waste, learning how to properly manage their waste, regularly getting rid of bulky and hazardous materials, attempting to recycle when possible and demanding proper delivery of services from authorities when these are unavailable.

II. Preparedness and Planning

The majority of authors and interviewees agree on the importance of **preparedness and planning** in DWM (Brown & Milke, 2016; Nakayama et al., 2013; Tajima et al., 2023; Trivedi et al., 2015) as key elements to minimise disruptions (Brown et al., 2011a; Trivedi et al., 2015), significantly lower the costs of recovery (Crowley, 2017; Fernandez et al., 2023) and contribute to a speedy clean-up process (Crowley, 2017; Modica et al., 2021; Zhang et al., 2019). Without preparedness and proper planning, it is not possible to deal with the disaster waste immediately after the disaster (E5). Only relying on post-disaster planning contains multiple risks, such as cost and untimeliness (Tajima et al., 2023) and providing no space to public engagement and consultation due to urgency (Domingo & Luo, 2017). Proper planning helps to **clarify roles and responsibilities**, and identify available resources, staff, legal frameworks, and assets (Tajima et al., 2023).

a) Planning

According to E1, in **contingency planning**, outlining the responsibilities is crucial for DWM. Additionally, E7 considers not prioritising preparedness and planning as a major barrier to DWM. Often, a lack of (personal) capacities also interferes with the contingency planning (e.g. in cases of some smaller local municipalities in Japan) (E7). Based on the research and interviews, the community is considered one of the DWM stakeholders, so its participation is crucial in the preparedness and planning phase (Crowley, 2017; Fernandez et al., 2023; Hatcher et al., 2012; Milton & Mateo-Babiano, 2016; Mori & Tajima, 2020; Trivedi et al., 2015; Zawawi et al., 2018). Authors agree that plans should be formulated prior to the event, although the opposite is often the reality (Brown et al., 2011a). Participation of the community in the plan's formation also enhances its quality (Crowley, 2017).

> "*Community has to be involved from the planning stage or of the DWM plan creation. That is essential because they have practical experience in the field after disasters*" (E7).

Planning with communities can even develop a common vision, thus leading to fewer claims against government handling of DWM if the authorities are involved (Hatcher et al., 2012). Additionally, participating in the planning for disaster waste facilitates the community's ownership and sense of responsibility toward waste and proactive attitude (Mori & Tajima, 2020). Plans are influenced by commonly accepted DWM ideas (Asari et al., 2013) and having a shared goal improves public understanding and acceptance of the DWM (Milton & Mateo-Babiano, 2016). According to E7, involving the community in planning helps to understand the importance of waste management issues while keeping the local government accountable (E7). Additionally, DRM/DWM strategies and plans should always be elaborated in consultation with the community because their understanding of waste management issues is crucial, and their opinions on disaster waste should be reflected (E7).

During the DWM planning process, social factors (e.g. race, class, education) and cultural context need to be considered (Milton & Mateo-Babiano, 2016), as improperly carried out DWM can deepen existing inequalities based on existing race, gender, and class discrimination (Alfa, 2016).

b) Decision on TSS Location

Decision on the location of the TSS and its management can be a challenge under the urgency of the response, therefore it is advisable to do this beforehand (Crowley, 2017; Kazemi et al., 2022; Mori & Tajima, 2020). Moreover, Sakai et al. (2019) and Memon (2016) highlight the importance of considering multiple options in case of inaccessibility of the chosen one. Crowley (2017) adds that the community should come up with a list of the potential TSS locations ideally on the land owned by the municipality for cost efficiency. Dugar et al., (2020) stated that selecting a proper location for TSS should be thought through strategically, not to threaten the environment while simultaneously not creating an economic burden. Inadequately chosen locations of the TSS can have a negative impact on a community (Milton & Mateo-Babiano, 2016), affect health and the environment (Nakayama et al., 2013) or even lead to setting up the TSS illegally by the locals without the knowledge of the local municipal authorities (Milton & Mateo-

Babiano, 2016; Mori & Tajima, 2020). Additionally, the waste must stay in place only for a limited time to serve the purpose (Zhang et al., 2019). By investigating citizens' attitudes during the 2014-2015 Malaysia Floods, Ismail et al. (2018) found that 70% of respondents in the study were unsatisfied with the placement and management of the TSS near their houses which brought discomfort and safety issues. Citizens were also unhappy about the insufficient communication about proper DWM from authorities, and the lack of information they received about the matter.

c) Preparedness Trainings and Information Sharing

Communication strategies, and pre- and post- disaster consultation should be also a part of plans (Brown et al., 2011b). Separation rules should be publicised before, as it is difficult to share information with the public in disaster times (Mori & Tajima, 2020) due to power outage or general chaos. Lack of necessary skills in DWM and absent trainings have impact on public officers' availability to provide information to the public and raise awareness among the communities (Ahmed et al., 2022). Asari et al. (2020) also underline the importance of conducting disaster trainings with local communities, with the disaster waste as integral part of it, connected to environmental education and waste reduction as prevention/mitigation. As part of the preparedness, trainings should be provided to personnel, officials, volunteers and the community (including the informal waste sector) to be able to manage the debris safely and efficiently (Trivedi et al., 2015). Pradhananga et al. (2021) explain that providing health and safety trainings on using personal protective equipment and handling debris is a critical gap in DWM to address for enhancing public health resilience and post-disaster recovery. They also highlight the importance of choosing methods of trainings that would serve the underprivileged groups in low-income countries.

According to E7, in places where no preparedness trainings were conducted to generate awareness of DWM, response and recovery activities were spontaneous, usually with the help of community social change agents. In contrast, in places where preparedness trainings were conducted, awareness was raised, and people mobilised into action quickly, were more responsive, and even supported the nearby community. When a community experiences disaster for the first time without proper awareness, they might be more psychologically affected (E7).

There is strong evidence that the major role of the community in the preparedness and planning phase is at the table during the planning; the decision-making about various DWM issues including the placement of TSS as well as in DWM preparedness trainings, preferably mainstreamed with existing DRM preparedness trainings, as advised by authors and interviewees. Making sure awareness and information about the disaster waste is there before the impact of a hazard is yet another step in ensuring speedy and pro-active cooperation and maximising the potential for expedited recovery and safe DWM.

III. Response

Debris management significantly affects disaster response by potentially hindering the evacuation and rescue services from reaching people, posing long-term health and environmental risks (Ahmed et al., 2022; Brown et al., 2011a; de Magalhães et al., 2020; Trivedi et al., 2015) and impacting the economy (Zhang et al., 2019; Zawawi et al., 2018). De Magalhães

et al. (2020) point out that how the response is carried out during emergencies often reflects the (lack of) preparedness and planning. DWM in the response phase is usually characterised by the first clean-up of the debris and hazard and environmental assessment (Brown et al., 2021). Parura & Rahardyan (2020) specify that in the emergency response phase (from 0-72 hours), besides basic road clearance for search and rescue services to reach victims, a first assessment must be carried out, and TSS location must be determined, if not done already. In this phase, multiple decisions must be carried out such as whether and when to activate a **coordinated clean-up**, as delaying can negatively impact the people's health and the environment (Brown et al., 2021).

IV. Recovery

DWM is a critical task for fast recovery, especially in the early phases (Fernandez et al., 2023; Milton & Mateo-Babiano, 2016), and it can impact how long recovery takes (Atchue & Morse, 2023; Brown et al., 2011a). DWM also consumes a significant part of the recovery costs (Brown et al., 2011a; Crowley, 2017; Fernandez et al., 2023). Most disaster waste is generated during the recovery and rebuilding phase due to the demolition of houses and clean-up (Sakai et al., 2019; Pradhananga et al., 2021; Pradhan & Xu, 2018; Dugar et al., 2020). In line with previous phases, efficient recovery depends both on how well the preparedness (Crowley, 2017; Srinivas & Helmy, 2015), and the response was organised (Crowley, 2017; de Magalhães et al., 2020; López & Hooper, 2020). Alfa (2016) emphasise that omitting to involve communities in the DWM prolongs the recovery. According to de Magalhães et al. (2020) involving local partners in the recovery has the potential to increase sustainability by using the existing social capital.

a) Communication and Information

Communication plays a key role in the DWM pre- and post-disaster (Trivedi et al., 2015), especially regarding the clean-up. Brown et al., (2011b) explain that lack of communication with the public during the 2009 Victoria bushfires in Australia before and during the clean-up caused community dissatisfaction and concerns about the impacts on health and environment that could have been easily prevented. This became a major drawback of the authorities' response to the bushfires. Zhang et al. (2019) agree that improperly conducted clean-up can cause community resistance, therefore DWM particularities need to be discussed. Mori & Tajima (2020) further reveal that it is especially during the chaos of a disaster situation that public cooperation must step in, to share the information among each other. Therefore, knowing the municipality rules of DWM beforehand can be useful. E5 highlighted that clarification on how to deal with disaster waste, especially hazardous waste like asbestos or animal carcasses must be provided by the authorities due to the usual lack of awareness of the public. In Japan, E1 highlighted the importance of including the public in post-disaster recycling. After a disaster, information about the separation of the disaster waste and to which designated TSS to bring the waste is broadcasted through various channels (e.g. television, TikTok) (E1). People are asked to only bring the disaster waste and wait for solid waste management services to resume. Sometimes volunteers come to the affected area and help with the transportation. On the local level in Japan, various guidelines and handbooks are available, sometimes in English (e.g. Kurashiki city – see *Annex 4*) with user-friendly explanations (E4). A well-informed community can both help spread information further, and act according to the rules and regulations, thus protecting its health and

environment while facilitating the process towards fulfilling the criteria of effective DWM.

b) Psychological State of Victims and Effect of the Clean-up

Multiple authors agree that participating in the clean-up can have a positive effect on the psychological health of the survivors (Alfa, 2016; Brown et al., 2011a; de Magalhães et al., 2020; Kawamoto & Kim, 2016; Milton & Mateo-Babiano, 2016; Tajima et al., 2023; Trivedi et al., 2015), especially during houses demolition. Being able to physically participate in the removal of the debris empowers the community and reduces feelings of despair and depression (Brown et al., 2011b; Milton & Mateo-Babiano, 2016). Additionally, according to Tajima et al. (2023), mutual trust improves the coordinated clean-up and makes working together more effective and predictable for the survivors. According to E4, many people experience mental health problems and loneliness after disasters. Working together on DWM is important for affected people [in Japan] and for the recovery of the area, as it helps to rebuild the community and gain control over the process (E4).

However, Pradhananga et al. (2021) pointed out that in the early recovery phase after the 2015 earthquake in Nepal, communities involved in debris management demonstrated post-traumatic stress disorder signs and were under a lot of pressure due to interaction with other victims, anxiety from potential earthquake aftershocks, and handling of corpses. E3 considers the loss and trauma of survivors to be one of the barriers to having the motivation to join the clean-up:

> "*Now the uniqueness of my involvement is that every time I talk to the people, (…), especially in the post-disaster context, I encourage them. It's not easy especially in the recent period after the disaster to encourage them, to motivate them (…). Sometimes it's challenging because the emotion is still there. But then I tell them: (…) we can, we will recover, and we need to work. You know, it takes time, of course, but we will get over it.*"

Trauma and loss can have a diverse impact on any community and can significantly affect the motivation to work and participate, thus acting as a barrier. Trivedi et al. (2015) imply that understanding the psycho-social impacts of the speed of debris removal is crucial. It can be assumed that psychosocial support to survivors is an important step in regaining control of their lives to potentially activate the clean-up.

Despite considering expedited disaster waste removal as crucial for recovery, not leaving enough time for survivors to salvage their personal items from their houses is considered counter-productive and raises dissatisfaction in the community (Milton & Mateo-Babiano, 2016). Even more so, communication with the community as well as the volunteers, and motivating people by adopting a sensitive approach, becomes essential in this phase.

c) Clean-up – Heavy Machines or Manual Labour?

As mentioned previously, waste composition and quantity are also affected by solid waste management. In turn, waste composition affects how the debris should be dealt with and how much community engagement in the clean-up is possible, depending on the presence of heavy or hazardous waste (Brown et al., 2011a; Crowley, 2017). Brown et al. (2011a) mention the

example of communities in Haiti post-2010 earthquake, who, despite wanting to join the clean-up efforts, were unable to do so, as the mass of the debris required heavy machinery use. Having special equipment is a matter of sufficient capacity of a developed, present, and engaged private sector or involvement of donors. In developing countries poor debris management is a persisting phenomenon (Atchue & Morse, 2023) and as Dugar et al. (2020) point out, when lacking technical capacities and funds, such as in Nepal, people are forced to somehow clean-up the disaster waste on their own, or just leave it lying around, as is often the case in Malaysia (Yusof et al., 2016).

Community involvement is particularly important for the separation/recycling of DWM on the ground (E5). Heavy machines are very important as well, but broader involvement in the clean-up is necessary as the first step for the reconstruction after disasters. E3 advocated for a combination of manual labour and heavy machinery:

> "*I always encourage to not solely depend on the heavy machinery work because it can destroy the recyclable material (...) but to combine between the machinery and people working [manual labour]. There are many advantages to this combined work. Most importantly, (…) it can divert their mindset from thinking about themselves as victims so they can have activity and income, salvage and recover the material and rebuild their houses. It has some economic impact on the local economy as well. It can trigger market circulation*."

E3 further elaborated, that at the same time, people must be provided with safety first, such as boots, safety helmets, gloves, and then some tools for efficiency. When additional funding is provided, heavy machinery, cash-for-work programmes, and other interventions can be used to expedite the recovery. Not having personal protective equipment and proper tools for clean-up can be a major barrier for physically (not) participating in the recovery (E3, E6). In another case of the 2009 Victoria bushfires in Australia, a proper government intervention, well-coordinated community activity, and engagement of the private sector in a centralised demolition led to fast clean up with 50% of the contractor human resources being local (Brown et al., 2011b). On the other hand, Brown et al. (2011b) highlight a potential challenge for the future which is too high reliance of a community on the government and lack of self-preparedness in the form of insurance or reluctance to carry out any work, leading to potential illegal dumping.

It can be assumed that community involvement in the clean-up is possible both in developed and developing countries under context-specific conditions. The level of a government's involvement, availability of resources and other hard and soft factors determine the level of community engagement possible. In developed countries, this role is often taken over by the private sector. In developing countries, participation in the clean-up can be facilitated by providing trainings, personal protective equipment and tools, guidance, information and proper coordination. This can be mutually beneficial both to the community due to livelihood recovery as well as the municipality. It can foster mutual trust and social capital and speed up the recovery process and reuse of the materials.

5. Conclusion

This research explored the emergent field of DWM, particularly the social and organisational aspects related to leveraging the potential of community engagement in the DWM process for better efficiency and effectiveness. The exploratory nature of this study utilised two methods: a scoping study of the existing literature and semi-structured interviews with key informants – practitioners and scholars – with expertise in the DWM/DRM field. Data obtained were processed and analysed using the inductive research strategy and open coding. This way the overarching objective of this thesis, and the two research questions, were answered in chapter 4.

5.1 State-of-the-art of DWM

Due to the nature of the topic, the first research question delved into the broader context of DWM, trying to uncover the current or persisting debates and issues in academia and practice. The themes that emerged under the state-of-the-art DWM umbrella were purposefully chosen to serve as a solid foundation for the topic, and all demonstrated having relevance for community engagement.

DWM has proven to be a complex and dynamic field influenced by a range of intertwined and mutually dependable determinants. *Hard determinants*, such as geography, size, remoteness, or type of hazard can be difficult to influence. On the other hand, the composition and quantity of the disaster waste, as other hard determinants, are fluid variables that can be impacted by a range of well-placed measures, including decreasing the amount of waste before a disaster happens, as well as promoting separation and advancing recycling processes. *Soft determinants* of DWM (such as social, economic, political, and legal factors combined with awareness and non-prioritisation of the topic, (non)existing disaster experience, and development level of a particular country or region) are even more complex, interrelated, and difficult to analyse in isolation and far from being exhaustive. Capacity and context-dependency seem to underline most of the soft determinants and some of the hard determinants, thus proving to have a major impact on DWM. Similarly, a *regular "peace-time" solid waste management system* is yet another relevant determinant of DWM that affects the composition and quantity of post-disaster waste was considered. Poor solid waste management and neglected waste services, due to a variety of reasons including capacities, levels of development, or unclear roles and responsibilities, are barriers to DWM that disasters magnify.

Another recurring theme in the research was a perceived *dilemma* between *disposing of the disaster waste quickly* versus *adhering to environmental standards* which often seems to take more time. Two themes emerged as playing a role in this dilemma. *Recycling* of disaster waste is one of the most advised solutions for waste disposal that depends on many factors, for example, available capacities and technologies, functional recycling market, legislation in place, or community priorities. A high degree of mixing of waste pre-disaster and poor solid waste management can complicate the recycling of disaster waste in the aftermath. This cyclic relationship of pre- and post-disaster waste is an important yet often overlooked element, in

which communities can play a significant role. *Temporary storage/disposal sites* (TSS/TDS) are used as a tool for temporary placement of waste for further treatment. Their location is a sensitive issue that must observe certain rules and regulations. Choosing a location for TSS/TDS is an important decision that affects the community, therefore their participation in the process is essential.

Disaster waste, even though often following a tragic and disempowering event, does not solely constitute a problem. Research has shown that debris can be perceived as an opportunity. When formal systems are limited, waste often becomes a source of livelihood for some. In such contexts, the *informal waste sector* often becomes a part of the waste management processes, salvaging and recycling the otherwise not recycled but valuable material. People working in this sector play a role in DWM and thus are considered stakeholders that should be invited to decision-making. Another opportunity, particularly for those whose livelihood has been impacted by the disaster, is *cash-for-work programs,* funded by donor organisations. These can temporarily substitute the lost livelihood while facilitating the clean-up of debris.

The last theme under the state-of-the-art, permeating the current DWM debates, was the necessity of mainstreaming DWM into DRM for the purposes of better coordination in preparedness and planning, but also for using the existing DRM financial resources when DWM funds are lacking. Mainstreaming at all levels – local, regional, and national – is deemed to be regarded as a priority for the advancement of the field.

5.2 Community and DWM

There seems to be a consensus about the important role that the community plays in DWM. Community engagement in DWM is a complex phenomenon affected by a multitude of factors, including awareness and understanding of the risks that disaster waste poses, which can influence preparedness also social and cultural factors, such as a particular community context, age, or gender. Social capital is considered important for the clean-up, but its use in practice is often impacted by the lack of resources and capacities to mobilise in disaster. One of the major pre-conditions of communities to participate in DWM is a clarification of roles, responsibilities and proper coordination of stakeholders. This can pose a major barrier to leveraging communities' potential in chaotic and uncoordinated response and recovery situations. Network governance called heterarchy, with the use of diverse resources and actors while still having a single point of responsibility particularly for communication, is regarded as beneficial in complex topics such as DWM.

This research has shown that community engagement has the potential to make DWM more efficient by playing a role in all the DRM phases. In *prevention and mitigation*, due to cyclic relationship between solid waste management pre-disaster and DWM, a community can try to reduce household waste, reuse material and recycle as much as possible to prevent the potential high level of mixing of waste. They can also step up pressure and demand proper delivery of waste management services from local authorities.

In *preparedness and planning*, often regarded as a decisive phase for DWM, having a contingency plan in place helps to kick-start the DWM process immediately after a disaster. Planning helps to clarify roles and responsibilities which is crucial for efficient community engagement. Including the community in planning helps to develop a common vision, and sense of ownership, and improves acceptance of DWM activities and their easier implementation. This includes the involvement of communities in the decision-making on the location of TSS. Pre-disaster communication on rules of recycling disaster waste helps spread the information and raise awareness among community members and influences their ability to recycle post-disaster. Preparedness trainings should help to mobilise the community faster, overcome the shock, and ensure safety during clean-up.

The response is often affected by the level of preparedness. It is usually characterised by the first clean-up and removal of major debris for search and rescue services and several important decisions on activation of coordinated clean-up and first assessments of the situation. Communities are the first people in the affected areas before the help can reach them, so they naturally become the first responders. A well-prepared community can mobilise faster. Response often blends in with *recovery* activities, particularly with regard to communication and post-disaster information. A community can help spread information and adjust their behaviour based on the recommendations, so they play a role in this phase, too. The composition and quantity of waste affect, whether the use of heavy machinery is required or if community can participate in the clean-up. Capacity and resources can be significant barriers, including the lack of protective equipment and tools necessary for debris removal as well as the lack of trainings on the safe handling of waste. Often a mixed approach, i.e. a combination of manual labour with heavy machinery (if available), is recommended, as it helps to salvage valuable and reusable material that would otherwise be damaged by the machines while managing to move bulky parts of debris. Community help is important for waste separation and recycling of valuable material. Additionally, cash-for-work programmes can help to recover lost livelihood without the necessity to contract external help. However, the psychological state of survivors can become a barrier to participation in the clean-up, as people are often subject to trauma and loss. Research has shown that taking part in the community clean-up can have a positive impact, empower the community, and help to regain the control over recovery process.

The role of the community in DWM is diverse and affected by many determinants that need to be taken into consideration during planning and developing the DWM system. Barriers such as lack of skills, resources, and protective equipment can be tackled relatively easily. Other barriers are more complex, requiring a systemic approach to economic and social development, working with people's attitudes and understanding of the matter. A sensitive approach is necessary combined with acknowledging the uniqueness of each community and specific features of the setting.

The overarching objective of the research was to find out how can community engagement support efficient and effective DWM. By elaborating on the four main themes found under the current state-of-the-art debate on DWM, as outlined above, more light was shed on how DWM is presently framed and where is the potential space for community engagement. This

way, the first research question complementing the overarching objective, was answered. By outlining the context in which communities operate and elaborating on different DRM phases and the activities of DWM conducted in those phases, including activities that communities can contribute to while also stating out the barriers, if present, the second research question, contributing to overarching purpose, was answered.

5.3 Future Research

A potential for future research could entail looking deeper at particularities that the results of this research uncovered - a closer investigation of social capital in different geographic and economic settings and its impact on DWM, while simultaneously working closely with the communities that are living in the hazard-affected areas. Mainstreaming of DWM into DRM as well as with climate change adaptation policies is another field with a potential for further exploration as to how to achieve the most benefits.

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Annexes

Annex 1: Overview of Literature Used for Scoping Study

Number	Authors	Country of work of main author	Title	Year of publication
1.	Ahmed I.; Johnson T.; Fuller S.; Guinto M.B.; Sagapolutele F.	Australia	Strengthening Capacity in Disaster Waste Management in Vanuatu	2022
2.	Alfa F.M.	US	The social implications of disaster waste management on displaced residents: The case of Hurricane Katrina - A brief systematic review	2016
3.	Asari M.; Kirikawa T.; Sakai S.	Japan	Status of Disaster Waste Countermeasure Execution and a Survey of Public Awareness in Japan	2020
4.	Asari M.; Sakai S.-I.; Yoshioka T.; Tojo Y.; Tasaki T.; Takigami H.; Watanabe K.	Japan	Strategy for separation and treatment of disaster waste: A manual for earthquake and tsunami disaster waste management in Japan	2013
5.	Atchue J.A. III, Morse A.	US	Planning and implementing effective debris management is a crucial part of ensuring resilience	2023
6.	Brinton A.; Diehl D.C.; Townsend T.G.; Deliz Quiñones K.; Lichtenstein M.M.	US	Trees, trash, and hurricanes: The case study of Puerto Rico and vegetative disaster debris management after Hurricanes Irma and Maria	2022
7.	Brown C.; Milke M.	New Zealand	Recycling disaster waste: Feasibility, method and effectiveness	2016
8.	Brown C.; Milke M.; Seville E.	New Zealand	Disaster waste management: A review article	2011
9	Brown C.; Milke M.; Seville E.	New Zealand	Disaster waste management following the 2009 Victorian bushfires	2011
10.	Brown C..; Hayes J.L.; Milke M.W.	New Zealand	Planning to adapt: identifying key decision drivers in disaster response planning	2021
11.	Crowley J.	US	A measurement of the effectiveness and efficiency of pre-disaster debris management plans	2017
12.	De Magalhães M.R.; Lima F.S.; Campos L.; Rodriguez C.T.; Maldonado M.	Brazil	Disaster Waste Management Using Systems Dynamics: A Case Study in Southern Brazil	2020

13.	Domingo, N.; Luo H.	New Zealand	Canterbury Earthquake Construction and Demolition Waste Management: Issues and Improvement Suggestions	2017
14.	Dugar N.; Karanjit S.; Khatiwada N.R.; Shakya S.M.; Ghimire A.	Nepal	Post-disaster Waste Management: Lessons Learnt from 2015 Nepal Earthquake	2019
15.	Fernandez G.; Asari M.; Uy N.; Veitata S.; Fayazi M.; Ling Y.; Xu Q.; Wang H.; Ramos L.V.; Singh S.	Philippines	Developing capacity for post-typhoon disaster waste management in Lautoka, Fiji and Makati, Philippines	2023
16.	Guerrero-Miranda P.; Luque González A.	Ecuador	Social responsibility, sustainability, and public policy: The lessons of debris management after the Manabí Earthquake in Ecuador	2021
17.	Hatcher L.J.; Strother L.; Burnside R.	US	The USACE and post-Katrina New Orleans: Demolitions and disaster clean-up	2012
18.	Hernández-Padilla F.; Angles M.	Mexico	Earthquake Waste management, is it Possible in Developing countries? Case study: 2017 Mexico City Seism	2021
19.	Ismail S.N.S.; Abidin E.Z.; Hashim Z.; Rasdi I.; How V.; Praveena S.M.; Karuppiah K.; Bin H.Y.; Ismail S.; Mohamad S.; Azme N.N.A.N.	Malaysia	Disaster Debris Management during the 2014-2015 Malaysia Flood Incident	2018
20.	Ismail S.N.S.; Nasir N.M.; Abidin E.Z.; Rangga J.A.	Malaysia	Exploring Urban Residents' Understanding, Attitudes and Behaviors Towards Disaster Waste Management: A Survey-based Study	2023
21.	Karunasena G.	Sri Lanka	Capacity building for post disaster waste management: Construction and demolition waste	2010
22.	Karunasena G.; Amaratunga D.; Haigh R.	Sri Lanka	Post-disaster construction & demolition debris management: A Sri Lanka case study	2012
23.	Kawamoto K., Kim K.	Japan	Efficiencies of bonding, bridging and linking social capital: Cleaning up after disasters in Japan	2019
24.	Kazemi S.; Mokhtari M.; Vaezi A.; Salmani I.	Iran	The challenges of strategic management of the wastage produced due to earthquake in Kermanshah and Varzaghan-Ahar: A qualitative study	2022

25.	López D.; Hooper M.	Mexico	Disaster Planning Across Scales: Lessons from Post-Earthquake Rubble Management in Oaxaca, Mexico	2020
26.	Manami S.; Misuzu A.	Japan	The Possibility of Cooperation with Disaster Volunteers and Residents in DWM	2020
27.	Maryono; Nakayama H.; Shimaoka T.	Japan	Identification of factors affecting stakeholders' intentions to promote preparedness in disaster waste management: A structural equation modelling approach	2015
28.	Memon M.A.	Japan	Disaster waste recovery and utilization in developing countries-Learning from earthquakes in Nepal	2016
29.	Milton P.; Mateo-Babiano D.	Australia	Social effects of disaster waste management: A case study of Brisbane suburbs post 2011 January floods	2016
30.	Modica M.; Paleari S.; Rampa A.	Italy	Enhancing preparedness for managing debris from earthquakes: lessons from Italy	2021
31.	Mori T.; Tajima R.	Japan	Strategy to Promote Residents' Behaviors for Appropriate Disaster Waste Management	2020
32.	Nakayama H.; Shimaoka T.; Omine K.; Maryono; Patsaraporn P.; Siriratpiriya O.	Japan	Solidwaste management in Bangkok at 2011 Thailand floods	2013
33.	Pradhan M.; Xu Q.	Japan	Building Resilience Through Disaster Waste Management-UN Environment's Experiences and Approaches	2018
34.	Pradhananga P.; S.; ElZomor M.,; Kasabdji G.S.	US	Disaster Waste Management Challenges in Nepal: Health Impacts and the Need for Safe Practices	2021
35.	Parura T.C.P.; Rahardyan B.	Indonesia	Evaluation of Post-Earthquake, Tsunami, and Liquefaction Disaster Waste Management in Palu, Indonesia	2020
36.	Sakai S.; Poudel R.; Asari M.; Kirikawa T.	Japan	Disaster waste management after the 2016 Kumamoto Earthquake: A mini-review of earthquake waste management and the Kumamoto experience	2019

37.	Srinivas H., Helmy F.	Japan	Disaster waste management: lessons learnt from Banda Aceh, Indonesia	2015
38.	Tajima R.; Tsuji T.; Suzuki K.; Muhamad A.F.	Japan	Conceptualizing disaster waste governance using network governance perspectives	2023
39.	Trivedi A.; Singh A.; Chauhan A.	India	Analysis of key factors for waste management in humanitarian response: An interpretive structural modelling approach	2015
40.	Yadav D.K.; Barve A.	India	Analysis of enablers for disaster waste management	2016
41.	Yusof N.S.; Zawawi E.M.A.; Ismail Z.	Malaysia	Disaster Waste Management in Malaysia: Significant Issues, Policies & Strategies	2016
42.	Zawawi E.M.A.; Yusof N.S.; Ismail Z.	Malaysia	Adoption of post-disaster waste management plan into disaster management guidelines for Malaysia	2018
43.	Zhang F.; Cao C.; Li C.; Liu Y.; Huisingh D.	China	A systematic review of recent developments in disaster waste management	2019

Annex 2: Consent Form for Participation in Research Study

Title of Study: Disaster Waste Management and Community Engagement

Researcher: Simona Meszarosova

For ethical reasons in academic research, you as an interviewee must explicitly approve the conditions of your involvement and how the data collected will be used. Kindly read and sign this consent form to assure that you understand and agree with the following:

1. I understand that my participation in this study is voluntary and that I am free to withdraw at any time, without giving a reason, by contacting the researcher at meszarosovasim@gmail.com or si0302me-s@student.lu.se.
2. I understand that all information or quotes used from my participation in this study will be anonymous. My identity will not be disclosed in any reports or publications resulting from this study.
3. I understand that I can withdraw the permission to use data from my interview within one week after the interview, in which case the material will be deleted.
4. I agree to the identification of my profession/expert field, and the country of expertise in the study.
5. I give permission for the discussion in which I participate to be audio-recorded and transcribed for research purposes.
6. I understand that any data collected from my participation in this study will only be accessed by the researcher for this study and will be deleted after the study is finished.

By signing this form, I agree to take part in the above study.

Participant's Name: _____

Participant's Signature: _____

Date: _____

Annex 3: Interview Guide

Segment	Interview question	Probing question
General introduction	*Open ended question to comfortably open-up the interview and get to know the interviewee*: 1. Can you **tell me more about yourself** and the area of your work/expertise? 2. How has **your work**/the work of your organisation **been connected to disaster waste management**?	
Segment I: DWM in general	*Open ended question to establish mutual understanding of the concepts and narratives in the research:* 3. How do you **understand disaster waste management** and what determines efficient DWM for you? 4. Can you briefly explain, **how is the response** to major hazardous events **carried out** in (your country)? 5. How does (country) deal with DWM – **whose responsibility** is the management process? 6. What do you see as the **main barrier** or **challenge in DWM** as done in (country)? 7. Where do you see the most room for improvement in DWM?	4.*a) Are there some DRM national plans or strategies? Is DWM a part of them? Has DWM been mainstreamed into DRM policies and practices?* 4.*b) Can you briefly walk me through the management process, as you know it (based on the interviewee)?* *5.a) Are you aware if the TSS is chosen beforehand?* *5.b) Is government actively cooperating with IGOs and NGOs during "normal times" to prepare for the disaster?* 5.*c) Is DWM managed in a more hierarchical style (i.e. chain-of-command - strictly top-down) or more decentralised - vertical management (like a network governance)?* 5.*d) Who is **carrying out the actual clean-up** after a major hazardous event? **If private sector:** Are you aware if they are contracted pre-disaster? Is there any room for public/community to join the process of the response? Is **government** (national or local) **actively cooperating** with local communities/volunteers on DWM?*
Segment II: Social capital and	*Open ended question – more specific to the RQs:*	

community engagement in DWM	8. Based on your experience, how **spontaneous or organized** are people´s reactions and response to a hazardous event in the context we speak about? 9. Does the **local/national authority communicate**/count on people to carry on some work after disaster? 10. In your opinion, is the **general public aware of what to do in response to a hazardous event?** 11. What do you consider the **main barriers for people/community to help** with clean up after disaster? 12. **How do you think the community could help with the whole DWM process (also in preparedness)?** 13. **Cognitive social capital** (shared trust, norms, values, attitudes, and beliefs within a community) – based on your knowledge/impression **do people share the same understanding of the priorities** in clean-up process? Are there norms that they adhere to (formal, informal, religious)? Does this differ based on different regional context (rural vs urban context)? 14. **Structural social capital** *(information sharing, decision-making, and collective action through roles, networks, and structures guided by rules, procedures, and precedents*) – do people in the communities have **access to information and decision-making processes in DWM**? Do they know what are their roles in DRM – are their roles clearly pronounced somewhere?	10.a) Do people organize themselves to deal with the aftermath/help with cleaning up? **IF YES:** Is their participation somehow formalized (in the plans, guidelines) or spontaneous? **IF NO:** Are they somehow **encouraged/incentivised** (by state, municipality...) **to volunteer for clean up** or at least clean their own properties? 12.a) Are people provided any **trainings or protective equipment** to help facilitate the clean-up? 12.b) Do you think is there any way how **community could help <u>before</u>** the disaster with preparedness?
Ending	*Return back to any point if clarification is necessary. Invite the interviewee to discuss points or topics that were not brought up previously* 15. Do you have any question or comments you would like to share and discuss? 16. Are there any other people that you think I should speak to?	
	Thank the interviewee for their time.	

Annex 4: Excerpt from Kurashiki (Japan) information brochure (p. 2) – means of informing public after disaster (English version)

For the quick disposal of waste, collect accurate information first.

The state of the city just after the water drained (Kurashiki City Mabi District)

In case of disaster

If a major disaster occurs, the first thing you need to do after being given the all clear is to clean up your house.

When cleaning up after a disaster, a large amount of disaster waste such as wet tatami and muddy furniture, is generated that would not normally be generated as household waste.

In order to properly dispose of disaster waste, the city will decide how to separate the garbage and where to bring it, depending on the type of disaster and the extent of damage.

Citizens will be notified by the following means:

①Websites
②The Garbage sorting app, "Sana~ru" (“さんあ～る”)
③Leaflets (Posted and distributed in shelters, community centers* etc.)
④PR vehicles

After a disaster, connectivity may be disrupted and it may be difficult to connect to websites and apps. Please confirm the location of the bulletin board nearest you, so that you can also see it in writing.

*The public halls in the city are the 4 major public halls in Kurashiki, Mizushima, Kojima, and Tamashima, 24 community centers and their branch centers.
Kurashiki, Kurashiki East, Kurashiki West, Kurashiki South, Kurashiki North, Tatsumi, Shinden, Sho, Chayamachi, Nishiachi, Mizushima, Fukuda, Fukuda South, Tsurajima, Tsurajima South, Kojima,Shimotsui, Honjo,Kotoura, Karakoto, Gonai, Tamashima,Tamashima East,Tamashima west, Tamashima North ,Tamashima Kurosaki, Funao, Mabi etc.

POINT
Know where to get information in an emergency.

Household items washed away by muddy waters
In the case of flood damage, not only household items but also earth, sand and sludge are washed along with the muddy flow and can become the cause of stench.

Shelter
In addition to supplies, information of all kinds can be found at the shelters.

Public hall notice
Public halls are regional hubs. Please proactively utilize them even in the event of a disaster.

Please download and register the app.

Download on the App Store

ANDROID APP ON Google play

Annex 5: Excerpt from Kurashiki information brochure (p. 4) – information on waste separation after disaster (English version)

Disposal will be much faster, if disaster waste is separated before being brought in.

Debris mixed with earth and sand | Combustibles | Incombustibles | Metals | Debris

4 household appliances | Small appliances | Tatami, Mattress | Gypsum board, Slate | Hazardous Materials

Separation of disaster waste

～ Second sorting of garbage required after a disaster ～

The second sorting is to separate out disaster waste.

Kurashiki City has conducted extensive studies with businesses that have actually disposed of disaster waste from the heavy rains in western Japan, and is envisioning the following categories to facilitate prompt sorting and disposal:

①Debris mixed with earth and sand

②Combustibles (Wooden furniture, Dirty clothes, Plastic products)

③Incombustibles (Glass, China, Bottles, Fluorescent tubes)

④Metals (Metal furniture, Bicycle)

⑤Debris (Tile, Block, Brick, Concrete)

⑥4 specific household appliances

(TV, Refrigerators / Freezers, Washing machines / Clothes dryers, Air conditioners)

⑦Small appliances (Microwaves, Rice cookers, Fans)

⑧Tatami, Mattresses, Sofas

⑨Gypsum board, Slate, Siding

⑩Hazardous Materials (Fire extinguishers, Kerosene stoves, Batteries)

(note) Categories may change depending on the type of disaster.

POINT

Please dispose of disaster waste by putting designated items in their designated place.

Work to remove the contents of refrigerators at the temporary storage space.

Any food left in abandoned refrigerators must be manually removed before it can be handed over to a disposal company. Delays can lead to stench and pests.

【Main disposal methods for disaster waste】

①Debris mixed with earth and sand	Landfill
②Combustibles	Incineration / Melting process
③Incombustibles	Recycle / Landfill
④Metals	Recycle
⑤Debris	Recycle / Landfill
⑥4 household appliances	Recycle
⑦Small appliances	Recycle
⑧Tatami,Mattresses,Sofas	Incineration / Melting process
⑨Gypsum board, Slate, Siding	Landfill
⑩Hazardous Materials	Proper processing

Why do we have to separate disaster waste?

Waste that has not been separated will take extra time to process as it cannot be handed over to a disposal company without further sorting at temporary storage spaces.

We ask for your cooperation in separating waste so that disaster waste can be removed from the affected areas as soon as possible.

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Annex 6: Excerpt from Kurashiki information brochure (p. 5) – information on temporary storage site (English version)

Items unrelated to the disaster and industrial waste cannot be placed in the temporary storage spaces.
Illegal dumping of non-disaster waste is prohibited by law.

Temporary storage space (Kibiji clean center)

What is a temporary storage space ?

When disasters such as earthquakes, heavy rains, and typhoons occur, an unimaginable amount of disaster waste is generated.

Much of this disaster waste is not normally disposed of as household waste, and due to damage, much of it cannot be treated as usual. Therefore, in the event of a disaster, temporary storage spaces for disaster waste will also be opened in the disaster area.

Please cooperate as much as you can with bringing disaster waste to temporary storage spaces in order to remove it from the affected area as soon as possible.

(Please do not put disaster waste in your garbage station.)

We are considering a transportation support system, in cooperation with the volunteer center, of door-to-door collection for those, such as elderly households, who do not have transportation. Please be patient until the system is in place.

If disaster waste blocks the road, it will obstruct the passage of fire engines and ambulances. Please cooperate with storage on site until the temporary storage space is opened.

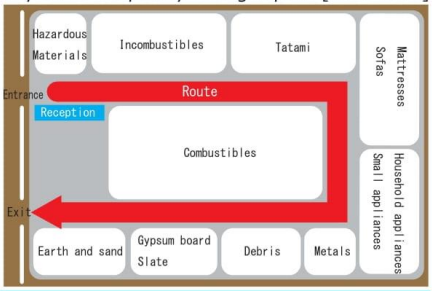
Sorting display at a temporary storage space

At temporary storage spaces, please drop your garbage down at the designated places according to the display.

Requests by local residents to stop reckless garbage disposal.

Abandoned piles of disaster waste can also block roads and hinder reconstruction. Please cooperate as a community in the event of a large-scale disaster.

Layout of temporary storage space [basic form]



POINT

Occasionally, we may check whether waste is disaster waste by asking to see your disaster certificate and personal identification.

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