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YSSP Report
Young Scientists Summer Program

Evaluating Risk Governance Practice Against the Sendai Framework: The Case of Forest Fires in Sweden

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Table of Contents

Abstract

Understanding the processes and institutions of 'inclusive risk governance' is crucial for addressing disaster risks strategically and on a systemic level. The Priority for Action no.2 of the Sendai Framework for Disaster Risk Reduction aims to guide countries around the globe in increasing their capacity to reduce disaster risks by strengthening disaster risk governance. However, the imprecise requirements for its implementation set out in its text and the ambiguity of its language, leave considerable room for interpretation and make accountability for progress difficult. We, therefore, develop an analytical tool that disambiguates the text by increasing the sharpness of meaning of its conceptual components. Using this tool, we rigorously evaluate the extent to which the global ambition to foster risk governance has been achieved in the real-life practice of forest fire risk governance in Sweden - elicited in qualitative interviews from experts and practitioners. We find that the Swedish practice of forest fire risk governance is adopting new governance mechanisms such as creation and maintenance of semi-formal and informal coordination structures that enable cooperation, collaboration and partnerships that transcend territorial and administrative boundaries and foster the exchange of disaster-specific expertise and knowledge. Tensions and bottlenecks remain, however, in how the use of the available knowledge resources is approached. This is indicative of a lingering focus on response and recovery rather than on prevention and preparedness. The results of the study contribute to the global discourse of disaster risk reduction by introducing a new and systematic way of evaluating high-level policy objectives. A rigorous evaluation of the practice of forest fire risk governance in Sweden against Sendai Priority 2 contributes to a better understanding of the governance mechanisms in place in the practice in question. The experimental application of business motivation modelling to the governance practice opens a dialogue and new possibilities for application of this method outside of the business organisational context.

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1 Introduction

1.1 The Sendai Framework

The Sendai Framework for Disaster Risk Reduction 2015-2030[1] (United Nations, 2015a) is a global agreement dedicated to preventing the creation of new disaster risks and reducing existing risks. It was developed in response to the escalating toll of disasters despite the progress of its predecessor, the Hyogo Framework for Action (United Nations, 2007). More generally, the Sendai Framework is part of the United Nations 2030 Agenda (United Nations, 2015c) which also includes the Sustainable Development Goals (United Nations, 2015b) and the Paris Climate Agreement (Paris Agreement, 196 Parties, 2016). This agenda recognises the increasing threat posed to society at large by the complex systemic risks that result from the fast-flowing developments in the political, social and technological spheres combined with the unprecedented climate and weather shocks and stresses that are resulting from planetary change.

Although the Sendai Framework is non-binding, the UN member states helped to develop it and agreed to implement it, and to report on progress. However, the scope of the framework is exceptionally broad as it aims to address hazards, exposure, and vulnerabilities of each and every kind. In addition, its wide range of goals, targets, and priorities for action is vaguely worded. Following its adoption in 2015, the research community noted that although these goals, targets, and priorities for action were undoubtedly important, they were not concrete enough to be operationalised directly and, as a consequence, were open to interpretation. This implied that the accountability for the work done and the work neglected with respect to implementation was expected to be difficult (The next era of disaster risk reduction, 2015).

UNDRR defines *disaster risk* as a function of hazard, exposure, vulnerability and capacity (UNDRR, 2020; UNDRR, n.d.a). The current global trends indicate that exposure is increasing alongside "high levels of inequality, rapid urban development and environment degradation" (UNDRR, n.d.a), which contributes to increasing vulnerability. If the trends are not contained, disaster risk will keep increasing rapidly. When discussing the global vision and aspiration of risk reduction that is put to the core of the Sendai Framework, we find ourselves in the domain of systemic risks where many interdependencies and causalities between these variables are possible. This perspective poses a challenge for both risk management, traditionally used for dealing with risks, and a more recent notion of inclusive risk governance (Lucas et al., 2018; Schweizer, 2019). Recent research demonstrates that the most effective approach to unify the phenomena of systemic risks across domains should be based on complexity science and that appropriate instruments and institutions should be developed to address "global, interconnected, stochastic, and nonlinear risks" (Lucas et al., 2018).

Priority for Action no.2[2] of the Sendai Framework urges to reduce disaster risks by strengthening disaster risk governance (United Nations, 2015a; pp.17-18), which, considering the points above, is not the most effective approach available to date. Hence, it is of great interest to evaluate how Priority 2 has been operationalised in practice. Moreover, such evaluation becomes all the more interesting if we look at the text of Priority 2 with a semantic lens. The text, which is split into three sections, starts with a description of goals on a general level, not bound by context, and is followed by two lists of subgoals addressing the 'National and local' and the 'Global and regional' levels, correspondingly. The text in each section is interspersed with qualifying phrases such as "if relevant", "as appropriate", "where

[1] Referred to hereinafter as the Sendai Framework.
[2] Referred to hereinafter as Sendai Priority 2 or Priority 2.

needed," and the like, which introduces a particular kind of ambiguity that leaves plenty of room for decision-makers to tailor the implementation of the Priority 2 to their specific contexts. However, the lack of clarity in the requirements for this implementation can lead to inadvertently misguided decisions on the operational, managerial, and strategic levels about which actions should be prioritised with regard to establishing disaster risk governance.

1.2 Evaluation the operationalisation of the Sendai Framework

To date, there have been no systematic approaches to evaluating the operationalisation of Priority 2 of the Sendai Framework, or the operationalisation of disaster risk governance. A number of studies exist, however, presenting different forms of evaluation of other aspects of the framework. Some examples include a case of lessons learnt with respect to Goal One of the framework (Ray-Bennett, 2018), a case of progress evaluation of the framework against the targets (van Niekerk et al., 2020), reflections summarising the first five years since the framework's adoption (Aronsson-Storrier, 2020; Mizutori, 2020), and a national Gap Analysis that serves as a basis for the development of a national action plan on DRR in Sweden (Aronsson-Storrier, 2021).

In addition, a list of Sendai Framework Indicators (UNDRR, n.d.f) is available that countries can use for measuring the progress in moving towards the global targets. This progress can then be captured in the Sendai Framework Online Monitoring Tool (UNDRR, n.d.d) and on PreventionWeb (UNDRR, n.d.e), two global platforms set up by the UNDRR. On the national level, countries are tasked with setting up a focal point for Sendai Framework implementation represented by a governmental agency.

A common feature in the evaluation approaches listed above consists in them relying on documents and formal reports as main data sources. While these approaches provide valuable insights, none of them seem to be well-suited for the task of evaluating the operationalisation of disaster risk governance addressed in Priority 2 in real-life practice. This is in part due to the lack of rigor in the qualitative methods used which render the results to be somewhat speculative, and in part due to the potential bias introduced through the disconnection of the formal documentation from the reality of real-life practice.

In contrast to these approaches, we maintain that while global reporting on the implementation of the Sendai Framework is an effective mechanism to motivate consistent action towards the high-level policy objective of disaster risk reduction, the reported content might not fully reflect the state of the practice in which the framework is being implemented. The implementation of a framework addressing a time period of 15 years should be understood as an ongoing process. An erroneous understanding of the state of this process might result in uninformed strategies, policy decisions, as well as missed opportunities for development. Hence, the outcome of an evaluation of operationalisation of the framework should first and foremost reflect the real-life practice in which the process of implementation is ongoing.

Drawing upon the notion of "strategic pragmatism" coined by Schmiegelow & Schmiegelow (1989) with reference to Charles Sanders Pierce and John Dewey, the forefathers of pragmatism as a philosophical approach, we recognise that theory should be put to the service of practice. In the context of this study, this means that it's the practical implications of the implementation of the Sendai Framework in real-life practice that matters most for understanding its progress and not the mere correspondence between the framework and the progress that is reported formally.

With this, we set out to evaluate Priority 2 of the Sendai Framework against a real-life practice of disaster risk governance while relying on the knowledge of key actors who are working in the practice

directly. A similar approach was taken by Ray-Bennett and Shiroshita (2019) who used desk reviews as theoretical support for the main focus of the study – empirical investigation using interviews.

We focus on forest fires which are becoming a greater risk and have been gaining increasing attention in Northwestern Europe for the past couple of years. We look at the case of forest fire risk governance in Sweden where 2018 saw the largest forest fires that occurred in the country to date and where the Swedish Civil Contingencies Agency (MSB) has been a designated focal point for the implementation of the Sendai Framework. Although MSB is active with publicly sharing information about their work, the availability of information on forest fire risk governance let alone its evaluation is limited. However, as the Swedish group are keen on improving their practices of handling forest fires and are open to suggestions and learning, the timing is right for making a contribution that can lead to a better understanding of the practice and therefore result in better policy.

1.3 Research questions

In this study, we address the following research questions:

RQ1: *How can we analytically evaluate a real-life practice of disaster risk governance against the goals set in the Priority for Action no.2 of the Sendai Framework?*

This question prompts us to develop an analytical tool that we can use for the evaluation. Once developed, it can be applied to a case of real-life practice of forest fire risk governance to evaluate the extent to which Sendai's vision has been operationalised. In this study, we are addressing a Swedish case, which determines our second research question:

RQ2: *To what extent has disaster risk governance been operationalised in the real-life practice of managing forest fires in Sweden?*

We apply the analytical tool we created to the coded interview data that we collect from the key actors in the practice. We do this by mapping the codes over the goal model. As an outcome, we are able to see the thematic areas with reference to Priority 2 that have been addressed more than others and by what means, as well as to what practical effect. As we are left with a number of qualitative insights that come out from the analysis of the interview data, we further inquire:

RQ3: *What are the main characteristics of forest fire governance in Sweden?*

We present the most prominent points we uncovered in the analysis while relating them to Priority 2.

2 Background

2.1 Disaster risk governance

Sendai Priority 2 holds that strengthening disaster risk governance is a means to reducing disaster risks. We therefore assume that disaster risk reduction can be operationalised through improving governance mechanisms. To make sure we are evaluating the right phenomenon, clear definitions of *disaster risk governance* and *governance mechanisms* are needed.

UNDRR defines *disaster risk governance* as "the system of institutions, mechanisms, policy and legal frameworks and other arrangements to guide, coordinate and oversee disaster risk reduction and related areas of policy" (UNDRR, n.d.b). In addition, it is noted that "good governance needs to be

transparent, inclusive, collective and efficient to reduce existing disaster risks and avoid creating new ones" (UNDRR, n.d.b) as the interconnectedness and feedback within complex socio-ecological systems determines how they respond to shocks (IRGC, 2018). This official definition with relevance to the Sendai Framework addresses the disaster governance part but does not specify what goes into the *risk governance mechanisms* it refers to. We turn to the definitions of risk governance to extract that understanding.

The Society for Risk Analysis (SRA) defines *risk governance* as "the application of governance principles to the identification, assessment, management and communication of risk" (Aven et al., 2018). The notion includes "the totality of actors, rules, conventions, processes, and mechanisms concerned with how relevant risk information is collected, analysed and communicated and management decisions are taken" (Aven et al., 2018).

Schweizer (2019) and Klinke and Renn (2019) expand on the definition provided by SRA by adding that risk governance combines risk analysis and governance. *Governance* is seen as an extension of government which refers to "the formal and institutional processes which operate at the level of the nation state to maintain public order and facilitate collective action" (Schweizer, 2019). It extends the government with flexible forms of control that allow for elements of deliberation and negotiation, a wider range of actors that allow for "bottom-up and top-down flows of information and energy" (Schweizer, 2019), network structures that supplement traditional decision making, and finally, with innovative informal processes that support the work of the formally established ones. In relation to this, Jones et al. (2015) note that the shift from 'government' to 'governance' is marked with how DRM communities share power when making collectively binding decisions. Namely, the emerging networks of actors would operate alongside formal governmental structures and pursue similar strategic goals through mechanisms characterised by a diffusion of power. *Risk analysis* includes systematic processes aimed at understanding the nature of risk such as "risk assessment, risk characterization, risk communication, risk management, and policy relating to risk, in the context of risks of concern to individuals, to public and private sector organizations, and to society at a local, regional, national, or global level" (Aven et al., 2018).

In the context of disaster risk reduction, this effectively means that the paradigm of disaster risk governance (DRG) is thought to encapsulate mechanisms that are more capable of prevention and preparedness as advocated by the Sendai Framework, when compared with the traditional paradigm of disaster risk management (DRM). The latter focuses on the application of policies and strategies for response and recovery activities (UNDRR, n.d.c) rather than on finding new ways to reduce disaster risks.

Therefore, for the purpose of this study, we understand *risk governance mechanisms* as a set of formal and informal arrangements, including resources, processes and associated activities carried out by the network of actors in the DRM community in the pursuit of a governance goal in a particular governance context. The *governance goal* is disaster risk reduction, that is, reducing the existing risk and preventing new risk from occurring and the *governance context* is a risk of a particular disaster that can cause societal disruption.

2.2 Wildfires globally

Wildfires are closely connected with climate change. A more hospitable environment is created for rapid fire development and spread as the warmer and drier weather conditions are becoming more common and more flammable fuel is accumulated (Dunne, 2020). In the context of wildfires, fuel is any dry plant material that can burn including "grasses, shrubs, trees, dead leaves, and fallen pine needles" (U.S. Department of the Interior, 2015). The more of these flammable materials pile up, the higher the

risk that a large wildland fire would develop and be more difficult and dangerous to manage (U.S. Department of the Interior, 2015).

Record breaking extreme heat worldwide has greatly exacerbated this trend, with extensive severe and long-lasting fires in Australia, California, Canada, Southern Europe and elsewhere gaining global attention. The increase in wildfire hazard is especially noticeable in the boreal regions which circle the northern hemisphere (Hess, 2020). Hence, in addition to heightened fire risk in areas that have traditionally been fire-prone, we see the occurrence of severe fires in areas where fires have previously been rare or of low intensity and easily controlled.

Large fires in areas remote from habitation may seem to pose little threat, as to turn a hazard into a disaster takes exposure and vulnerability of humans and things they value. Remote wildfires produce environmental feedback as the smoke can release massive amounts of carbon into the atmosphere. Furthermore, the smoke can spread hundreds of kilometres or more from the fires creating severe impacts on health and disrupting transport and outdoor activities (Borchers Arriagada et al., 2020).

Fires are unlike many natural hazards in that fire-fighting can reduce or even eliminate the hazard after a fire has started. This has tended to result in a strong emphasis on funding and expertise for response with a steady increase in the use of technology. Prevention occurs mainly through fuel reduction by planned or prescribed burning (Penman et al., 2020). Both approaches are expensive and their effectiveness in terms of risk reduction declines as fire weather conditions become extreme.

2.3 Large forest fires in Sweden

Historically Sweden has been viewed as a country with low risk of wildfires even though significantly large fires did occur in the past. The natural fire hazard is referred to as forest fire (skogsbrand) and vegetation fire (vegetationsbrand), with forests covering two thirds of the country's territory (Duxbury, 2021).

The main risk has traditionally been posed to the extensive commercial forests, and not to human settlements. Fire suppression has generally been successful at preventing large out of control forest fires (Pinto et al., 2020). Nowadays, however, there is concern about human health and safety through forest fires both threatening settlements and critical infrastructure and through extensive smoke pollution potentially affecting everyone in the country.

The first case of particularly severe forest fires in Sweden occurred in 2014 and resulted from extreme fire weather conditions, that is a period of drought and heat, in areas previously not considered to be at significant risk. As the vegetation dried out and became more flammable, the conditions exacerbated the risk. A more recent and the most severe fire outbreak to date occurred in 2018, with over 50 fires burning throughout the country following a period of hot and dry weather. Although the fires broke out in areas of low population, some small urban areas were evacuated and the smoke had spread throughout the country's populated areas causing invisible damage. The fires worsened rapidly and were challenging to contain as the shortage of resources became apparent. Local fire-fighters were assisted by the Swedish military, and neighbouring countries were called on for help with personnel and equipment including aerial appliances (Wikipedia contributors, 2021).

This rapidly rising complexity of the hazard, risk and management of the disaster as it unfolds raises challenges for governance and questions the adequacy of the traditional institutional structures.

2.4 Qualitative evaluation

As mentioned in Section 1.2, most evaluations of the implementation of the Sendai Framework available to date rely on documents and formal reports as main data sources and use qualitative methods that lack rigor, e.g., discussion and reflection, for data analysis. This is highly problematic if such an evaluation is aimed at informing high-level policy decisions or supporting the development of a national action plan on DRR. Reliance on the documented reality rather than practice coupled with the lack of rigour in the analysis can lead to misguided priorities and inadvertent setbacks, as we maintain in Section 1.2.

One such example is a comprehensive Gap Analysis of the implementation of the Sendai Framework in Sweden conducted by Aronsson-Storrier (2021), as commissioned by MSB. The report is officially appointed to serve as a basis for development of a national action plan on DRR in Sweden. It focuses on reviewing 34 relevant laws, policies and guidelines with relevance to DRR published by government authorities. Its methodological base includes interviews that are structured as questionnaires where respondents use a 6-item likert-scale ("strongly disagree" to "strongly agree") to provide their answers. The respondents are also prompted to provide clarifying comments, where needed. The quotes from the interviews included in the report indicate that the interview data convey subjective opinions rather than objective facts, which might be compromising the reliability of the results of analysis. Fore example, the following quotes are provided: "a national picture is lacking" and "ambitious system, but too many pitfalls." Furthermore, the list of respondents is said to have been supplied by MSB and includes representatives for different national and local authorities.

From the technical standpoint, the evaluation presented in the Gap Analysis by Aronsson-Storrier (2021) consists in relating the numbered items (referred to as "measures") in the four Priorities for Action of the Sendai Framework to three levels of maturity of implementation, as established by the researcher:

- Level 1: "Work with this measure is ongoing and beneficial for achieving the SFDRR[3] global targets,"
- Level 2: "Measure is partially fulfilled, but more work in this area could strengthen Sweden's ability to meet the SFDRR global targets," and
- Level 3: "Measure is relevant for Sweden, but not yet fulfilled. Significant action needed."

The evaluation does not address the preamble and the global goals of governance included in the text of Sendai Priority 2. It summarises the state of implementation and provides recommendations. The comments are phrased rather generally, e.g., "Sweden performs relatively well in terms of sectoral laws," and "In addition, municipalities need further support and incentives." This makes the conclusions, what they mean and what they are based on, unclear. The combination of methods used for data collection and analysis in (Aronsson-Storrier, 2021) compromises its rigor, and therefore potentially, its reliability.

In the present study, we are proposing a systematic and rigorous way for qualitative evaluation of the operationalisation of Sendai Priority 2 with the focus on large forest fires in Sweden. We use business motivation modelling (The Business Rules Group, 2010), an approach from the domain of information systems, to increase the transparency and sharpness of qualitative analysis, and therefore, reduce the risk of misguided conclusions that, if incorporated into the high-level policy decisions, can cause inadvertent setbacks on the level of planning and policy with respect to national DRR strategy.

[3] 'SFDRR' stands for the Sendai Framework for Disaster Risk Reduction.

3 Methodology

3.1 Data collection

For this study, the main reference document is the text of Priority 2 of the Sendai Framework titled "Strengthening disaster risk governance to manage[4] disaster risk" (United Nations, 2015a). To reduce confirmation bias during the empirical data collection, we used the short version of the text of Sendai Priority 2 (United Nations, 2015a; p.36) to guide the empirical data collection and its full text (United Nations, 2015; pp.17-18) as a basis for modelling.

To evaluate the implementation of forest fire risk governance in Sweden against this reference, we carried out 12 in-depth interviews with key representatives of the Swedish Civil Contingencies Agency (MSB), the County Administrative Boards of Jämtland, Västernorrland, and Gävleborg, the Forestry Research Institute of Sweden (Skogforsk), and with private entrepreneurs, all of whom were recruited using snowball sampling (Johnson, 2014). The resulting sample of interview respondents was heterogenous and balanced, with professional roles ranging in focus from high-level strategic work, research and policymaking to operational work including "blue-light" emergency response. We stopped sampling when no new insights could be gained from additional interviews, this is known as data saturation or theoretical saturation (Glaser and Strauss, 1967; Mason, 2010). This procedure reflects the explorative nature of our study and a small target population of sectoral experts is sufficient to ensure a complete picture of the area and subject in question.

The hotlines of MSB and the County Administrative Board of Jämtland served as initial points of contact. The hotline operators connected us to potential respondents, preliminary conversations with whom led to either expressions of interest in being interviewed or to further recommendations of potential respondents.

We used semi-structured interviews to capture the diverse knowledge and expertise of the respondents. To avoid introducing a potential bias, the Sendai Framework and the DRR terminology in general were not used to frame the interview. Instead, the respondents were encouraged to provide detailed descriptions of various aspects of their professional environments which were expected to reflect the everyday reality, and by extension, the state of the real-life practice of forest fire governance in Sweden. The main part of the interview guide[5] consisted of open-ended questions, with easier and more generic ones used at the start to set the scene and encourage long narrations from the respondents and more specific ones used for following up to ensure that the necessary level of detail was covered. Based on our definition of the *governance mechanisms*, the questions were grouped into the following sections:

- 'Professional role' capturing the information about the occupations of the respondents and the related tasks and responsibilities,
- 'Colleagues and collaborators' capturing the information about the actors in the network,
- 'Sources of information and knowledge' capturing the information about tools and mechanisms for decision support and knowledge exchange, and finally,
- 'Strategic work' and 'Operational work' zooming in on the tasks and responsibilities in more detail.

[4] In this study, we use the verb 'to manage' in its general sense denoting 'to deal with' or 'to handle.' We use the noun 'management' denoting 'actions taken to control and contain' in the context of DRM and related domain-specific terminology.
[5] See Appendix A.

A brief supplementary part of the interview guide consisted of Yes/No questions and addressed the degree of familiarity of the respondents with the DRR terminology. As advised by Weiss (1995), the pool of questions was addressed selectively as the conversations took shape in real time. To reduce the cognitive load on the respondents and increase the validity of the interview data, the interviews were held in Swedish, the respondents' native language.

The interviews were conducted in April—May 2021 before the official start of the forest fire season in Sweden. Prior to contacting the respondents, we took the necessary measures to ensure a high ethical standard of the interview procedure, interview data storage, and data processing by consulting the ethics support function at the Office for Research, Engagement and Innovation Services of Stockholm University. The interviews were held online over Zoom and on average took between 60 to 75 minutes. With the respondents' consent, each interview was recorded, with the video files permanently deleted and the audio files stored for transcription. Verbal expression of consent was captured in the recordings at the beginning of each interview.

The informed consent document[6] had been sent to each respondent prior to the interview to provide the opportunity to opt out. As advised by Seidman (2019), the document included the information on the "what", "how long", "how", "to what end", and "for whom" of the study; an overview of possible risks for the respondents and the measures taken to mitigate them, including the considerations of confidentiality and anonymity; a clarification of the rights of the respondents; and finally, researchers' contact details. Being aware that the work environments of the interview respondents could have been highly politicised by virtue of the connection of their organisations to Government Offices, we expected expressions of political perspectives and opinions. As this could pose a risk to respondents' professional integrity, we addressed it by informing them that we held a neutral position towards all organisations and individuals who work with the forest fire risk governance on the local, national, and international level, and that we did not intend to collect any political views or opinions. We were also prepared to handle such expressions off-record should they nonetheless have occurred.

Interview data is securely stored on the SUNET[7] cloud platform which is fully compliant with the GDPR regulation, with other traces permanently deleted. Interview recordings can be accessed by the members of the research team and an external transcription service provider. We used a non-disclosure agreement provided by the Stockholm University's legal department that was signed by the provider to mitigate the risks of the interview participants' data to be shared with third parties.

3.2 Data analysis

3.2.1 Hybrid coding of interview data

Thirteen hours of interview recordings amounted to 419 pages of interview transcripts that were iteratively analysed using a hybrid approach blending deductive (top-down) and inductive (bottom-up) coding for added rigour (Fereday and Muir-Cochrane, 2006).

To capture the codes emerging from the data, we used descriptive coding (Saldaña, 2016) and subcoding (Saldaña, 2016) aided by NVivo (QRS International, 2021). These coding techniques were straightforward and well-suited for this analysis as it aimed to extract descriptive information about the governance mechanisms in the form of objective facts rather than subjective perspectives on the quality

[6] See Appendix B.

[7] SUNET stands for 'Swedish University Computer Network.'

of governance structures. The software support provided time efficiency in processing the large amount of qualitative data and clarity over the intermediate findings.

Guided by the theoretical considerations we made when defining *disaster risk governance* in Section 2.1, we grouped the emerging codes into five deductive high-level categories:

- *Government* (processes and activities characterised by a highly regulated structure),
- *Governance* (mechanisms that enhance Government with respect to decision making and the exchange of knowledge),
- *Resources* (valuable assets existing in the system),
- *Risk* (activities and states with relevance to governing the risk of forest fires), and
- *Actors* (a complete list of actors mentioned by the respondents that participate in the practice of forest fire risk governance).

We picked and sorted relevant excerpts from the interview data into these categories and then proceeded to break them down into smaller pieces until no further splitting and sorting could be done. In this part of the coding process, we extracted 500+ codes with references to direct quotes from the interview data that were nested into 2-3 levels under each category. The leaf-codes in each hierarchy were carefully reworded to summarise the interview data through descriptive context-free statements so that they could be self-explanatory when read independently. Expressing objective facts, these codes reflected a number of critical components of the forest fire risk governance in Sweden. At this stage, uninformative codes (e.g., "Email is used for internal communication") were weeded out and the remaining informative codes were logically arranged into semantic clusters denoting activities, resources, outcomes, special cases and instances, amounting to 199 informative codes[8]. The analysis resulted in five coding hierarchies corresponding to the high-level categories described above and were further represented graphically as mind maps[9] using the Miro platform (*Miro*, n.d.). An example of a coding mind map is presented in Appendix E.

The first two top-level elements in each mind map were tagged with a logical reference to facilitate further analysis. All such references consist of three capital letters, e.g., e.g., RESOURCE (RES), Monetary value (MON), Tangible value (TAN), Intangible value (INT), with the exception for those referring to GOVERNMENT and GOVERNANCE where four letters were needed to disambiguate between these two words. The structure of a code that is ready to be mapped over the model can be represented as follows:

"*RES—INT Informationsbolaget: Conferences on forest fires for a broad spectrum of actors*,"

where *'RES'* and *'INT'* are logical references separated by an em-dash and linking the code to its place in the 'Intangible value' branch of the 'RESOURCE' coding tree; *'Informationsbolaget'* followed by a colon ':' is an example of a descriptor that refers to an actor in the actor network who is responsible for, is carrying out, or is performing the action; and *'Conferences on forest fires for a broad spectrum of actors'* is the descriptive code with high relevance for the analysis.

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[8] A full list of codes can be accessed here: https://docs.google.com/spreadsheets/d/1aXgYTVIEoVQK6M3NezjSUNRlWLK81PpFmld8mf8BFQ8/edit?usp=sharing.

[9] The mind maps can be accessed via the following links:
Government: https://miro.com/app/board/o9J_lvcAOyk=/,
Governance: https://miro.com/app/board/o9J_lvcw-EQ=/,
Resources: https://miro.com/app/board/o9J_lvcPbdE=/,
Risk: https://miro.com/app/board/o9J_lvcw_ro=/,
Actors: https://miro.com/app/board/o9J_lvcPYO4=/.

In this shape, the codes were mapped over the goal model to facilitate the evaluation of the operationalisation of Sendai Priority 2 in the practice of forest fire risk governance in Sweden. The goal model is described in Section 3.2.2 and the mapping is expanded upon in Section 3.2.3.

3.2.2 Goal modelling of Sendai Priority 2

To evaluate to which extent Sendai Priority 2 (United Nations, 2015a; pp.17-18) has been operationalised in the case of forest fire risk governance in Sweden, we developed an analytical tool based on the text of Priority 2 which took shape as a *goal model*. To achieve that, we applied a light version of business motivation modelling, part of a larger enterprise modelling methodology (The Business Rules Group, 2010) in the domain of information systems where it is used for creating a graphical representation of various cross-sections of organisational structure. This is done to help stakeholders to acquire a shared understanding of how the organisation functions as a system and make informed decisions on how to improve its operations. A brief search for applications of this methodology to representing a governance structure returned no results, and therefore, our application is experimental though grounded in our conviction of the methodological synergy.

Business motivation modelling offers a form of qualitative reasoning (Werthner, 2012) by which the structure of a system can be identified with respect to its elements, their interrelations, and what they depend on. In the context of an organisation, the focus lies on identifying factors that modulate achieving business plans. A goal model, more specifically, helps uncover a strategic vision, goals, means, and influencers for an organisation that is operated by an actor or a network of actors, i.e., departments and units, but is perceived as a single entity. In the context of governance, it would reflect the same aspects of the governance structure uncovering governance mechanisms. Such a governance structure would be "operated" by a network of actors, each of which is a separate organisation. This way, the forest fire risk governance structure is governed by the Swedish state represented by a network of actors such as, for example, governmental agencies (e.g., MSB, County Administrative Boards, the Fire and Rescue Services, etc.), NGOs (e.g., Volunteer Air Corps), and private entrepreneurs.

The resulting goal model of forest fire risk governance consists of the following four conceptual components, with definitions consistent with (The Business Rules Group, 2010), the main guiding document of the methodology of business motivation modelling. A *Vision* describes the desired future state of the governance structure that is not focused on a particular aspect. A *Goal* amplifies the vision and although it also reflects the desired future state, it is understood to be attainable and is oriented toward a single aspect of the governance structure. It can be framed in abstract terms, can be achieved fully or only to some extent, and can be operationalised through reaching measurable objectives. *Means* indicate the capabilities of the governance structure that can be exploited to achieve the goals and is framed as a concrete activity involving the use, creation or modification of resources which can either exist or be absent and, unlike a goal, cannot be partially fulfilled. *Influencers* reflect the objective state of some aspect of reality that can have an effect on the capabilities of the governance structure without exerting any effort.

Therefore, a lighter version of business motivation modelling using the components listed above was deemed to be an intuitive fit with the content of the text of Priority 2. We applied semantic analysis to extract the statements of goals, means, and influencers.

A reservation had to be made about how to represent the actor in the model. In business motivation modelling, a model is developed from the perspective of a single actor, i.e., a business organisation, and it is implicit in the goal statements. In application to governance that has the entire nation as its scope, we understand the actor as the network of actors in that governance practice. Similar to the

division into departments and units within a business organisation, a governance practice can be understood to be characterised by the responsibility that is distributed among the actors in its network. Hence, governmental agencies, private entrepreneurs, and other actors can be likened in that sense to departments and units within a business organisation.

The benefit of applying business motivation modelling method to create a goal model of Priority 2 consists in developing a concrete qualitative representation of the governance goals, means, and influencers. When applied to a case of real-life governance practice it highlights the existing governance mechanisms and helps to make informed judgments on the degree to which the desired state of governance has been operationalised.

The resulting goal model[10] is specific to the text of Sendai Priority 2 but is not tied to any particular case. It universally represents what is expected of all global actors in terms of DRR. The structure of the model and the reasoning behind it is presented in Section 5.

3.2.3 Evaluation of the operationalisation of risk governance

We used our goal model of Sendai Priority 2 as an analytical tool for evaluating the extent to which risk governance has been operationalised in the practice of forest fire risk governance in Sweden.

To connect the model and the interview data, we mapped the codes over the model by matching the meaning they expressed with the corresponding components of the model as shown in Figure 1.

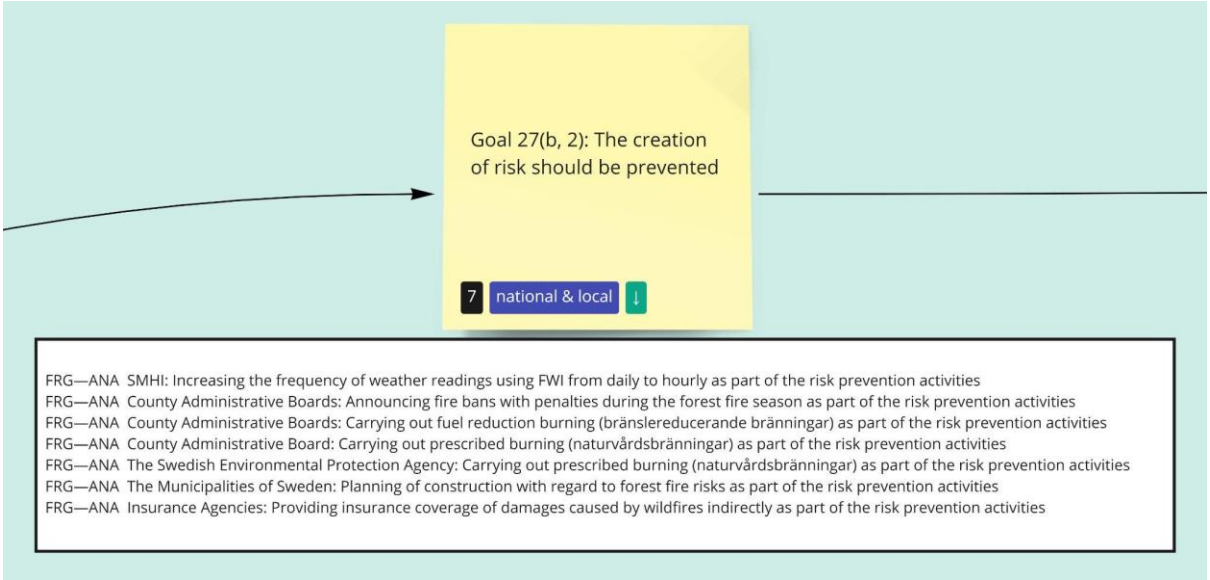


Figure 1: An example of how the codes are matched with the components of the model. Here, Goal 27(b, 2), with the scope of "national & local" (blue tag), addresses the prevention of creating risk and the codes matched with this goal denote activities explicitly aimed at the prevention of risk. Black numerical tag indicates the number of direct hits with the codes and the green tag with a downward arrow indicates that this Goal has also matched with suggestive codes (not shown in the picture).

In the mapping, we were guided by the semantic content and the scope of the codes and the components of the model. For example, a goal, a means or an influencer tagged with "national & local" in the model were matched directly with the codes referring to activities and resources on the same

[10] A "bird's" view of the universal goal model of Sendai Priority 2 is presented in Appendix C. A full version can be accessed here: https://miro.com/app/board/o9J_lvcIjP8=/

level, i.e., national or local, and not global or regional. Similarly, a goal, a means or an influencer tagged with "global & regional" could not be directly matched with the codes referring to the activities and resources on the national or local levels. A considerable number of codes made a strong semantic match with the goals, means and influencers but not with their scope. They were mapped as suggestive hits and linked to the matching components of the model as shown in Figure 2.

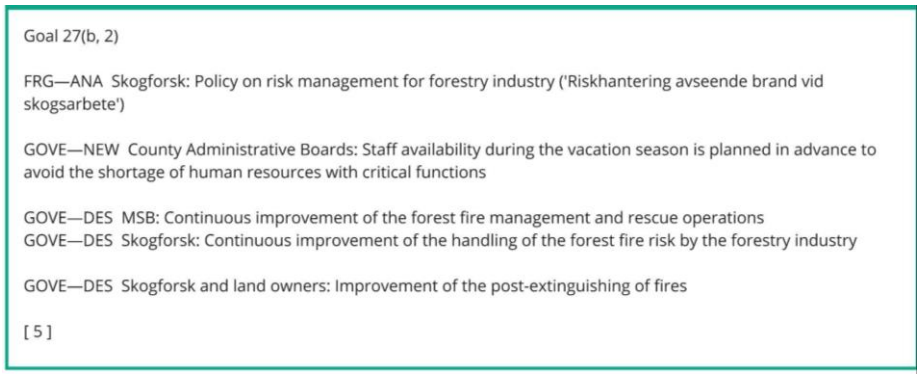


Figure 2: An example of how the codes are matched with the components of the model when the mapping is suggestive. Here, Goal 27(b, 2) with the scope of "national & local" and addressing the prevention of creating risk is matched with five suggestive codes addressing the prevention of risk only implicitly.

As with any qualitative analysis, using interpretation poses a threat to validity by introducing a researcher bias. To address this, the mapping was undertaken by two members of the research team independently, with the results of this process subsequently discussed and finalised using group consensus.

The resulting analysis is captured in a separate instance[11] of the goal model and includes direct and suggestive hits which graphically highlight the thematic areas receiving the most and the least attention with respect to forest fire risk governance in Sweden. In addition, quantitative measures representing hits per goal, means, and influencer are captured in numerical tags marked with black for direct hits and put in square brackets for suggestive hits.

Finally, we demonstrated the viability of the goal model as an analytical tool for evaluation of the match between the Sendai Framework and real-life risk governance practice by relating the results of our evaluation to the results presented in the Gap Analysis by Aronsson-Storrier (2021) that we introduce in Section 2.4.

[11] An example of mapping is presented in Appendix D; a full version of the mapping of codes over Sendai Priority 2 reflecting the Swedish case can be accessed here: https://miro.com/app/board/o9J_lvcI7Ho=/

4 Results and Analysis

4.1 Modelling

4.1.1 Semantic analysis of the text of Sendai Priority 2

To develop a goal model of Sendai Priority 2, we broke down its entire text into smaller structural components, i.e., paragraphs, sentences, and verb phrases. We then extracted statements of goals, means, and influencers while clarifying their meaning to reduce ambiguities.

General goal statements, i.e., not tied to a particular level of governance, were extracted from the preamble of Sendai Priority 2. Means and influencers were extracted from the subsequent paragraphs, grouped into numbered lists corresponding to the national and local and the global and regional levels of governance. In the course of analysis, it became apparent that those paragraphs contained goal statements as well.

The *goal* statements were phrased using *should*-phrases to express obligation. For example, Goal 1: "Disaster risk management should be effective and efficient." The statements of *means* were phrased using *action verbs* to denote either a finite action or an action on an object. For example, Means 27(k): "Formulate public policies for prevention or relocation of human settlements in disaster risk-prone zones" and Means 28(a, 1): "Foster more efficient planning with regard to DRR." The statements of *influencers* were phrased as objective facts reflecting the state of reality. For example, Influencer 27(k): "Law and legal systems addressing DRM are in place."

We do not include the text providing examples, e.g., "..., including by parliamentarians and other relevant officials" and "including on development and climate issues, as appropriate." We also split some of the means into smaller parts if they contained two action verbs that posed a semantic conflict. For example, "to foster" and "to implement" something would have different outcomes, and if they are used in the same means, it could be unclear which action is required. Therefore, we differentiate them to capture this difference in the outcomes in practice.

To further reduce the ambiguity of language, we added explicit references to the DRR context to each component of the model. We added either 'DRR', 'DRM' or 'disaster risk', depending on what was stated in the text from which that component was extracted. Without this addition, they could be placed in any context, e.g., "employee representation by unions" or "adhering to good research practices," without any particular problem.

In total, the semantic analysis revealed **27 goals** (9 of which were extracted from the preamble, 9 – from the list with the national and local levels, and 9 – from the list with the global and regional levels); **26 means** (18 of which were extracted from the list with the national and local levels, and 8 – from the list with the global and regional levels); and **2 influencers** (all of which were extracted from the list with the national and local levels)[12].

Furthermore, grouping goals and means together according to their semantics rather than their place in the text of Sendai Priority 2, allowed the following themes to emerge (Table 1):

[12] A complete list of goals, means, influencers including the original text of the framework and examples of our reasoning about this classification can be found here: https://docs.google.com/spreadsheets/d/1swC0exFF6BW62pZ6TukNiwJaACVniiyFCN9nSbScuC0/edit?usp=sharing

Table 1: An overview of the distribution of goals, means and influencers over the emerged thematic areas in Sendai Priority 2. The areas that have the highest number of components are highlighted with blue.

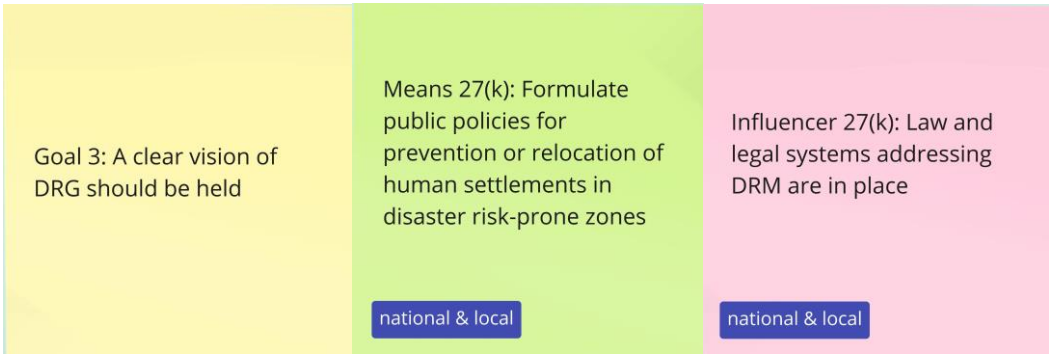
	Goals	Means	Influencers
Theme 01: Risk	4		
Theme 02: DRM Phases	1	2	1
Theme 03: Mainstreamed DRR	2		
Theme 04: Legislation	2	2	
Theme 05: Coordination & Stakeholders	6	8	1
Theme 06: Resilience	2		
Theme 07: DRG	2		
Theme 08: Competence	1	2	
Theme 09: Finances	1		
Theme 10: Plans	2	1	
Theme 11: Instruments & Tools	2	5	
Loose components	2	2	

The model is described in Section 4.1.2.

4.1.2 The goal model of Sendai Priority 2

The results of the semantic analysis enabled us to develop the goal model of Sendai Priority 2[13] using the Miro platform (Miro, n.d.).

We used colour-coding to graphically distinguish between the components of the model as well as we tagged each component with its reference to the original text as shown in Figure 3.



[13] A full version of the model can be accessed here: https://miro.com/app/board/o9J_lvcIjP8=/

Figure 3: Left to right: Goal 3 in yellow was extracted from the preamble, and the numerical identifier '3' indicates its place in relation to other goals extracted from the same place; Means 27(k) in green was extracted from the corresponding item in the list of actions on the national & local level of governance (blue tag); Influencer 27(k) in pink was extracted from the corresponding item in the same list.

We preserved the thematic groupings of the components described in Section 4.1.1 by enclosing them in rectangles to create graphical boundaries as shown in Figure 4 below and as presented in Appendix C.

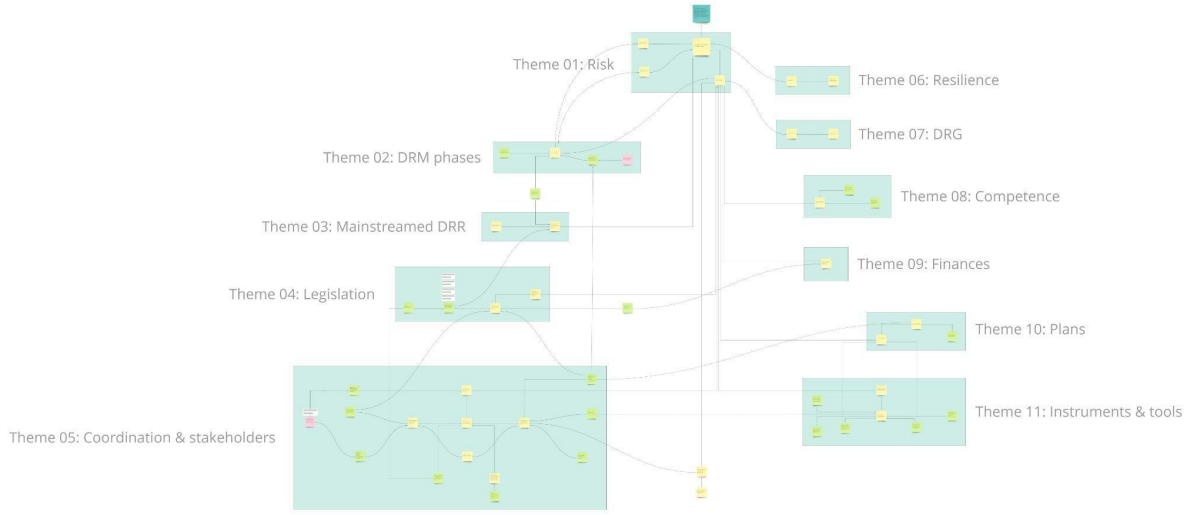


Figure 4: Thematic groupings of the components of the model are enclosed into rectangles to make it easier to read the model.

We connected the components with arrows to create a top-down hierarchy reflecting the semantic dependencies: goals are operationalised through fulfilled means, and means are enabled or threatened by influencers. Some goals received subgoals, and some means received submeans. Although there are many interconnections between the components in different thematic areas, we revealed no cases where one and the same component would belong to multiple themes. However, four loose components were distinguished that were rather generally framed and therefore did not belong to any thematic areas.

The resulting model shows that Sendai Priority 2 has a clear emphasis on thematic areas of Coordination & Stakeholders and Instruments & tools. This might mean that more is known about the requirements on their implementation in practice as well as they are considered instrumental to strengthened disaster risk governance.

4.2 Evaluation of Swedish practice of forest fire risk governance

To evaluate the Swedish practice of forest fire risk governance against Sendai Priority 2, we mapped the descriptive codes presented in Section 3.2.1 over the goal model presented in Section 4.1.2. That is, we thematically and diagrammatically associated the codes with the matching components of the goal model to uncover the extent of the operationalisation of Sendai Priority 2 in practice.

4.2.1 Coverage of thematic areas

Matching the codes with the components of the thematic areas of the model provides a clear picture of the focus areas of the practice. The distribution of hits is presented in Table 2.

Notably, apart from direct hits, we encountered a considerable number of suggestive hits. These could not be mapped directly either because of their scope (national and local vs. global and regional levels of governance) or because they lacked explicit semantic connection but could nonetheless be associated implicitly. We are presenting an overview of each thematic area below.

Table 2: An overview of the distribution of direct and suggestive hits of coded evidence over the model's thematic areas.

	Direct hits	Suggestive hits	Total
Theme 01: Risk	**8**	**12**	**20**
Theme 02: DRM Phases	9	2	11
Theme 03: Mainstreamed DRR	1	0	1
Theme 04: Legislation	1	2	3
Theme 05: Coordination & Stakeholders	**52**	**29**	**81**
Theme 06: Resilience	0	5	5
Theme 07: DRG	**24**	**9**	**33**
Theme 08: Competence	**14**	**25**	**39**
Theme 09: Finances	1	7	8
Theme 10: Plans	0	8	8
Theme 11: Instruments & Tools	**19**	**10**	**29**

As seen in Table 2, Swedish practice of forest fire risk governance is markedly covered with governance mechanisms related to coordination between stakeholders (Theme 05), competence (Theme 08), DRG (Theme 07), instruments and tools (Theme 11), and risk analysis (Theme 01), in the order of strength in coverage on the interval from 81 to 20 summative hits. The rest of the themes contain fewer than 12 summative hits but some of them nonetheless present interesting evidence.

We present each case below in the order from the most to least covered.

Theme 05: Coordination & Stakeholders

With **81** summative hits, this theme represents the strongest side of forest fire risk governance in Sweden.

52 direct hits include evidence on formal (top-down), informal (bottom-up), and semi-formal (top-down but voluntary) networks of actors present in the system; efforts towards facilitating coordination and leadership under large emergencies; common information systems and other collaboration mechanisms set up on global level, government coordination forums composed of relevant stakeholders being in place on national level; institutional framework assigning clear tasks and responsibilities to the representatives of Swedish forest fire risk governance community; and an instance of supporting local authorities to coordinate with civil society on the local level.

29 hits are mapped as suggestive because some of them do not provide a match in scope, i.e., national vs. global; some reflect meeting the requirements by actors different from those stated in the text of Sendai Priority 2, i.e., County Administrative Boards are not DRM institutions but they appear to have a number of DRM-related responsibilities; and one refers to a list of Swedish and international actors participating in the practice as implicit stakeholders, as extracted from the interviews.

Theme 08: Competence

With **39** summative hits, this theme highlights competency resources present in the forest fire network nationally and globally. **14** direct hits specify tacit competencies of actors while **25** suggestive hits point at activities indicating other relevant competencies, including a mismatch in scope. The Sendai Priority 2 sets a requirement on promoting mutual learning globally while a lot of these activities are ongoing in Sweden domestically.

Theme 07: DRG

With **33** summative hits, this theme indicates **24** governance mechanisms with relevance to DRG via risk analysis activities set in place and therefore matched directly. **9** suggestive hits point at the governance mechanisms not directly connected to risk analysis but nonetheless contributing to strengthening governance mechanisms through establishing formal, informal, and semi-formal network structures.

Theme 11: Instruments & Tools

With **29** summative hits, this theme lists **19** instruments, including information systems, decision support systems, apps, knowledge management activities, and methods, as well as mechanisms for assessment of DRM capacity, all of which are matched directly. **10** suggestive hits lists instruments and methods that are in development and therefore have not been implemented yet.

Theme 01: Risk

With **20** summative hits, this theme points at **8** activities targeted at risk prevention and mitigation, all of which are matched directly. **12** suggestive hits indicate activities targeting these areas implicitly, for example, through improving the practices of post-extinguishing of fire.

Theme 02: DRM Phases

With **11** summative hits, this theme reflects **9** directly matched activities and work orders targeted at encouraging the establishment of mechanisms and incentives with regard to DRM and **2** suggestive hits reflecting encouragement of efforts in continuous improvement of various aspects of the governance practice.

Theme 09: Finances

With **8** summative hits, this theme has only **1** direct hit matching the requirement of Sendai Priority 2 with regard to obtaining financing from the government. **7** suggestive hits indicate other mechanisms available in the practice for acquiring financial support, including EC.

Theme 10: Plans

With **8** summative hits, this theme has **0** direct hits and **8** suggestive hits indicating mechanisms related to increased efficiency in planning, including various efforts in strategic reporting and setting up specific routines for structured action under large emergencies.

Theme 06: Resilience

With **5** summative hits, this theme has **0** direct hits and **5** suggestive hits indicating activities implicitly related to building resilience, including improved awareness of risks and incorporating risk considerations in planning for construction.

Theme 04: Legislation

With **3** summative hits, this theme shows **1** direct hit referring to the Amendments to the Civil Protection Act (Lagen om skydd mot olyckor, LSO) effective 2020 following the large forest fires of 2018. **2** suggestive hits link to the Policy on risk management for forestry industry ('Riskhantering avseende brand vid skogsarbete') developed by Skogforsk and The Civil Protection Act (Lagen om skydd mot olyckor, LSO) established by the government, neither of which fits with the requirement of Sendai Priority 2 to set up legal frameworks or develop and amend legislation for DRR activities.

Theme 03: Mainstreamed DRR

1 direct hit reveals evidence that DRM integration into relevant sectors is being promoted, namely, that the government gives the forestry industry a work order to undergo Forest Stewardship Council certification (FSC) so that the way they work satisfies the international standard.

Loose components

Two global goals (28[c, 4] and 28[c, 1]) as well as two global (28[c, 1]) and national (27[i]) means were not included in the themes because they were phrased too generally. No matches for them were found.

As seen from the analysis, not all components of the model were covered by the empirical data. For example, the lack of hits for Goal 3: "A clear vision of DRG should be held" can indicate that those particular components are not relevant for the real-life practice of forest fire risk governance in Sweden. One reason for that might be the focus on the operational work rather than abstract concepts. Another possibility is that our measurement and analysis contain errors. For example, we might have missed this information during the interviews, and by including other respondents who work with high-level strategies, we could have caught some indications of a DRG vision being held.

4.2.2 Demonstration of viability of goal model as analytical tool

To demonstrate the viability of the goal model, we compare the results we obtained using its application against the results presented in the Gap analysis by Arronson-Storrier (2021), introduced in Section 2.4.

Our analysis and evaluation demonstrate that the text of Sendai Priority 2 has not been written in a straightforward way. Blurred thematic boundaries between the requirements on governance on the

national and local levels vs. the global and regional levels is one example of that. This means that the actions listed in Sendai Priority can hardly be used as measures for evaluation as-is.
We have also shown that the national practice of forest fire risk governance in Sweden is successfully integrating and addressing global goals. Therefore, excluding the global and regional level of governance, as presented in Sendai Priority 2, from the analysis would undoubtedly lead to loss of data.

Aware that the scope of our study is smaller than that of the Gap Analysis (Arronson-Storrier, 2021), we are sceptical about the findings that state that law, regulations and policy are a strong basis for disaster risk governance in Sweden. We found that in the practice of forest fire risk governance only a few of them have been operationalised, and hence, readily mentioned by all our respondents. Namely, the The Civil Protection Act (Lagen om skydd mot olyckor, LSO) developed by the government, as well as its Amendment in 2020, and Policy on risk management for forestry industry ('Riskhantering avseende brand vid skogsarbete') facilitated by Skogforsk.

Moreover, the focus on documents in the Gap Analysis does not help to completely uncover the formal, informal and semi-formal voluntary governance structures set up in Swedish practice in question in support of the DRR agenda.

4.2.3 Methodological findings

This interdisciplinary application of business motivation modelling to the modelling of governance proved to be successful. The outcome of the evaluation showed that the broad focus characteristic to governance issues relieved some of the methodological tensions. For example, it turned out that addressing the means in practice is not a necessary condition for achieving the goal as some of the codes fitted the goals but not the means instrumental to achieving the goal, as conveyed by Sendai Priority 2.

Given that both the codes representing the interview data and the goal model are qualitative in nature, the challenge we were posed with was to be as systematic as possible in order to maintain rigour of the analysis. To achieve this, we maintained transparency through documenting our methodological choices and decisions, aimed for objectivity in descriptive coding, and made considerations of completeness, soundness, and heterogeneity with regard to modelling.

Completeness. We mapped only those codes that clearly corresponded to the components of the model. This means that we had to omit a few dozen codes that did not fit directly. We included as suggestive some of the codes that seemed like a good thematic match but did not correspond to the semantics of the components of the model.

Soundness. We assume that the majority of the codes that are mapped are in the right places. To decrease the risk of matching the codes incorrectly, we were guided by the semantic content of the components of the model. For example, Means 28(a, 1) speaks of fostering more efficient planning with regard to DRR. 'Fostering', together with 'encouraging' and 'promoting', the three commonly encountered words in the text of Sendai Priority 2, implies that the scope of responsibility of actors in the network is limited to nudging the development of something by someone rather than developing that something themselves. On the other hand, Means 27(e, 1) speaks of development and strengthening of mechanisms for following up, regular assessment and public reporting on progress on DRR plans, which sets a more practical scope of responsibility focused on development. Hence, only those codes that corresponded to this reasoning were mapped to the model as direct hits.

Heterogeneity. The semantic content of the codes in one and the same box in the model is not uniform as the coding trees represent different aspects of risk governance, and they naturally capture

heterogeneous information. For example, Goal 9: "Instruments relevant to DRR and sustainable development should be implemented" is matched with codes that refer to information systems artefacts (e.g., GOVE—DES MSB: "RIB", a decision support system with an extensive knowledge base and the functionality for calculation of spread for fires and explosions), methods of performing a particular action (e.g., GOVE—DES MSB, SMHI, Fire and Rescue Services: A method of detecting forest fires using satellite imaging), and outputs of activities (e.g., GOVE—DES MSB and Vinnova: Ground cover mapping [marktäckekartering]).

5 Discussion and Conclusions

Since the Sendai Framework for Disaster Risk Reduction is a non-binding agreement, one cannot formally comply or not comply with it. However, as countries agreed to incorporate it in its work, some progress is expected. We have carried out a study that evaluates the Swedish practice of forest fire risk governance against Sendai Priority 2 that sets requirements for reducing disaster risk reduction by strengthening disaster risk governance.

RQ1: *How can we analytically evaluate a real-life practice of disaster risk governance against the goals set in the Priority for Action no.2 of the Sendai Framework?*

Before evaluating the progress of implementation of Sendai Priority 2 in the practice of forest fire risk governance in Sweden, we considered the existing tools and approaches to evaluation and none were deemed suitable for conducting a rigorous evaluation. We therefore developed an analytical tool that helped reduce ambiguity of the text of Sendai Priority 2 by increasing the sharpness of meaning of its conceptual components. Using this tool, we rigorously evaluated the extent to which the global ambition to foster risk governance has been operationalised in the real-life practice of forest fire risk governance in Sweden, as elicited in qualitative interviews from experts and practitioners. We further validated the tool by comparing the results we obtained to those presented in the recent Gap Analysis study on the implementation of the Sendai Framework in Sweden (Arronson-Storrier, 2021). We conclude that the experimentally goal model we developed performed rather successfully in its analytical application.

RQ2: *To what extent has disaster risk governance been operationalised in the real-life practice of managing forest fires in Sweden?*

We find that the Swedish practice of forest fire risk governance has operationalised the governance mechanisms related to cooperation, collaboration and partnerships between stakeholders (Theme 05), exchange of knowledge and competence (Theme 08), establishing coordination structures that facilitate collective action (Theme 07), implementation and development of instruments and tools that support the practice (Theme 11), and activities of risk analysis (Theme 01). In particular, we found that forest fire risk governance has been operationalised through creation and maintenance of informal and semi-formal voluntary coordination structures that transcend territorial and administrative boundaries and foster the exchange of expertise and knowledge specific to forest fire risk.

RQ3: *What are the main characteristics of forest fire governance in Sweden?*

From the interviews, we found that it might be challenging to develop strategies and carry out practical activities with direct relevance to the DRR agenda if they are not directly supported by funding or if they concern risks of hazards that are dormant or rare. In Sweden, the practice of forest fire risk governance began its rapid development following the large fires of 2018. Because the risk of the forest fires was recognised as a "new normal," the development of the practice received financing from the

government, and as a consequence, new operational procedures, strategic planning, and policymaking were developed.

This might mean that the system in question is vulnerable to unknown threats but it can improve rapidly after it experiences a shock. However, having to experience and survive a shock in order to become "smarter" in handling disasters is hardly an attractive risk governance strategy. Hoffmann and Muttarak (2017) found that formal education can be an effective mechanism for increasing resilience through reducing vulnerability, which can be effective in the absence of disaster.

Therefore, professional training and knowledge exchange may be a critical mechanism of governance in the context of disaster risk reduction. In the Swedish context, a wealth of knowledge resources is available with regard to forest fire risks, as well as forums for knowledge exchange have been set up. However, as brought up by some respondents, connecting the practitioners with the required knowledge they may be missing remains a persistent challenge. As preparation for response and mitigation is prioritised, the value of educational initiatives as well as that of research and development become inadvertently downplayed.

5.1 Implications for policy and practice

5.1.1 Swedish Practice

This national-level study of a global framework demonstrated that Sweden has operationalised a number of requirements stated in Sendai Priority 2 in its practice of governing risks of forest fires. However, the implementation of the Sendai Framework, including Sendai Priority 2, is a continuous process and gaps remain to be addressed.

With relevance to the development of a national action plan on DRR in Sweden, we show that rigorous sector-specific investigations of practices of disaster risk governance are important for avoiding overgeneralizations that may lead to one-size-fits-all approaches. Specific disasters require specific sectoral competence. Therefore, a requirement on the common denominator for the development of policy relevant to real-life practice and compliant with DRR goals would include the development of governance mechanisms that are sector-independent but encourage intersectional cooperation, collaboration and partnerships.

We conclude that in the Swedish context one such mechanism is continued development of the capacity for cooperation with emphasis on the maintenance of informal and semi-formal voluntary networks of actors across sectors. Although laws, regulations and policies are necessary enablers of informed action, they can hardly be suitable for passing down tacit knowledge and competence unlike professionals directly engaged in the practice (Hackett, 2002).

Tensions remain in Sweden between the historical focus on response and recovery and the current global agenda of prevention and preparedness. Therefore, with reference to Sendai Priority 2, an overall recommendation for Sweden is to provide financial incentives for furthering exchange of knowledge between actors to guide action for improving prevention and preparedness. This is supported by our finding that Goal 27(i, 2): "Budget should be allocated for DRR activities by parliamentarians" is not sufficiently covered, and therefore, cannot provide enough support in that direction.

5.1.2 Global Discourse

Understanding the processes and institutions of 'inclusive risk governance' (Schweizer, 2019) is crucial for addressing disaster risks strategically and on a systemic level (UNDRR 2015; Klinke and Renn, 2019; Schweizer, 2019). The Priority for Action no.2 of the Sendai Framework aims to guide countries around

the globe in increasing their capacity to reduce disaster risks by strengthening disaster risk governance. However, the imprecise requirements on its implementation coming up from the text, and the ambiguity of its language, leave considerable room for interpretation and make accountability for progress difficult (The next era of disaster risk reduction, 2015). The results of the study contribute to the global discourse of disaster risk reduction by introducing a new and systematic way of evaluating high-level policy objectives. A rigorous evaluation of the practice of forest fire risk governance in Sweden against Sendai Priority 2 contributes to a better understanding of the governance mechanisms in place in the practice in question.

5.2 Methodological discussion

The overall design of the study was decided upon iteratively and made us consider and reject several methodological options. Given that we aimed to assure reliable results in a purely qualitative study, the final strategy was based on the following considerations:

- The opportunities and limitations for data collection were defined by the subject of research. Given that we aimed at evaluating real-life practice, data had to be empirical. Therefore, it had to be collected with the participation of key decision makers and practitioners of forest fire risk governance in Sweden. This was approached by tailoring the interview design suitable for expert elicitation.
- The efficiency of the method of analysis of the qualitative interview data given its large amount (419 pages of transcribed text) led to us choosing descriptive coding. As the coding resulted in revealing a number of objective facts about the practice rather than subjective experiences of actors, it was suitable for qualitative modelling.
- The suitability of the qualitative modelling approach to modelling a case of governance as presented in the text led us to combining semantic analysis – from the domain of linguistics, and business motivation modelling – from the domain of information systems. The application of these methods contributed to increased transparency, sharpness, and therefore, replicability of the qualitative analysis.

Overall, the resulting combination of the methods helped us achieve the objective. However, we acknowledge a number of weaknesses in our approach. The analysis we performed does not provide an exhaustive picture of the Swedish practice but it does provide a sharp qualitative reasoning about the state of practice based on the empirical data. Furthermore, the combination of methods we use requires an interdisciplinary team with relevant competence, which might not be easy to achieve. However, the experimental application of business motivation modelling to the governance practice opens a dialogue and new possibilities for application of this method outside of the business organisational context.

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APPENDIX A: Interview Guide

— Hur ligger du till med tid? Hur länge kan vi hålla på? Är det ok att dra över några minuter om så behövs?

— Helena kan komma att ställa frågor på Engelska om det blir svårt att hitta rätt ord.

1	Professionell roll	
	Vad har du för professionell roll? Hur passar ditt arbete in i det övergripande arbetet med skogsbrandshantering?	• Hur länge har du haft denna roll? • Hur ser året ut? • Hur ser en typisk arbetsvecka ut annars? • Vilka projekt arbetar du med för närvarande? • Kan du berätta om vilka utmaningar du har mött när det gäller skogsbrandshantering i din nuvarande roll?
2	Kollegor / aktörer	
	Vem arbetar du med när det gäller skogsbrandshantering? Både inom och utom din egen organisation.	• Tänk på alla typer av arbete du utför: rutinarbete, planering inför om något skulle hända (skogsbrand), etc. • Vilka är dina primära samarbetspartners? Vad har de för professionella roller? • Vem eller vilka är de primära beslutsfattarna i din professionella omgivning? Har de alltid denna roll eller förändras det beroende på situation? • Arbetar du även med medborgare? Vad innebär det i så fall?
3	Informationskällor och kunskapsutbyte	
	Från vilka källor får eller hämtar du information som stödjer dig i ditt arbete?	• Tänk på alla typer av informationskanaler: människor, media av olika slag, konferenser, etc. • Hur väljer du informationskanal och vad beror det valet på? • Hur kommunicerar du med andra aktörer (t.ex. konferenser, samverkanskonferenser, professionella rapporter, informella samtal, annat)?
4	Strategiskt arbete (om personen jobbar mest på strategisk nivå)	
	Vad utgör de fundamentala delarna i ditt arbete? (insatslogistik, koordinering, utrustningsfrågor, konsekvenser för samhället, etc.)	• Vad och vilka är beroende av dig och dina beslut? Vilka får ta konsekvenserna? • Hur skapar man och beslutar om strategier för olika scenarion? • Hur koordineras samarbetet mellan dig och andra aktörer? • Använder du någon särskild teknologi i arbetet, t.ex. varningssystem, etc.? • Utför du några former av riskbedömning? • Använder du några särskilda skalor eller andra mätetal för att uttrycka riskers allvarlighetsgrad?
5	Operativt arbete (om personen jobbar mest på operativ nivå)	
	Vad utgör de fundamentala delarna i ditt arbete? (insatslogistik, koordinering, utrustningsfrågor, konsekvenser för samhället, etc.)	• Hur vet man vad som ska göras givet ett förväntat scenario? • Hur vet man vad som ska göras om situationen är helt ny? • Hur koordineras samarbetet mellan dig och andra aktörer? • Använder du någon särskild teknologi i arbetet, t.ex. varningssystem, etc.? • Utför du några former av riskbedömning? • Använder du några särskilda skalor eller andra mätetal för att uttrycka riskers allvarlighetsgrad?
6	Termer, begrepp, definitioner	
	I ditt arbete, använder du något av följande termer och begrepp, alternativt på engelska? Använder du några andra begrepp?	• Skogsbrandsriskbedömning? Om ja, vad innebär det? • Använder du begreppet samhällsrisker? • Använder du begreppet "multiple risks and hazards"? T.ex. kombinationen skogsbrand och torka? • Använder du begreppet resiliens? Om ja, vad innebär det? • Finns det några ramverk som du arbetar efter eller har hört talas om? Har du hört talas om Sendai Framework for Disaster Risk Reduction?

— Är det OK om vi återkommer ifall vi skulle behöva ett förtydligande eller fråga om ytterligare någon detalj?

— Skulle du kunna tänka dig att delta i en framtida studie som bygger på denna?

APPENDIX B: Informed Consent Document

Informerat samtycke

Delad med alla intervjupersoner inför varje intervju genomförd under maj 2021
för en studie om skogsbrandshantering

Vi som intervjuar
Helena Zhemchugova och Andreas Paulsson, doktorander på Institutionen för data- och systemvetenskap (DSV), Stockholms universitet. Vi forskar om beslutsstöd, riskanalys och resiliens.

Målet med intervjun
- Vill vi höra om din professionella roll och hur den spelar in i den övergripande bilden av skogsbrandshantering.
- Intervjun beräknas ta cirka en timme.
- Intervjun genomförs på distans över Zoom. Den kommer spelas in och endast ljudupptagning kommer att sparas och analyseras. Inspelningen kommer inte starta utan ditt uttalade samtycke, vilket behöver upprepas så snart inspelningen startat.

Om studien
- Vi vill lära oss hur omfattande skogsbränder hanteras i Sverige, både när det gäller det operativa och strategiska arbetet med förebyggande åtgärder och direkta insatser. Att veta mer om det verkliga arbetet med skogsbrandshantering kan hjälpa till vid utformandet av framtida policyer och fungera som stöd i arbetet med att skapa samhällsresiliens.
- Studien genomförs vid Stockholms universitet av Helena Zhemchugova med assistans från Andreas Paulsson under intervjuerna, och görs i samarbete med Susanne Hanger-Kopp och John Handmer, forskare från International Institute for Applied Systems Analysis (IIASA) i Österrike. Studien är delfinansierad av Formas.
- Vi följer Stockholms universitets forskningsetiska policy och förhåller oss neutrala till alla organisationer och individer som arbetar med skogsbrandshantering på lokal, nationell och internationell nivå. Vi samlar inte in några politiska perspektiv eller åsikter.

Hantering av personuppgifter och intervjudata
- Ditt namn och din organisatoriska tillhörighet kommer endast vara kända av studiens arbetsgrupp och hanteras konfidentiellt.
- Inga personliga uppgifter kommer delas med tredje part.
- När resultatet presenteras kommer all data från intervjuerna att vara anonymiserad. Direkta citat eller sammanfattningar av delar av en intervju kan komma att användas. Slutresultatet kommer presenteras i t.ex. en slutrapport eller vetenskapligt granskad artikel.

Deltagares rättigheter
- Du har rätt att läsa transkriptionen av din intervju när den är färdigställd (beräknat till juni 2021).
- Ditt deltagande är frivilligt. Du har rätt att avbryta din medverkan när som helst innan studieresultatet är skickat för publicering (beräknas till oktober 2021).

Kontaktinformation
- Har du frågor eller funderingar kopplade till studien så är du välkommen att kontakta oss. Du når oss lättast via e-post:

  Helena Zhemchugova: helena.zhemchugova@dsv.su.se

Vi uppskattar ditt deltagande och tackar dig för din tid!

APPENDIX C: A Goal Model of Sendai Priority 2

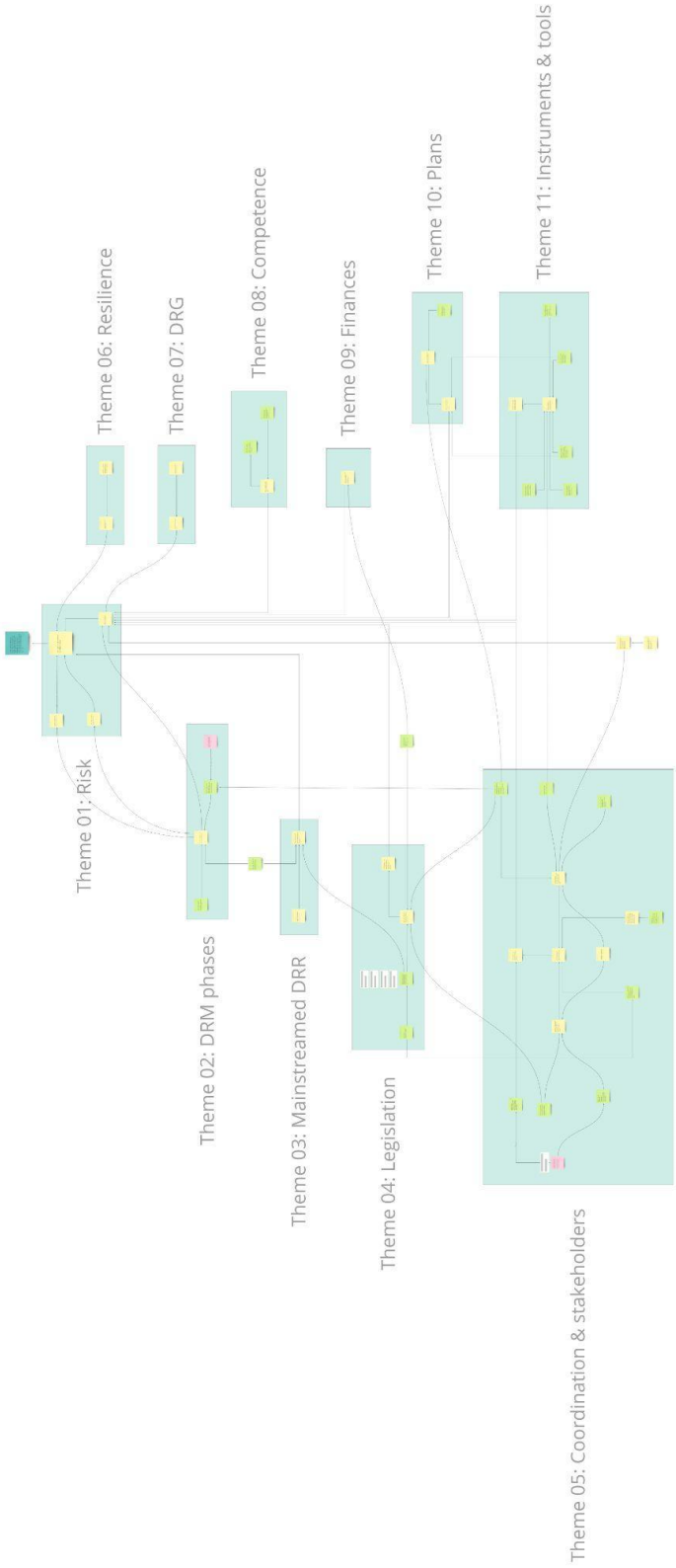

Figure 5: A "bird's" view of the Goal Model of Sendai Priority 2. A scalable digital version of the model can be accessed here: https://miro.com/app/board/o9J_lvcIjP8=/

APPENDIX D: Mapping

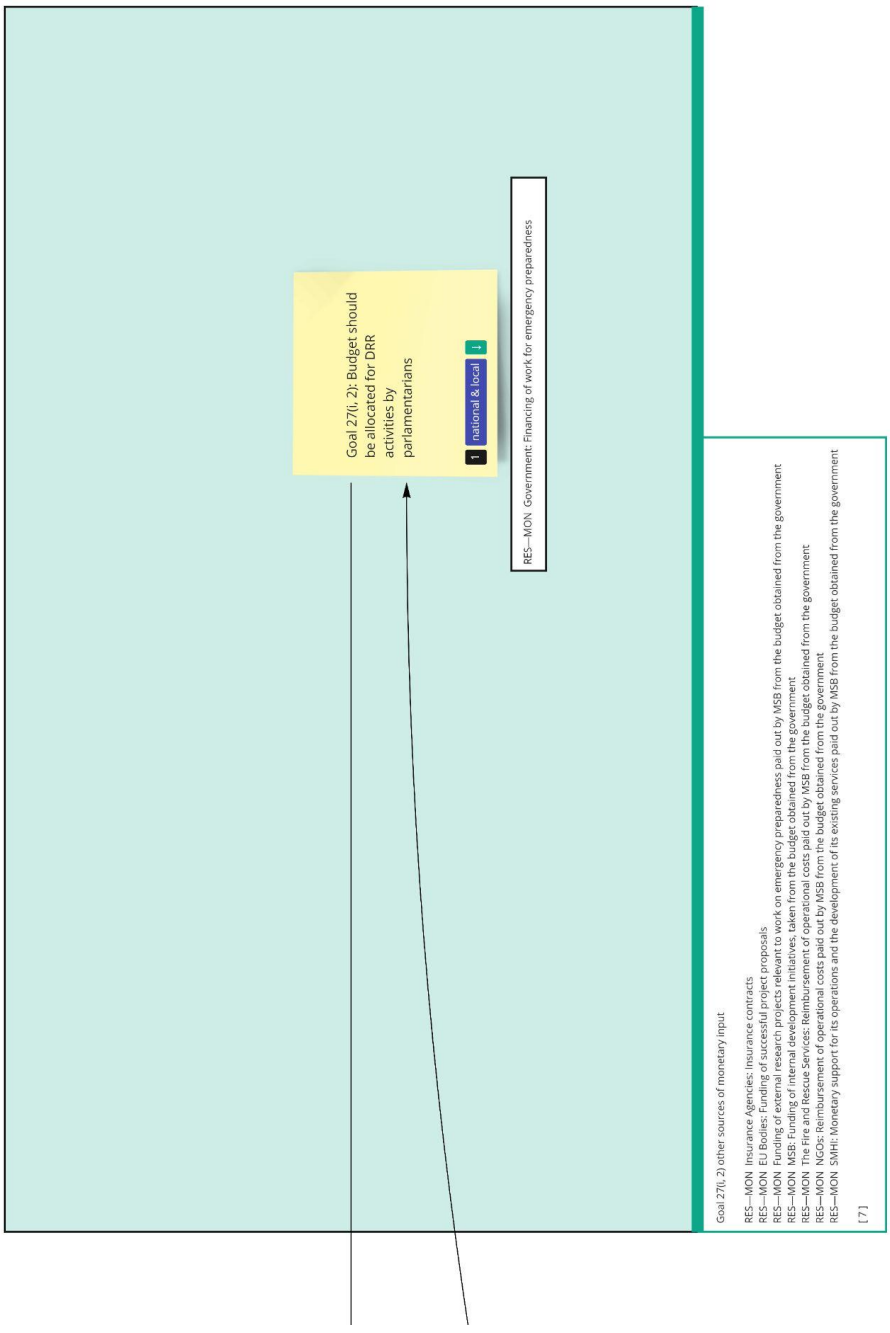

Figure 6: A fragment of the mapping of interview data over the goal model, Theme 09: Finances. Direct hits are mapped to the corresponding components of the model, while suggestive hits are placed below the thematic box. Here, Goal 27(i, 2) has three tags: a black numerical tag reflecting the number of direct hits, the blue (or, in other cases, a grey tag) denoting the scope, and a green tag with the downward arrow indicating that it has suggestive hits. A numerical tag reflecting the number of suggestive hits is put in square brackets at the bottom of the suggestive hits box. The full scalable version of the goal model with the codes mapped over can be accessed here: https://miro.com/app/board/o9J_lvcI7Ho=/

APPENDIX E: A Coding Mind Map

Figure 7: A fragment of a coding mind map 'Resources.' It should be read from left to right. It starts with the main category, then moves into special cases and instances. A full version of this mind map can be accessed here: https://miro.com/app/board/o9J_lvcPbdE=/. Links to the rest of the coding mind maps are provided in Section 3.2.1.