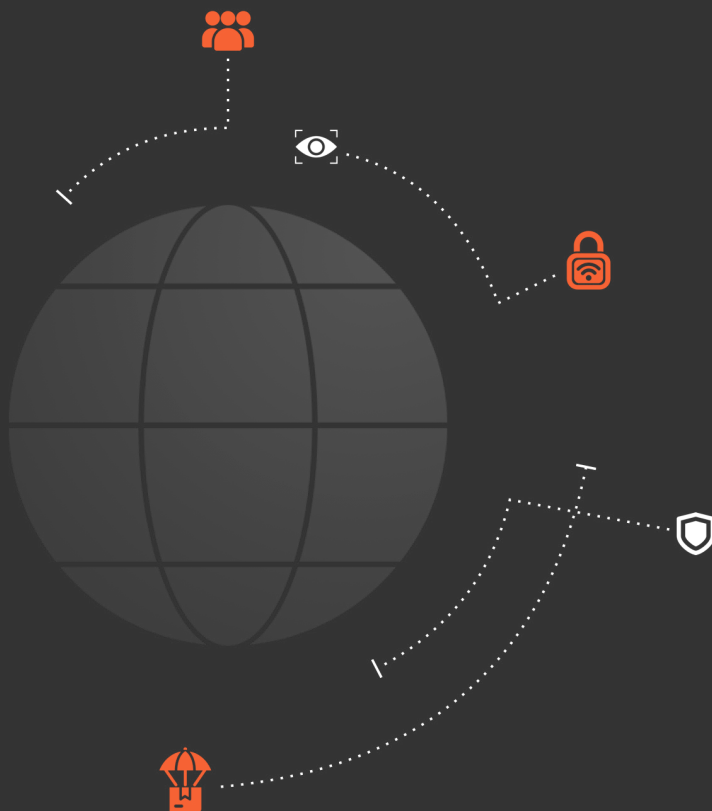# Modelling Humanitarian Interaction

N.M. Mok

Modelling Humanitarian Interaction

Exploring the factors that determine humanitarian interaction
and the policies that influence them through agent-based
modelling. The case of information security.

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Acknowledgement

Before you lies my thesis for obtaining the master's degree in Engineering and Policy Analysis. This thesis is the result of a lot of work, energy, hours, and frustration and looking back, I do not know why I was so convinced that I would enjoy the process. My enjoyment of this thesis is best described by the Bathtub model Igor uses to describe the flow of a master thesis. It is perfectly applicable to my mental condition the past 7 months. For the one unfamiliar with the Bathtub model, here a visualization of the model applied on my thesis process (please note that the right side is higher and that I believe I grew as a person):
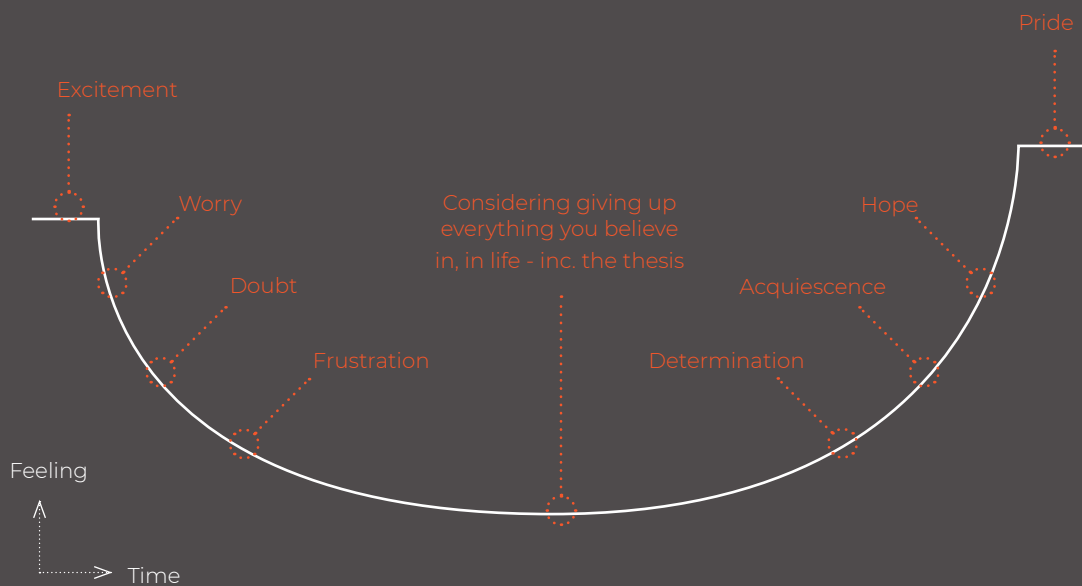
Just months ago, I was ready to throw everything out of the window, including the thesis. I am happy I did not and looking at the thesis as it is now, I am proud of myself. Proud that I finished it, proud of the result, and proud of what I have accomplished the past year. However, I did not have to go through this process alone, and I like to take this moment to thank everyone that were there for me in the millions of ways people where.

Starting with my supervisors. I would like to thank them for their guidance and remarks. I would especially express my gratitude for Igor Nikolic for all his guidance, work, and advice throughout my master. Igor did not only question the content of my work and my line of arguments, but also questioned my role

Summary

Humanitarian assistance is driven by data and information. Through the whole chain of actions – from early warning systems to evaluation – information determines priorities, resource allocation, and donors' willingness to donate. However, the potential harm that comes with data is often overlooked. Inadequate data management increases the potential of data to harm the same people humanitarians are trying to help. The goal of the presented research is to identify the characteristics and mechanisms that influence humanitarian interaction, with the aim to find those mechanisms that can influence humanitarians towards better information security. The most influential characteristics are analysed in order to determine what is likely to increase information security sector-wide. To reach this goal, the following research question is formulated:

"What are the characteristics of humanitarian interaction and how can this be used to gain insight in which policy measures will help the humanitarian sector to improve information security?"

To be able to answer this research question, the following sub questions have been formulated:

1. Which characteristics and policy interventions can be identified that influence humanitarian interaction?
2. How can the identified characteristics of humanitarian interaction and policy interventions be conceptualized using MAIA?
3. How can the implementation of the conceptual model into an agent-based model provide insight on how humanitarian interaction can be used to improve information security?

There are three methods used in this research. First, the humanitarian sector is conceptualized using MAIA as theoretical background. MAIA is developed as a method to translate a real-world system into an agent-based model, using the Institutional Analysis and Development framework. This method allows the researcher to map the knowledge about the humanitarian sector into an understandable and analysable framework. Furthermore, it allows the researcher to systematically identify the knowledge gaps and missing data so that the research can be valuable to the current and future body of knowledge.

The second method that is agent-based modelling. One of the main advantages of this approach is that complex systems can be grasped in a transparent and understandable set of rules. This will help understand the system, its dynamics, and the complexity that it entails.

Little research has been done on interaction in the humanitarian sector. Therefore, by modelling it, a lot of the relevant unknown knowledge can be identified. Furthermore, agent-based modelling enables the researcher to model humanitarian interactions in a dynamic way. Thereby allowing the changes and impacts of interactions and policy interventions to be measured and compared. The final method that is used is expert validation. The research entails a wide range of topics and no similar research has been found. The validation of the characteristics and mechanism that are included in the conceptual and agent-based model will show if these decisions form a right first step into research about humanitarian interaction and policy.

On the basis of an extensive literature review, humanitarian interactions are identified, selected, and conceptualized. The conceptualization is displayed in Figure 0-1 and shows all the components that are taken into account. One of the main advantages of the use of MAIA for this conceptualization is that it is easy to understand using the visualization and that it is easy to use in further research.
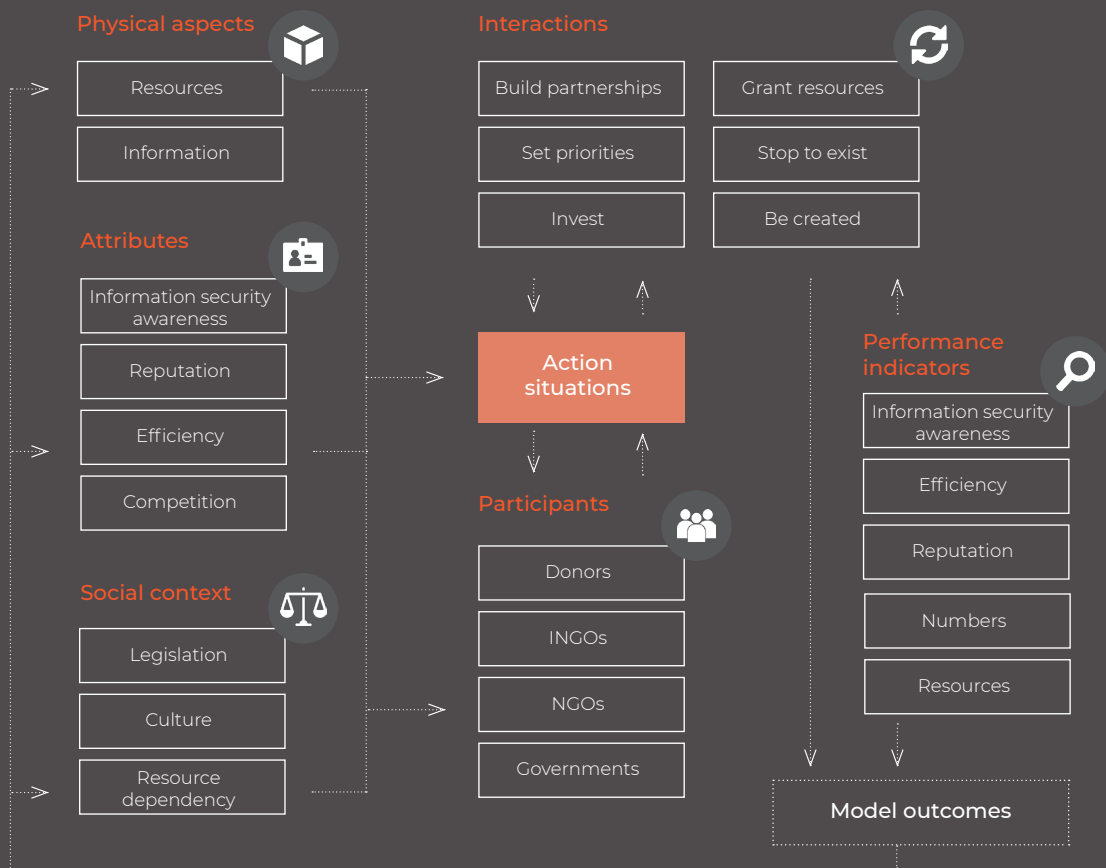

Figure 0-1: The conceptualization of the humanitarian sector using MAIA

This conceptualization is formalized in an agent-based model. The model results point towards the policy recommendation UN umbrella organization that coordinates efforts to spread information security awareness in the humanitarian sector and works towards a coordinated set of common standards. This option provided the most positive results because it works on both the INGO and the NGO level and is backed by research that is predominantly positive about the possibilities that an umbrella organization provides.

However, apart from the identification of a promising policy option, insights about information security in the humanitarian sector are obtained that can help to improve the current situation. First, the process of improving information security will be a long-term process. In the model, information security is assumed to be on the humanitarian agenda and even then, it takes some time before information security levels are improved due to the policy interventions. Considering that this topic is not – yet – regarded as pressing, no big improvements are expected in the short term. Therefore, results regarding information security must not be expected overnight.

Second, the NGO level is more complex and dynamic than the INGO level. Therefore, it is more likely that results are gained if the focus lies on the INGO level. INGOs have less resource scarcity and are more stable in terms of the numbers and time of existence. The NGO level knows more dynamics, dependencies, and resource scarcity. Adding that to the notion that information security expertise demand resources and time, which decreases the likelihood of satisfying results on the NGO level.

The third insight obtained by the modelling process and results show that the policy options that include both Donor – INGO and INGO – NGO interactions show the most promising results. Results are more likely to be booked if INGOs and NGOs are included in the process, however, the NGO level needs more attention and resources to book the same results as INGOs.

Due to the insights obtained in this thesis, a research agenda with the missing information and identified knowledge gaps is formulated. The seven proposed studies focus on:

1. Data gathering about humanitarian interaction: which factors are involved and how?
2. What is the current state of information security in the humanitarian sector?
3. Extension and better utilization of MAIA in the current conceptualization and model.
4. The spread of information security awareness on an organizational and interactional level.
5. The successes and failures of humanitarian policies
6. The feasibility of the UN initiated umbrella organization to improve information security.
7. The gap between humanitarian literature and practise

Table of content

List of figures

List of tables

01

Introduction and approach

Data is a vital component of modern societies. It has become an inseparable part of the daily practice of people and companies. Large and small organizations depend on the availability and use of data and the opportunities that accompany data are extensive. Unfortunately, the gathering and use of data is not without risk. As human behaviour, business processes, and government procedures can be more completely captured in analysable data, this knowledge becomes also available for those with malicious intentions. Dealing with the risks that accompanies data will be one of the challenges of the coming decades (Rossi, 2015).

As the growth and opportunities of data have touched upon every sector of modern economies, it has not surpassed the humanitarian sector. The humanitarian sector experiences the same struggle of balancing the opportunities and threats (IFRC, 2013). The goal of this thesis is to create a better understanding of the steps that can be taken towards responsible data protection in the humanitarian sector. This section starts with a general introduction of the use of data in the humanitarian sector, followed by the definitions of the core concepts used during this research. This leads to the knowledge gap that forms the foundation of the research and provides justification of the chosen perspective, research questions, methods, and tools, as described in the final parts of this chapter

(UNHCR, 2018)

1.1 Data in the humanitarian sector: a general introduction

The number of (armed) conflicts in the world is rising, resulting in an estimated 164.2 million people in need of international assistance at the end of 2016, of which 65.6 million are displaced and forced to flee within or outside their country (Development Initiatives, 2017). Figure 1.1 shows an overview of the countries who experience crisis due to conflict, highlighting the many places where humanitarian aid is required. Worldwide, many people rely on humanitarian assistance, and this number is likely to increase in the coming years (Nissen, 2017; Piguet, et al., 2011).
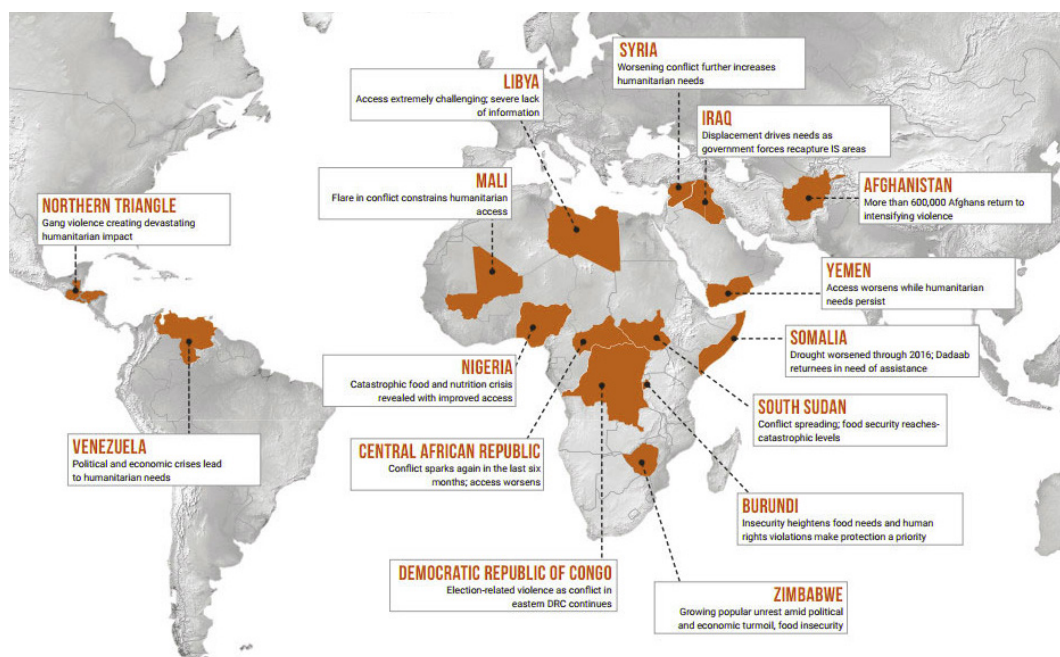
Figure 1.1: Overview of all (armed) conflicts in 2016 (Nissen, 2017)

Humanitarian assistance is driven by data and information. Through the whole chain of actions – from early warning to evaluation – information determines priorities, resource allocation, and donors' willingness to donate (OCHA, 2014). However, the benefits of data often overshadow the potential harm that comes with data. Furthermore, inadequate data management increases the potential of data to harm the same people humanitarians are trying to help (Sandvik & Raymond, 2017). The moral obligation of do-no-harm that guides humanitarian action has not – yet - reached the domain of humanitarian data. This creates an

environment where humanitarians are not granting information security the priority or resources it requires (The Guardian, 2017). This puts people in need of aid in serious, due to the possibility that their data ends up by the people they are trying to escape from. On the other hand, implementing responsible information security is a complex practice that most practitioners, fieldworkers, project designers and technologists have little expertise in (Engine Room, 2016). This situation creates an urgency to increase awareness about information security in the humanitarian sector.

To provide assistance, humanitarian organizations gather a lot of data. This data entails personal identities, habits, activities, networks, religion, locations and many more. As more data is generated in various ways – think about satellite images, biometrics, and social media – more data about how people behave, where they are, and what they believe becomes available. In conflict situations, this data – even if it does not include personal identifiers – can pose a serious threat. With the increased sophistication of analytical techniques, combining data sets can lead to re-identification of individuals and data that is associated with them. This phenomenon is known as the Mosaic Effect (Gatewood, 2014). The dangerous part of the Mosaic effect is that it is impossible to anticipate the different types of datasets that are - and will be - produced and could be combined with the current anonymous dataset to re-identify people.

Some humanitarian organizations seem to understand the risks that come with the irresponsible use of data. However, it is often put aside as something with low priority. As the IFRC states in the 2013 World Disaster Report, for example:

 "Concern over the protection of information and data is not a sufficient reason to avoid using new communications technologies in emergencies, but it must be taken into account." (p.96).

This benevolent attitude regarding data partly explains why responsible information security is not widely implemented in humanitarian practice (Belliveau, 2016). Furthermore, in an article published by The Guardian, an anonymous humanitarian worker describes a system where there is no incentive for humanitarians to consider responsible information security. The humanitarian describes that most humanitarians do no talk about data-driven projects that go wrong since they do not share the harm done to the individuals whose data is somehow compromised (The Guardian, 2017).

Given the negligence of information security in the humanitarian sector, the questions need to be asked as to what changes are necessary to facilitate a better understanding of information security and to establish adequate

measures to protect people in need from harm caused by this negligence. Some humanitarian organizations are starting to realize that something must change, but there is still a long way to go for the humanitarian sector (OCHA, 2016; ICRC, 2016; OXFAM, 2015). The goal of the present research is to see if this situation can be improved. The aim, therefore, lies with the identification of the characteristics and mechanisms that influence the behaviour of humanitarian organizations regarding information security, with the purpose to find those mechanisms that can influence humanitarians towards better information security. The most influential behaviours and interactions between actors are analysed in order to determine what is likely to increase information security sector-wide.

1.2 The core concepts

This section focusses on the concepts of information security, characteristics that influence humanitarian interactions, and policy interventions to incentivise behaviour sector-wide. These concepts form the foundation to solve the problem of how the humanitarian sector perceives and treats information security. The first concept – information security – is needed to understand what is being researched and how this can be measured. The characteristics that influence behaviour are - through literature identified- characteristics that increase the willingness of organizations to change or improve processes. The third concept – policy options to incentivise behaviour sector-wide – is closely connected to the second concept but operates on a different level. The second concept is approached from an organizational level while the policy options are perceived from an overarching systems perspective.

1.2.1 Information security

The international standard ISO/IEC 27002 defines information security as the preservation of the "confidentiality, integrity, and availability of information" (ISO/IEC, 2012). This definition describes information security in its broadest form and entails all forms of information currently known. Many scholars have tried to scope the definition of information security to make it more applicable to practice. Whitman & Mattord (2009), for example, have defined information security as "The protection of information and its critical elements, including the system and hardware that use, store, and transmit that information" (p.8). By using this definition, Whitman & Mattord (2009) put the emphasis on the protection of the infrastructural elements of information systems. On the other hand, there are researchers like Mitnick & Simon (2002), who have emphasised the human side

of information security. They describe information as a human process, and not as a sum of its technological components. According to them, the process of information security entails tools, policies, security concepts, guidelines, actions, safeguards, risk management approaches, best practices, training, assurance and technological components. Thereby covering the whole spectrum of information security. A fourth perspective on information security is provided by Solms & Niekerk (2013) who approach information security from a business perspective by defining it as the process that *"ensures business continuity and minimise business damage by limiting the impact of security incidents" (p.95).*

Different authors provide different perspectives and definitions. For this thesis, the definition of Mitnick & Simon (2002) is used because it acknowledges both the technological and the human side of information security. However, defining information security is just the first step. The second step is breaking down the concept of information security into something that can be measured and compared. This can be achieved with the concept of information security awareness (Parsons, et al., 2017; Franke & Brynielsson, 2014).

Information security awareness focusses on the consciousness of employees or organizations regarding the potential risk that the utilization of information systems bring. It can be perceived from multiple angles. However, it is often defined as organizational information security awareness where the organization, its management, or its employees fulfil the central role of research. Little research has been done on information security awareness from a sector perspective, whereby awareness is measured and compared between institutions (Franke & Brynielsson, 2014). However, information security awareness is applicable at multiple levels and is therefore used in this research to measure the organizational information security of different institutions within the humanitarian sector. Furthermore, information security is measured in information security awareness under the assumption that more awareness leads to more information security (Siponen, 2000; Bulgurcu, et al., 2010).

1.2.2 Characteristics of the humanitarian sector

Therefore, the next step is to identify the characteristics that influence behaviour in the humanitarian sector. The three most important characteristics of the humanitarian sector are the specific market mechanism, jurisdictions that are often conflicting and the dependency on partnerships. The first characteristic is due to the fact that humanitarian organizations are first accountable to their donors and second to their aid recipients. The aid recipients are the consumers of aid, while the donors pay for it. This creates a situation where humanitarian

organizations often prioritize the interests of donors, which are not necessarily aligned with the interests of aid recipients (Fishstein & Wilder, 2012; Petersen, 2010). Therefore, issues such as information security that require a lot of resources but do not contribute to the efficiency or effectiveness of aid provision are often overlooked or ignored (Lutz, et al., 2017; Sandvik & Raymond, 2017).

The second characteristic is the fact that - compared with other sectors - the humanitarian sector is more complicated when it comes to legal issues. The sector is not easily regulated, since it does not influence where conflict takes place and therefore does not always have a choice in which legal field they operate in. One cannot create a list of countries where humanitarians are not allowed to provide aid based on regulatory preference. Humanitarian organizations can hardly ignore people in need of help for the simple reason of not agreeing with the regulations that governments have in place.

The third characteristic is that the humanitarian sector heavily relies on partnerships to reach goals and obtain resources. Interaction between different humanitarian organizations determine if and how partnerships are built. Therefore, this research focusses on the characteristic of humanitarian interactions in the light of partnership formation.

Looking at the above described characteristics, two of the characteristics that influence interactions in the humanitarian sector are already described: access to resources and regulatory obligations (Balcik, et al., 2010). However, there are more to take into account, especially when it comes to partnerships. partnerships are largely based on personal basis as trust, shared history, and competition (Kent, 2004; Stephenson & Schnitzer, 2006). Interactions and dynamics are determined by personal and technical characteristics and it is important to take both into account.

1.2.3 Policy measures

Sectors, organizations, and people are influenced by policy. A part of this study is to identify policy that can influence the humanitarian sector. These policy can be initiated by various actors that are part of the sector. Furthermore, the policy measures connect to the characteristics that influence interaction in the sector. Examples of policy measures that are quality marks, one single coordinating organizations, trust-based cooperation and subsidies. Research about which policy measures – initiated by which actors – can influence behaviour in the humanitarian sector on a sector level is limited. Studies about change in the humanitarian sector are done on organizational level or focus only on improvement

of supply chain management (Behl & Dutta, 2018; Clarke & Ramalingam, 2018). This is one of the knowledge gaps addressed in this research.

In this study, an institution perspective is taken. By taking an institutional perspective, the aim of this study is to find the institutional arrangement which can form the starting point to improve information security in the humanitarian sector.

1.3 Knowledge gap and research question

This section discussed the knowledge gap and the research questions that follow from it. Furthermore, the scoping of the research is discussed to show what will be taken into account and where the focus of the research lies.

1.3.1 Knowledge gap

Despite existing research about information security, the humanitarian sector, and policy, there is no research found that brings these concepts together. The question remains: How can the different characteristics, mechanisms, interactions, and policies in the humanitarian sector be understood and how can this knowledge be used to increase information security in the sector? An extensive body of literature focuses on research about the humanitarian sector on supply chain management on organizational level within disaster situations. However, other aspects of the humanitarian sector are largely ignored or described on a very conceptual level (Balcik, et al., 2010). These gaps leave much space for research. However, due to a lack of previous research, data, and the scope of this thesis, this study is an explorative research focussed on providing new insights into how the humanitarian sector-built partnerships, applied on the case of information security.

The problem surrounding information security in the humanitarian sector is a well-suited case to shed light on how interactions driving the humanitarian sector can be influence towards better information security. The problems that form the starting point of this research is shown by the following problem statement:

Given the need to improve information security in the humanitarian sector. Can knowledge about humanitarian interactions and especially partnership formation be used to improve information security and are there policy interventions that can positively influence this process?

Although coordinated change is difficult to achieve, the humanitarian sector itself is dynamic and changes over time (Clarke & Ramalingam, 2018). The sector is different than it was ten years ago and it will be different ten years from now. Taking into account the interactions and thereby combining actors, relations, jurisdictions, resources, and dependencies might result in policy that can become part of humanitarian interaction.

1.3.2 Questions

As the problem, concepts, and goal are set for this research, the main research question can be formulated. The main research question is divided into three sub questions which will guide the process of answering the main research question. The main question is:

What are the characteristics of humanitarian interaction and how can this be used to gain insight in which policy measures will help the humanitarian sector to improve information security?

Sub questions:
1. Which characteristics and policy interventions can be identified that influence humanitarian interaction?
2. How can the identified characteristics of humanitarian interaction and policy interventions be conceptualized using MAIA?
3. How can the implementation of the conceptual model into an agent-based model provide insight on how humanitarian interaction can be used to improve information security?

The first sub question identifies the characteristics of the humanitarian interaction and looks at different policy options that can be applied to improve information security. This is done via a literature study that covers multiple aspects of the humanitarian sector regarding interactions, perspectives on information security for different humanitarian actors, and different types of policy. These topics are discussed in Chapter 2 and Chapter 3.
The second sub question looks at the humanitarian sector from an institutional perspective. The knowledge obtained for the first sub-question provides the input for this part of the thesis. The Institutional Analysis and Development (IAD) framework developed by Elenor Östrom forms the theoretical foundation of this analysis and provides the structure of the agent-based model that is the output of this sub question. This process is documented in Chapter 4 and Chapter 5.
The third –and last – research question focusses on the insights that can be obtained when formalizing the conceptual model into an agent-based model. The

aim of this sub question is to provide policy advise on which actor should initiated what policy option to increase information security in the humanitarian sector. This chapter takes both the model outcomes into account and the in insights obtained from literature study to see of the model outcomes are consistent with earlier findings. These topics are discussed in Chapter 6, Chapter 7, and Chapter 8.

1.3.3 Scope

This research contains and brings together a wide range of topics. The combination of characteristics and mechanisms that influence interaction in the humanitarian sector combined with policy and information security require a wide focus. Therefore, taken into account the balance that must be found between broad and in-depth, this research leans towards the broad side of the spectrum. The main focus of the research is the humanitarian sector approached from a global institutional perspective. It will cover the main humanitarian organizational actors and the generalizable behaviour between them. It will not cover specific scenarios or aims to represent specific situations. The humanitarian organizations that are taken into account are perceived as homogenous, meaning that they are assumed to have one culture, one way of communication and one organizational structure. An international NGO – like OXFAM – operates in multiple countries and contains multiple largely autonomous departments. However, these internal interactions are not taken into account and the organization is perceived as one single entity. This decision is made because of the large number of actors present in the humanitarian sector and the need to reduce the complexity of an already very complex sector to keep the research feasible with the available time and resources.

Furthermore, the focus of the study is to obtain insight in how humanitarian partnerships are built. The aim is to use this knowledge to see how information security in the sector is improved, however, information security is considered the case study and not the research objective. Therefore, what information security entails for the different organizations and which measures they take as a result of an increase in awareness is considered outside the scope of the research.

The final demarcation is that the research does not contain an extensive risk analysis or focusses on the attack mechanisms that pose the risk towards humanitarian data. It poses information security as a black box solution to the identified risks that come with the gathering and use of data. Questions about who attacks what systems, how, why, and when are not considered inside the scope of the research.

1.4 Scope

The previous section has introduced the problem statement that fills a central position in this thesis. This section will focus on which steps are undertaken to analyse the humanitarian sector and provide an answer to the main research question.

1.4.1 Research approach

This research consists of four steps. The first step is the literature research that focusses on the characteristics of humanitarian interactions and the identification of possible humanitarian policy interventions.
The second step is the conceptualization of the humanitarian sector with the focus on how humanitarian partnerships are build and which characteristics influence this process. The theoretical foundation for the conceptualization lies in the IAD framework as developed by Ostrom (2010) and MAIA, a framework on how to construct agent-based models using the IAD framework.
The third step is the formalization of this conceptual modem into an agent-based model so that the impact of policy interventions on humanitarian interactions and partnership building can be measured and analysed.
The fourth -and final step – is the validation of the conceptual model via expert validation. Hereby an expert panel consisting of five different experts in the field of humanitarian practise and research is asked to validate the mode conceptualization and underlying assumptions. The goal of this step is to validate the decisions made to conceptualize the humanitarian sector and to see if this research is a right first step in to research about humanitarian interaction, policy, and information security.

1.4.2 Methods

The four steps described in the previous section require different methods to be used. In this section, these methods are described and it is explained why these methods are selected.

The first method that is described is the use of the IAD framework and MAIA for the conceptualization of humanitarian interaction and partnership building. The IAD framework relates a set of concepts that describe social structures via actors, position, roles, and rules (Ostrom, 2010). It provides a systematic method to conduct policy analysis via the description of its institutions. Human behaviour

is complex, intangible, and difficult to understand. Institution on the other hand are tangible and enable the research to restrict behaviour to a set of – in the social structure incorporated - understandable rules that determine decisions that form the basis of behaviour.

For a sector where little data is available and little research conducted on how the sector interacts, the IAD framework is very suitable to use as theoretical foundation due to two reasons. First it allows the researcher to map the knowledge about this sector into an understandable and analysable framework. Second, it allows the researcher to systematically identify the knowledge gaps and missing data, so that the research can be valuable to the current and future body of knowledge. With the IAD framework as theoretical foundation, the next step is the introduction of MAIA. Ghorbani, et al. (2011) developed a methodology called MAIA (Modelling Agent-based systems based on Institutional Analysis) that enables the researcher to translate the conceptual IAD framework into an agent-based model. MAIA provides a strong theoretical foundation to capture the complexity of the humanitarian sector in to an agent-based model. The IAD framework and MAIA are in-depth discussed in Chapter 4.

The second method that is used is the use of agent-based modelling to model humanitarian interaction and partnership building. MAIA is suitable to capture multi-actor, multi-objective, complex socio-technical systems – as humanitarian interaction – into an agent-based model. However, the reason why agent-based modelling is desired must be discussed as well.

Agent-based modelling can be seen as a set of entities (called agents) who can make reasoned decision and are able to communicate with each other according to a set of simple rules. One of the main advantages of this approach is that complex systems can be grasped in a transparent and understandable set of rules. This will help understand the system and communicate this understanding to problem owners (Nikolic, et al., 2013).

Not much research has been done about interaction in the humanitarian sector. Therefore, modelling it will help to understand the steps must be taken towards more information security. Furthermore, agent-based modelling enables the researcher to model humanitarian interactions in a dynamic way. Thereby allowing the changes and impacts of interactions and policy interventions to be measured and compared. It is therefore believed that agent-based modelling provides valuable contributions to the research. The tool to model the system is Netlogo. The implementation of the MAIA conceptual model into Netlogo is in-depth discussed in Chapter 6.

The third method that is used is expert validation. The research entails a wide range of topics and no similar research has been found. The validation of the characteristics and mechanism that are included in the conceptual and agent-based model will show if these decisions form a right first step into research about humanitarian interaction and partnership building. Furthermore, insights of the experts can be used to identity further research directions and missing knowledge about humanitarian interactions, policy, and information security in the sector.

1.4.3 Societal and scientific contributions

The humanitarian sector is a different sector than most due to its partnerships dependency, regulatory difficulties and the current accountability structure. It is a multi-billion dollar industry on which more and more people rely on every day (WFP, 2017b). Conflicts are on the rise and the amount of – for example - climate-change affected refugees is growing every day (Nissen, 2017; Piguet, et al., 2011). Furthermore, more data is gathered about people in need of aid through satellite images, biometrics, surveys, social media, and many more, documenting where they are, who they are, and what their network is. Adding new insights in how the awareness of information security can be increase in the humanitarian sector holds a significant societal value due to the protection of these people.
The scientific value of the research is more focused on the conceptualization of humanitarian interaction. Little research is done about this sector and no research is found that specifically focusses on how humanitarian interaction takes place or how policy can be used to influence these dynamics. This research can function as the first step in understanding how the humanitarian sector works, how and why interactions are initiated, what drives decision making, and how this knowledge can help solve the problems – like information security - the humanitarian sector faces in the (near) future.

1.5 Thesis structure

This thesis consists of 10 chapters. Each chapter covers one of the research steps that are needed to answer the main research question. Figure 1-2 shows an overview of the chapters and how they relate to each other. The literature and modelling sections are displayed in separated sides of the diagram. Furthermore, the arrows show information is build up and how the output of a chapter is used as input for the next.

Chapter 1

Introduction

Research questions and approach

Chapter 2

Literature review

The humanitarian sector

Chapter 3

Literature review

Characteristics and policies

Chapter 4

Literature review

IAD and MAIA

Chapter 5

MAIA

Conceptualization

Chapter 6

Agent-based Modelling

Formalization and verification

Chapter 7

Experimental design

Validation

Chapter 9

Conclusion

Limitations

Chapter 8

Model results

Data analysis

Chapter 10

Further research

Figure 1-2: The research flow diagram

02

Humanitarian data,
a background story

This chapter provides background information of the humanitarian sector and humanitarian data. The background information is considered the first step in understanding the sector to such an extent that it can be modelled in a next stage. This chapter contains an in-depth discussion on the relevant actors and their current state and view on information security (paragraph 2.1). Furthermore, a discussion on the legislative playing field provides insight in the difficulties the sector faces regarding legislation about information security and other topics (paragraph 2.2). Section 2.3 provides an overview of how other modellers coped with the difficulties and complexity of the humanitarian sector. Finally, paragraph 2.4 provides a conclusion with the main findings of this chapter.

(Harris, 2016)

2.1 The actors

There are many forms of conflict that affect people and communities in very different ways. Militarized violence, human rights abuses, misuse of power, and situations of impunity. These forms of conflict bring many forms of violence including conventional state centred warfare, warlordism, terrorism and suicide attacks, ethnic cleansing, and civil war (Goodhand, 2000). Often, violence is just a means to an end for some of the parties involved while the most vulnerable are the ones bearing the risks and consequences of it. This section provides a description of the actors that –often- play a role in conflict affected situations where humanitarian assistance is required. There are many actors involved in the humanitarian sector. Therefore, a selection is made based on what the literature marks as the most influential stakeholders in the humanitarian sector operating with conflict affected people (Behl & Dutta, 2018; Oloruntoba & Gray, 2006; Duffield, 2013). Per actor a general description and a description more focused on data is provided.

2.1.1 Aid recipients

At the end of 2016, an estimated 164.2 million people were in need of international assistance. Over a quarter of this estimated amount were located in three countries: Yemen, Syria, and Iraq. Conflict and conflict-related displacement where the most common drivers of need and most of the humanitarian means went to this group of people. Of 164.2 million people in need, 65.6 million people were displaced (Development Initiatives, 2017). The income of the countries where displaced people seek refuge determines – to a large extend- the capacity of the host country to provide assistance and care. If the capacity to host refugees is inadequate, international humanitarian assistance is needed to bridge the situational shortcomings.

Displacement, poverty, vulnerability and violence accelerate each other. People who are experiencing violence are more likely to end up in extreme poverty and long-term dependency on humanitarian assistance (Donnelly, 1993). Although most people affected by violence do not take part in it, they are the ones who pay the price. Poverty, disability, (mental) health issues, (sexual) abuse, trauma, and many more issues are connected to violent situations. The goal of this group of people is therefor to survive the situation and not end up in extreme poverty. Since they do often not have the power to influence the situation, they depend on more powerful actors to protect them(ibid).

There are two types of data that can be gathered about aid recipients that are of interest to a great deal of parties: Personal identifiable information (PII) and Demographical identifiable information (DII). PII includes personal data such as name, gender, and age, but also ethnical background, biometrics, data of family and friends, location history, social preferences, and religion. DII is data that ties groups together based on common characteristics as location, gender, religion, ethnicity etcetera (Sandvik & Raymond, 2017; Development Initiatives, 2017). Both types of data are sensitive and need to be protected. Misuse of DII is extremely dangerous since it can form the bases or information to fuel ethnic cleansing, religious violence, or gender-based assault. On the other hand, PII can be dangerous since it ties refugees to the ones who stay behind, thereby creating more risk for the people who are still in the area. Furthermore, it ties people to locations, exposing them to violence or decreases their chance of asylum based on where they have been or who they have met.

For people and communities affected by conflict, data protection can be of lifesaving importance. However, by sharing data humanitarians can provide faster and better care. This creates a difficult situation. People are dependent on others and humanitarian assistance. So if providing their data is required to receive help, they often have no other choice than to share. Furthermore, many surveillance systems do not need active sharing to gather data. Both governments and humanitarian organizations increasingly use surveillance systems, thereby diminishing the power of individuals to protect their personal and demographical data (Sandvik, 2016).

In sum, people affected by conflict have limited power regarding their data. However, they possess data that is of interest by many parties, both with peaceful and harmful intentions. Finding a balance between data gathering and safety is of outmost importance to them.

2.1.2 Local and national NGO's (NGOs)

Humanitarian funding rarely reaches conflict affected people and locations directly. It is often channelled from donors through multilateral humanitarian organizations (often UN or Red Cross) or international NGOs, via and national humanitarian organizations to local partners (WFP, 2017b; Development Initiatives, 2017). There are thousands of different NGO's, all with different perspectives, access, goals, ideologies, expertise, and knowledge. They are often the groups who deliver most of the jobs in the field and do most of the implementation work. NGO's know the culture and people, speak the same language and know the power structures. Furthermore, it is more efficient and cost-effective to employ

people in the region than only employing foreign humanitarians (Haverkamp, 2010).

Despite the importance of NGO's they only receive about 0.3% of the worldwide available humanitarian funding directly. A significant bigger number reaches them via different channels and partnerships (Development Initiatives, 2017).

NGO's hold a significant part of the implementation power. They hold power to influence a situation, but at the same time are extremely dependent on their partners and donors. Looking at data protection, a lot of data on various topics is held by NGO's. Since the variety of NGO's is enormous, their capacity, willingness, and knowledge to protect data varies as well. Since most of the implementation is done by this group, their trust relationship with aid receivers is extremely important. Therefore, these NGO's have much to gain by protecting data. However, their limited accessibility to funds and the high competition make it also attractive to share data with their donors and partners. Limited funding decreases the willingness to invest in data protection, because it does not touch upon their core business and more problems require their attention (Bergen, 2014). Therefore, NGOs lack a convincing incentive to prioritize data protection.

In sum, NGO's carry most of the implementation via partnerships. These partnerships often decrease the transparency of the humanitarian transaction chain. They hold a lot of data and have an incentive to protect it. However, they also have incentives to share data to receive funding and lack adequate funds to invest in protection.

2.1.3 International NGOs (INGOs)

International NGOs have the same purpose and mission as NGOs, but with an international scope and character. They are operational, meaning that their purpose is to help people and community trough (semi)direct care. Or advocacy, meaning that their purpose is to influence policy-making, or a combination of both. Examples of INGOs are OXFAM, Médecins sans frontiers, and the International Red Cross and Red Crescent movement (ICRC). INGOs provide relief services that are not provided by nation states due to either lack of ability or willingness.

Due to their international status, INGOs receive a lot of public and private funding. Some of the funds are used directly to provide help and other are funnelled down through more local partnerships (Development Initiatives, 2017). The position of INGOs makes them powerful players in the humanitarian sector. They receive a lot of money and they can decide to put their own boots on the ground or attract local implementors. However, the further in the transaction chain, the

lesser the influence of INGOs and more they depend on local people, practises, and knowledge. The partnership between INGO and Local NGO makes them both powerful and dependent because they rely on each other to be effective (Duffield, 2013).

There is a significant number of INGOs and always a limited amount of resources, which fuels competition. This increases the importance to be visible and provide efficient aid. Data protection does not directly contribute to these goals and is often overlooked. However, reputation is extremely important to keep donors close. A data breach with possible life-threatening results will significantly hurt an INGOs reputation. This provides an incentive to implement data protection protocols (Engine Room, 2016), or not disclose data related accidents (The Guardian, 2017).

INGOs are known to have large amounts of data about a wide range of things. They collect data on their beneficiaries – from which much is personal or sensitive –, their operations, their donors, and their staff. INGO's have the capacity to secure data, but it is unclear how well this is done. In 2015, OXFAM launched its Responsible Program Data Policy, thereby claiming to be one of the first INGOs to have such an organization wide implemented policy (OXFAM, 2015). In 2016, the ICRC established strict organization wide data protection protocols and organized multiple workshops with other INGOs to urge them to take steps as well (ICRC, 2016). However, in 2017 The Guardian published an article were a former humanitarian employee shows that data protection has little to no priority in the sector (The Guardian, 2017). He/she talks about privacy horror stories were "highly sensitive data is routinely emailed openly among staffers, without encryption. Personally-identifiable data is stored in the organisation's cloud storage without protocols for who can and cannot access it, and how this data can be used or not used. There are no guidelines as to what data should be collected in the first place, and how to collect it in a secure manner. There is no data anonymization that would remove personally identifiable information from what's collected. Informed consent protocols, if they exist within specific programmes, are inconsistent across the whole organisation and are not routinely enforced. Much of what should be "confidential" is accessible to all staff and even outside consultants" (ibid). Although this is only one article referencing an anonymous former employee, there is little to no information available about how INGOs implement their cyber security protocols, if they exist.

In sum, INGOs are powerful, relatively well funded players in the humanitarian field. They collect large amounts of data about various groups of people. Although data protection is becoming a priority for INGOs, proof of awareness and protocol implementation is still hard to find. The position INGOs possess in

the humanitarian field and their ties to local NGOs make them important players in enforcing data protection protocols. However, the fact that they struggle with implementing information security makes them less-than-ideal accelerators.

2.1.4 UN agencies

"The United Nations(UN) is a global organization that brings together its member states to confront common challenges, manage shared responsibilities and exercise collective action in an enduring quest for a peaceful, inclusive and sustainably developing world, in conformity with the principles of justice and international law" (UN, 2018b). With this mission in mind, the UN has multiple humanitarian organizations to support those in direct need of aid:

- Office for the Coordination of Humanitarian affairs (OCHA): responsible for coordination responses to emergencies (ibid).
- United Nations Development Programme (UNDP): connects countries to knowledge, experience and resources in order to help people, communities and countries to build a better life (ibid).
- United Nations refugee agency (UNHCR): The UNs program that holds the mandate to protect and oversee refugees, refugee programs, (forcibly) displaced communities, and stateless people (ibid).
- United Nations Children's Fund (UNICEF): provides both humanitarian and development assistance with the aim to help mothers and their children in third world countries (ibid).
- World Food Programme (WFP): The branch of the UN that is responsible for food assistance all over the world. It is the largest humanitarian organization in the world and addresses hunger and food security (ibid).

The UN agencies are located high in the transaction chain, meaning that they do have boots on the ground, but a relatively small amount. Their size, access to funding, and position makes that the UN agencies are perceived to be extremely bureaucratic. However, these characteristics also mean that the UN agencies have their data protection policies and protocols implemented (UNDR, 2017). As part of one of the largest organizations in the world, the UN agencies are responsible for (the data of) millions of people and hold a very public position. They cannot afford a data breach that would leak the identities of people and compromises the trust most people have in these organizations.

Unfortunately, this does not mean that all the UN agencies are fully protected. An internal audit in 2017 showed that the WFPs data handling platform did not protect sensitive- and identifiable data well (WFP, 2017b). The report showed that

religious data was freely copied and shared with partners. Although it was not clarified where, of the three countries that the audit team visited, Myanmar was the only one where multiple religious groups lived together and religious data gathering made sense. Myanmar recently also experiences religious violence. Although no hard conclusions can be drawn from this example, it shows how important data protection is. The data a humanitarian organization possesses should not endanger the people that same organization is trying to help (Parker, 2018a). Furthermore, is shows that despite protocols and policies, the practice of data protection is a challenge on itself. This example is focused on the WFP, however, UN employees have stated that the same test in different UN agencies would probably give the same results (ibid).

In sum, the UN agencies are large and powerful organizations who are in the position to enforce change. However, they struggle with the challenges of data protection on the ground. This shows that the distance between most implementers and the UN regulations is probably too far to enforce significant change.

2.1.5 Governments

Governments are in control of their own territory and people. Therefore, humanitarians must receive permission to enter the country and provide assistance. Humanitarians are dependent on governments they interact with. In this thesis, there are three types of governments considered (Harvey, 2009):

- Governments of conflict engaged countries
  There are two subtypes. First there are the governments who aim to protect their people against a perpetrator or terrorist organization. Second, there are the governments who have the defeat of the perpetrator or terrorist organization prioritized and do not care or do not have the capabilities to provide aid for the affected population.
- Host governments who harbour people fleeing conflict
  These governments are often the governments of neighbourhood countries, but they can also be the governments of countries where people seek asylum. The European counties who harbour Syrian refugees who have fled the violence in their own country are also considered in this group.
- Home government of the humanitarian organizations
  These governments set de regulatory environment humanitarian organizations based in these countries have to oblige to.

Looking at the first two government, there are four roles they can or must play in the humanitarian response following conflict (Haverkamp, 2010):

- Initiating response
- Providing relief and protection
- Coordinate external assistance
- Set the regulatory environment

During conflict situations, the first three roles are often ignored. Governments are often hostile towards their own or certain parts of their populations. Examples are the Syrian civil war (BBC, 2018) and the ethnic cleansing of the Rohingya population by the government of Myanmar (Al Jazeera, 2018).

If it is the government who causes conflict, it will deploy armed forces. The government will/can seek for ways to gather data about locations, families, and friends that can be used to target groups and individuals. However, direct conflict is not the only means where the government can cause harm. Discriminatory policies based on data or perceived relationships can cause serious harm and oppression (Sandvik & Raymond, 2017).

Governments are very powerful because they set the regulatory environment and humanitarians must comply with them. This creates a dangerous situation when it comes to data protection. When states have laws in place that oblige humanitarians to share their data there is not much they can do. An example is the biometric data the UNHCR collects and uses as identification method for Syrian refugees in camps in Jordan. The Jordan government has laws in place that ensure if the government wants access to certain data, it must be provided. So if the Jordanian government askes for the biometric data, the UNHCR must hand this data over, regardless of promises of secrecy and privacy (Engine Room, 2016).

Not every government has far-reaching data sharing laws in place, however, most governments have some. On the other hand, some governments do not have any data protection laws in place, which removes an incentive to be careful with data collection or have proper protection in place.

In sum, governments are very powerful players in the humanitarian field because of their ability to enforce data protection. However, they do not always have the rights and well-being for their citizens in mind. Due to their regulatory power, they can force humanitarians to provide them with sensitive data. However, they can also put data protection laws in place to protect those in need of aid.

2.1.6 Donors

International humanitarian organizations received 20.3 billion US dollars of funding from public donors in 2016. Most of these funds came from a small number of donors, with the US contributing one third of the total amount. Beside public donors, there is a large amount of money donated by private donors. Private donors can be individuals, trusts, foundations, companies, and corporations. Private donors tend to give more to conflict- and crisis situations as the Nepal earthquake or the conflict is Syria. Funding coming from private donors are about 25% of the total available funds (WFP, 2017b).

Since the humanitarian sector depends on funding of third parties, the power relations in this sector lie different than in most sectors. While the sector provides care to people who need it, it is accountable to its donors. If the donors are not satisfied with the results of aid, they will give their funds to other organizations. Only 14% of donor money is unearmarked – funding without conditions- meaning that the other 86% is funds with possibly far-reaching conditions (ibid). These conditions are means for donors to pursue their own goals through humanitarian assistance. There are many examples of religious NGO - funded by religious donors- who see religious promotion as their main goal instead of providing aid (Petersen, 2010). However, this is not only a religious practice. The famous Hearts and Minds campaign during US invasion in Afghanistan is also a good example. The US government hired humanitarian organization to assist the military forces and promote the US agenda. The humanitarian assistance during this campaign was deemed very ineffective – and even counterproductive - by many. These earmarked donations put humanitarian organizations in a difficult position. Providing aid according to the desires of their donors or provide no help due to lack of funds (Fishstein & Wilder, 2012).

Looking at data of people in conflict zones, donors do not have a direct incentive to protect it. Many sources mention public donors as the ones pursuing their own agenda and private donors are the ones who need regular updates and pictures of happy people receiving aid. Donors find it less sexy that their money is spend on internal security measures instead of the delivery of direct care (Lutz, et al., 2017). This picture is somewhat black and white, but it underlines the differences of interest between aid receivers, aid providers, and donors.

On the other hand, large donors might have an incentive to influence the system more towards data protection. The reputation of the organizations receiving aid is very important, since donors do not want to provide funds to organizations with a bad reputation. An example is the OXFAM sex scandal that caught the public eye in early 2018. After OXFAM lost face, many donors –including large public donors

– stopped or froze their funding until OXFAM proves it lives up to high standards to prevent such events from happening again (Slawson, 2018).

This example shows that donors do have much power to influence the system and increase sector standards. However, this example also shows that something must happen before action is taken. Thereby, data protection is a costly service that does not directly increase the results of aid provision. The unique position of donors makes this group a suitable actor to inspire more data protection but at the same time, not very likely at all.

2.1.7 Non-state violent forces

This group is diverse and represents forces who create – or take part in – conflict. This can either be terrorist groups, warlords, rebels or freedom fighters, depending on one's perspective (Goodhand, 2000). However, these groups often use violence to gain power over certain territories or groups. An example is ISIS, a militia of jihadi and Salafists who are seeking to establish an Islamic Caliphate. Non-state violent forces are often supported by other states with the goal to gain power, disrupt certain processes, or create chaos (Wennmann, 2011). Furthermore, these non-state actors often finance themselves through natural resources as diamonds, oil, or natural gas (ibid).

Although non-state violent forces are not the ones performing surveys and collecting data, they must be mentioned due to the threat the pose if the wrong data ends up in their hands. These groups can benefit from open source- or bad confidentiality policies (The Guardian, 2017). They can oppose harm to groups, spark violence, or engage in ethnic cleansing. Therefore, if there are violent non-state forces involved, humanitarians must be extremely cautious with the types of data they collect, who can access it, and how to protect it (Fast, 2017).

2.1.8 Conclusions actor analysis

As the previous paragraphs show, there are many groups with different interest in humanitarian data and data protection. These interactions form the foundation of the reluctance the humanitarian sector experiences when it comes to information security. Furthermore, this sector holds a series of power relations that cannot be found anywhere else. Looking at the different actors and power relationships, a few conclusions about why data protection management is difficult to enforce in this sector.

First, donors are a heterogeneous group with many interests, varying from governments who pursue their own agenda though humanitarian assistance to private donors who want to help others and receive proof of it. Both types of donors do not have a direct incentive to promote better data protection. Public donors gain more if there is more data collected because it might be usable for their own agenda. The private donor is more fixed on efficiency prove of how money is spent (Lutz, et al., 2017). Due to this mechanism, humanitarians experience upward accountability where they are accountable to their donors. Second, aid recipients are completely dependent on aid, but do not hold any power over the process of how aid is delivered. If their data is the condition to receive aid, they will comply. This creates a contradicting situation where humanitarians experience downward accountability towards the aid recipients, but aid recipients do not hold any power to enforce accountability.

Third, there is a vast competition in the humanitarian sector. Humanitarians must make sure that they can continue their core business in a highly competitive environment. Due to this competition, best practices and norm are not easily shared as well. This has two consequences: first, sensitive data is likely to be gathered if NGOs believe it will make their activities more efficient and will give them an advantage over others. Second, NGO's are less likely to spend money on information security, since there is a scarcity of resources and the need to proof money was well spent. This creates a situation where the use of data is supply driven instead of demand driven, thereby not necessarily solving problems of the aid recipients. In a situation where data does not solve problems of those in need, but rather of those providing aid, the protection of this data is not likely to be prioritized (Sandvik & Raymond, 2017).

The fourth and final aspects is that a lot of governments are involved with the humanitarian sector. This involvement brings different interests and different jurisdictions. Humanitarians have to comply with rules from different governments, who on the one hand can require protection and on the other hand are demanding to share data.

These four aspects of interaction within the humanitarian sector makes enforcing norms or rules about information security a difficult task. The legal playfield that humanitarians have to move in is as complex as the playfield that emerges when describing the actors. Due to the fact that the legal playfield is complex and important, the next section will shine more light on the jurisdictional difficulties the humanitarian sector faces.

2.2 Humanitarians and the rule of law

The humanitarian sector has a complicated relationship with the rule of law. Humanitarian organizations must comply with both their national law and the law of the countries where they provide assistance. When focusing on information security this becomes even more complicated. The legal field of information security, responsibility, and data ownership is still immature and there are a whole range of diverse and contradicting laws in place (Bulgurcu, et al., 2010).

Compared with other sectors, the humanitarian sector is different and more complicated. Most security issues are linear regulated, meaning that countries are either well regulated, non-regulated, or somewhere in between. For example, the ship- breaking and recycling industry. This industry faced a lot of illegal ship breaking taking place on beaches, with horrible conditions for employers, and no environmental precautions taken (Werth, 2013). To change this situation, the European Parliament and the Council of the European Union adopted the Ship Recycling Regulation in 2013. This regulation entailed safety and environmental requirements for ship recycling and demolishing among a list of facilities that where it is allowed to demolish European ships. Via this way, European ship owners are no longer allowed to demolish their ships in countries that do not have regulations in place regarding working condition and environmental protection (European Comission, 2018).

This example shows how international cooperation and law can change a situation. However, this way of solving problems does not apply on the humanitarian sector. One cannot create a list of countries where humanitarians are not allowed to provide aid based on – for example – their information security regulations. Humanitarian organizations cannot ignore people in need of help, for the simple reason of not agreeing with the regulations that governments have in place.

Furthermore, information security regulation is more ambiguous than most regulated areas. When it comes to information security, issues like privacy, ownership, and confidentiality are perceived different by different governments. If the sector is heavily regulated, it does not mean that people are well protected by their government. It could also mean that the government requires access to gathered data, banned certain forms of communication, and even ban the use of cell phones (Werman & Desmukh, 2012; OCHA, 2012). Therefore, humanitarians must balance their practices in a way that protect the people and communities and complies with the law.

To set forth the difficulties and collision of compliance that humanitarians face, this section will shine light on the rules and laws that humanitarians have to follow, mostly focussed on information security. The section will start with the

humanitarian principles, as universal guidelines for all humanitarian organizations. Then it will focus on the GDPR as international data regulation that will have a huge impact, and national regulations because they are leading in humanitarian practise.

2.2.1 The humanitarian principles

Almost all humanitarian organizations work from the four humanitarian principles of Humanity, Neutrality, Impartiality, and Independence. The humanitarian principles function as guidelines for all humanitarian action and distinguishes humanitarians from commercial, political, and military actors (Schenkenberg van Mierop, 2016). The ICRC originally formulated the humanitarian principles in 1965. In 1991, the General Assembly of the UN adopted the first three principles. Later –in 2004 – the principle of independence was added (Bagshaw, 2012). In short, the four core humanitarian principles are explained as follows:

- Humanity: "Human suffering must be addressed wherever it is found. The purpose of humanitarian action is to protect life and health and ensure respect for human beings" (ibid, p.1).
- Neutrality: "Humanitarian actors must not take sides in hostilities or engage in controversies of a political, racial, religious or ideological nature" (ibid, p.1).
- Impartiality: "Humanitarian action must be carried out on the basis of need alone, giving priority to the most urgent cases of distress and making no distinctions on the basis of nationality, race, gender, religious belief, class or political opinions" (ibid, p.1).
- Independence: "Humanitarian action must be autonomous from the political, economic, military or other objectives that any actor may hold with regard to areas where humanitarian action is being implemented" (ibid, p.1).

Furthermore, there is the 'Do-no-harm' principle, which dictates that the aid provided by humanitarian organizations should not endanger the aid recipient (Belliveau, 2016). This principle also applies on information. Data obtained by a humanitarian organization should not have short- or long-term consequences for the aid recipient its network.

There are critics who perceive the current developments regarding information security in the humanitarian sector as compromising the humanitarian principles (Belliveau, 2016; Sandvik & Raymond, 2017; Jacobsen, et al., 2017). They argue that humanitarian organizations do not understand the link between datafication

and harm distribution, meaning that by processing more data, (long term) risk is shifted to the data subject and away from humanitarian organization. By gathering more data, humanitarian organizations optimize their processes while the risk of exposure lies with the data subjects. This compromises not only the do-no-harm principle, but touches upon the other principles as well (ibid).

Furthermore, some organizations and scholars argue that the humanitarian principles are outdated and should at least get an update so that it covers the current technological possibilities that bring data possibilities and access to cyber space. The argument is made that in the network age, neutrality and independence are impossible and unrealistic principles to aspire, while accountability to the affected population as a principle would provide more guidance in the current struggles (Schenkenberg van Mierop, 2016; Gilman, et al., 2014; OCHA, 2014).

In sum, the humanitarian principles are guidelines for humanitarian action. These guidelines are designed to distinguish humanitarians from other actors in the field in a way that they can maintain a trust relationship with the affected population. However, some argue that the principals are somewhat outdated and do not cover the threats and struggle that come with information security.

2.2.2 National law

National laws addressing data protection and privacy are becoming more common. In December 2016, 120 countries had data protection and privacy laws in place (Greenleaf, 2017). In this research, three different types of countries with possible conflicting national laws are distinguished: The countries where humanitarian assistance is provided, NGOs home countries, and donor countries (Cochrane, 2017).

First, the country where humanitarian assistance is provided. This can be the country in conflict, a country in the neighbourhood where refugees are located, or a country outside the neighbourhood where refugees seek asylum (Harvey, 2009; Development Initiatives, 2017). If data protection rules are in place, they are often not strictly enforced due to the situation in the country. However, NGOs have to comply with all the national laws, not only data management and protection. Take – for example – Syria. Within this situation, all forces that are not Syrian government or aligned with the Syrian government are considered hostile. NGOs who work in government-controlled areas cannot work win rebel-controlled areas or neighbourhood countries that are not supportive of the Syrian government. If they do, they will be prosecuted for harbouring and/or helping terrorists (Cochrane, 2017).

Meanwhile in neighbourhood country Lebanon, no data protection laws are in place, while the government has far-reaching authority to collect and monitor any data it desires. This authority entails monitoring all telecom data, store and use biometric data of citizens, and request any data from third parties without a clear outline on why it needed or how it will be treated or protected (Marsi, 2015). This is incompatible with the GDPR (paragraph 2.2.3) (Uddin, 2017). If a NGOs home country is in the EU and works in Lebanon, the only possibility to comply with both laws is to have no personal identifiable or other sensitive data collected, stored, and processes at all. This will complicate humanitarian assistance enormously, and one might ask if this is even possible.

Second, the home country of NGOs. As described above, the GDPR will have far-reaching consequences for the NGOs who have their basis in the EU (Parker, 2018b). However, the GDRP is not the only regulation that affects the daily practices of the NGOs. The US has strict anti-terrorism (funding) laws in place. NGOs who have their basis in the US are required to vet all the individuals and entities they work with while in most conflict affected areas this is not possible. Taking the Syrian example again, this means that no employee of any US-based NGO must able to be linked to ISIS. Since this is –especially with NGOs limited budgets – impossible to do, many US based NGOs cannot work in Syrian rebel-controlled areas or must find loopholes to do so (Cochrane, 2017).

Finally, most donor countries put restrictions on how money can be spent and to whom. Taking the US – Syrian example, the US anti-terrorist laws also apply on their donor money. Meaning that NGOs must either prove that no part of the US donor money was spend on or by terrorist entities (Ibid). In that line of thinking, it is not clear yet how the GDPR will influence the donor money coming from the EU. However, it is clear that this compromises the principle of impartiality, since donors determine where NGOs can or cannot go.

In sum, NGOs have to take national laws into account of the countries they operate in, originate from, and where they receive money from. These laws often conflict, also when it comes to data management and protection. However, a lot of countries still do not have data protection laws in place or the means to actively enforce them. Furthermore, the GDPR conflicts with countries who prioritize government information gathering above personal data protection.

2.2.3 The GDPR

The EU General Data Protection Regulation (GDPR) is designed to Europe-wide harmonize data privacy and protection laws, to empower EU citizens when it

comes to data ownership and reshape how organizations perceive and use data (European Parliament, 2016). This entails protection of personal and sensitive data, regulation on sharing, and the obligation to provide insight in data processes. The GDPR focusses on more than just EU citizens and therefore, it will have a worldwide impact.

By time of writing, one cannot say with certainty how de GDPR will affect humanitarian organizations. However, some things are known. First, the GDPR applies to all people inside the EU and data of people that is processed inside the EU. Therefore, it will apply to data of donors, volunteers, employees, and aid recipients if they –or their data– are inside the EU. Furthermore, the GDPR states that if the data subject is incapable of providing consent, data sharing with (another) international humanitarian organization is only allowed if it is in public interest or because it is in the vital interest of the data subject. Finally, data sharing with authorities is only allowed if it is in the public interest, meaning *"in cases of international data exchange between competition authorities, tax or customs administrations, between financial supervisory authorities, between services competent for social security matters, or for public health, for example in the case of contact tracing for contagious diseases or in order to reduce and/ or eliminate doping in sport"* (EU, 2017).

Two things are most important here: Is the organization established inside the EU or is the aid recipient currently in the EU? If one of those questions can be answered with a yes, then the GDPR applies.

However, the GDPR covers not everything when it comes to the daily practice of humanitarians. First, data sharing with third countries is allowed if it is under national security. However, what countries perceive as national security differs and it is not clear if it applies under the national security laws of the home country or operating country. Second, the GDPR does not cover partners and subcontractors. If the NGO is established in a non-EU country but receives funding of an EU established NGO, the non-EU NGO does not have to comply with the GDPR. However, if the non-EU sends personal or sensitive data to the EU-established NGO, the GDPR is applicable. Finally, missing hardware and shared computers. During humanitarian operations, it is a lot harder to determine if data is unlawfully shared than it is in European office spaces (Parker, 2018b; Uddin, 2017; Kuner, 2018).

The GDPR will affect the practices of many NGOs, but compliance will have a price tag. Fortune 500 companies will be spending an estimated $7.8 billion to reach GDPR compliance in 2018 alone (Parker, 2018b). Understanding wat this regulation means for a NGO and implementing it organization wide will prove

to be significant burden. Furthermore, some INGOs have raised concerns about organizations trying to work their way around the GDPR by not letting personal or sensitive data leave the country where it is collected (ibid).

In sum, the GDPR has a significant impact on how humanitarian organizations will work with data. However, not everything is clear yet, including the implementation with partners and subcontractors, who play an important role in the operations of European based NGOs. Furthermore, it will burden the limited resources of NGOs who are expected to try to find their way around the GDPR – at least- until they are GDPR compliant.

2.2.4 Privileges and immunities of the UN agencies

Military and civilian personal of foreign states involved in UN peace operations hold a status of restrictive immunity from national law of the host state. The means that UN staff and agencies are considered immune from the legal consequences of acts performed when in line of duty or part of peacekeeping missions but not on active duty (Crawford, 2012). However, restrictive immunity does not mean impunity. It is not supposed to limit the accountability of UN staff, organizations, or contributing states. It rather prevents the host state to take legal action against UN staff from visiting countries. Therefore, if the UN staff members or agencies commit crimes, they are to be prosecuted by their own states or the UN courts (Fleck, 2013).

Taking the UN's restrictive immunity into account, it is not clear how this regards national or international laws and regulations regarding data. Especially the if and how the GDPR is applied to UN agencies or staff is an issue that is not clarified yet, since it depends on how the GDPR is implemented by sending states regarding their citizens and organizations as part of UN initiatives in foreign countries. For now, this will probably mean that in the near future, UN agencies are relatively cleared from prosecution regarding information security protection failures (Herta & Papakonstantinou, 2014).

2.2.5 Conclusion on the rule of law

Compared with other sectors, the humanitarian sector is different and more complicated when it comes to legal issues. The sector is not easily regulated and it does not influences where conflict takes place. Therefor humanitarian organizations have little choice in which legal field they operate in. Humanitarian

organizations cannot ignore people in need of help, for the simple reason of not agreeing with the regulations that governments have in place.

Therefore, humanitarians have to cope with different and changing legal fields. Because humanitarians have to take into account the laws and regulations of the country they are established in, work in, and receive money from they are in a difficult and often conflicting positions.

Looking at data management and protection, a lot of countries do not have data protection laws in place or the means to actively enforce them. On the other hand, the EU is implementing the GDPR, which will have a significant impact on how INGOs and NGOs will work with data. However, not everything is clear yet, including the implementation with partners and subcontractors, who play an important role in the operations of the European based NGOs. Also, the GDPR conflicts with countries who prioritize government information gathering above personal data protection.

With these regulatory requirements, - according to some – outdated humanitarian principles, and the need to prioritize data protection, the humanitarian sector faces some difficult decisions. In order to enforce change, one has to look further than just legal measurements. Therefore, some additional steps must be taken. The next paragraph will look how other researchers have approached the characteristics of the humanitarian sector and what lessons can be drawn from their research.

2.3 Modelling the humanitarian sector

The previous sections all hold a part of the humanitarian system when it comes to information security. The next step is looking at how other researchers dealt with the complexity of the humanitarian system. This will provide insight into which mechanisms, assumptions, and findings can contribute to the current research. Hereby, the focus lies on pre-identified coordination mechanisms and information technology research.

2.3.1 Humanitarian coordination models

Research about humanitarian disaster management and humanitarian logistics has been growing since 2005. Before 2005, research was mostly done about humanitarian ethics and humanitarian crisis. Behl & Dutta (2018) have done an

extensive literature review on what has been published about humanitarian logistics the recent decade. They conclude that between 2005 and 2011 most research about the humanitarian sector has been done about logistics and relief operations. After the academic journal Humanitarian Operations and Supply Chain management was founded in 2010, more room for studies focused on humanitarian operations was created and the studies started to diversify.

The diversification of academic literature about humanitarianism made room from topics as risk, IT, resilience, coordination, and collaboration. All topics that support logistics and supply chain but are not considered to be part of the humanitarian core business. However, even within the diversification of topics of humanitarian research, one of the most encountered complaints is that studies are mainly prescriptive or predictive. Researchers have noticed that modelling of quantitative studies are one of the biggest gaps in humanitarian research. Therefore, this paragraph will first focus on some important qualitative described model of the humanitarian sector and humanitarian mechanisms. Then, some types of actual simulation models of the humanitarian sector will be described.

Coordination between humanitarian organizations during relief efforts has time and time again proven to be difficult and ineffective. Leiras, et al. (2014) have conducted a literature study about humanitarian coordination in logistic and have concluded that more research is necessary were more and heterogeneous stakeholders are considered. They conclude that most literature doesn't go further than describing the kind of stakeholders and their perspectives on humanitarian relieve in a passive and generalizing way, thereby not contributing to the understanding of the actual decision-making mechanisms that drive stakeholders. However, there are two articles that take coordination mechanisms a step further in a way that can contribute to the current research and are described in the next paragraph.

In 2010, Balcik, et al. published an article about humanitarian coordination mechanisms. They describe a system where actors are inherently connected since none of the actors has sufficient resources and/or knowledge to respond effectively to a major disaster or pressing conflict situation. In an effort to improve humanitarian efforts, Balcik, et al. have focused on coordinating mechanisms during humanitarian relief operations. Per actor relation, they describe multiple coordination mechanisms, all visualized in Figure 2 1. For the coordinating mechanisms between NGOs, they describe no coordination, equal collaboration, and an umbrella organization in charge of coordination. Companies can either work together or attached themselves to NGOs uncoordinated. Finally, Balcik, et al. describe the interaction between international NGOs and local NGOs or the local military/government. The coordination between these types are dependent

on the hostility of the government, cultural characteristics, language, and type of governance structures.

Thomas & Fritz (2006) have identified five different humanitarian partnerships that are likely to work. The first is the Single-Company Philanthropic partnership, meaning that a company just donates money or supplies to the NGO. Thereby, a long-term relationship, experience and warm personal relations are needed. The second is the multi-company coordinated partnership, where multiple companies combine forces to provide a NGO what is needed. Again, this is a difficult mechanism and experience, trust, and warm relationships are key. Third, there are the Single-company integrative partnership, were humanitarian organizations directly use the business of their partners. Fourth, there are the multi-company integrative partnerships. Here a consortium of companies and organizations combine forces to achieve a certain goal, all using their own expertise to contribute in areas as supplies, logistics, education, donations, and influencing policy. Although this form of partnership holds an enormous potential, it is difficult to achieve due to cultural, trust, and commitment issues (Thomas & Fritz, 2006). Finally there are the contractual partnerships where the company is hired to provide services to the NGO.

Looking at quantitative models that have been used for research on the humanitarian sector, there is both a lot and not much at the same time. Past studies have focused on developing mathematical models do reveal and discuss complication in supply chain management in both pre-disaster and post-disaster phase (Balcik & Beamon, 2008; Behl & Dutta, 2018). There are variations of models that focus on facility locations and/or relief distribution. Research using facility location models focussed on inventory, capacity, costs, maximum coverage of supplies, and the strategy behind locations (Boonmee, et al., 2017; Habib, et al., 2016). Relief distribution models focus on the logistics of distribution and routing optimization (Acimovic & Goentzel, 2016). These models focus on different aspects of supply chain optimization. Therefore, there is a lot of research done that uses modelling and simulation, however, the topics that are covered by these models are not considered to be in the scope of this research.

The quantitative models that have been used to research the humanitarian sector are all focussed on process optimization and do not necessarily take the characteristics and dynamics of the humanitarian sector into account. Behl & Dutta (2018) have identified a lack of models about the humanitarian sector as an interactive system and simulations that capture effects of policy implications as one of the main research gaps of humanitarian academic literature. Therefore, the descriptive models are hold more value to this research than the published mathematical models. The interactions and relations as described by Balcik, et al
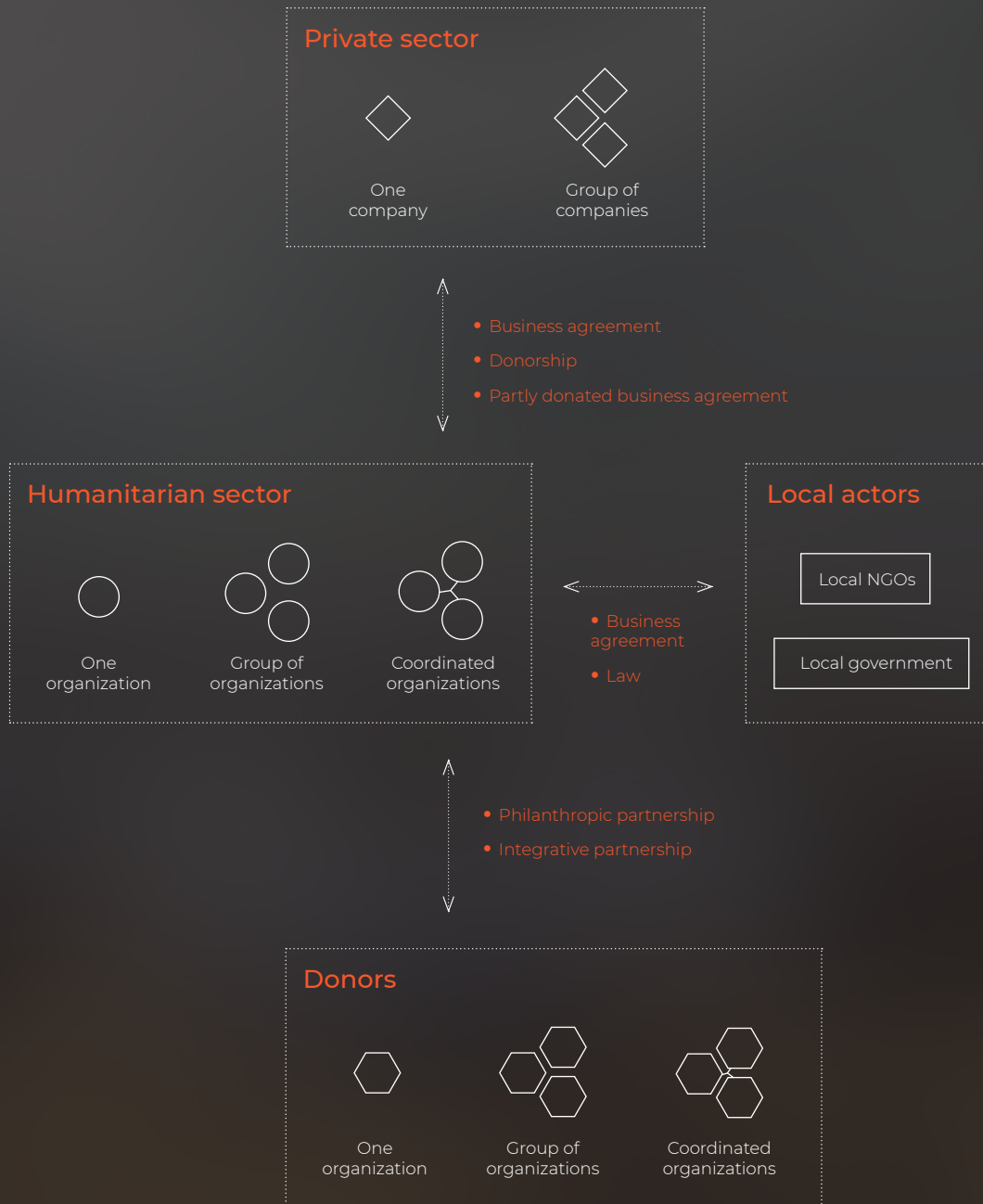
Figure 2 1: Relief chain relationships (Balcik, et al., 2010; Thomas & Fritz, 2006)

(2010) and Thomas & Fritz (2006) will be used in a later stage of this research.

2.3.2 Humanitarian IT and cyber security models

According to Behl & Dutta (2018), research about the role of information technology in the humanitarian sector has gathered pace from 2012 onwards. The fact that research about this topic is relatively new can explain the lack of research done about the security issues of the implementation of information technology is this sector. Most of the literature on information technology in the humanitarian sector is highly descriptive and focuses on how to implement certain technology – such as satellite imagery or cloud computing – (Read, et al., 2016; Jacobsen, et al., 2017) or use information technology as one of the factors to describe the organization structure of a humanitarian organization (Habib, et al., 2016). Furthermore, the models described in literature that focus on information management are descriptive at most and quantitative models or data about this topic are hard to find.

However, there is research done on a very context specific case study about the critical factors in the enhancement of the use of information technology in humanitarian organizations in India. Kabra and Ramesh have published a handful of articles explaining these success factors, scoring their influence on a company's behaviour, and drawing conclusions about how the use of information technology can be integrated in an organization structure (Kabra & Ramesh, 2015a; Kabra & Ramesh, 2015b; Kabra & Ramesh, 2016; Kabra, et al., 2017). Kabra & Ramesh (2015a) identified the different actors, situations, processes that influence the situation, learning characteristics, actions, and the performance indicators that influence the enhancement of the use information technology. Furthermore, in the same year, Kabra and Ramesh(2015b) published another article, identifying top management support, government support, feedback mechanism to facilitate learning from prior experiences, transparent and accountable supply chain, strategic planning and mutual learning with other commercial organizations as the main factors that will eventually change the culture of a humanitarian organization towards the use of information technology (Kabra & Ramesh, 2015b). However, these insights are on the organizational level and most of it falls outside of the scope of the current research.

Finally, Kabra, et al. (2015) and Kabra, et al. (2017) have published articles in the same line of research looking at barriers between actors instead of organizational characteristics. They found a lack of coordination between organizations can really harm the enhancement of the use of information technology. This can be

tied to the research of Balcik, et al. (2010) who proposed an umbrella organization as one of the possible options to influence change in the humanitarian sector.

There is one other research that has focused on modelling information systems and cooperation within the humanitarian sector. Wakolbinger, et al. (2013) have focussed on building a game theory-based model about information sharing in the humanitarian sector during natural disasters. The article itself does not describe a model, but a quantification of relationships with the aim to build a foundation that can be used for modelling in further research. They have identified the characteristics of behaviour of humanitarian organizations that determine the degree of competition within the sector under the assumption that the degree of competition determines how much information will be shared. These characteristics are – again- very similar to the characteristics of cooperation as described by Balcik, et al. (2010). Therefore, this research can be useful in modelling and quantifying the relations of the humanitarian sector in an Agent Based Model.

2.4 Conclusion humanitarian sector

This chapter provided background information on the humanitarian sector to create a more detailed understanding of the complexity that forms the humanitarian sector working in conflict. It provided insight in the perspectives of the most influential actors, who are the aid recipients, the local or national NGOs, international NGOs, UN bodies, Donors, governments, and non-state violent forces. The described interactions, objections, and power imbalances provided insight in how the humanitarian sector is formed and how implementing responsible data management and protection becomes a difficult task. This chapter continued with an explanation of the different rules and laws that apply on the humanitarian sector. It showed that increasing data protection is not a simple matter of increasing national standards and laws. Finally, this chapter discussed earlier research done on modelling the humanitarian sector as a system. There is much done in research using mathematical models for supply chain optimization. However, the models about interaction between actors that exist are scarce at best and only descriptive. Therefore, not much insight of the earlier created mathematical models can be taken into account in this research. Furthermore when looking at the models about data management and the humanitarian system, the conclusion that has been drawn is that they are basically non-existent. However, the research done about the enhancement of the use of information technology and the game theory-based relationship model seem promising and will therefore be used during later stages of this research.

03

Characteristics of humanitarian interaction

The previous chapter has described the different actors and the legal playing field that take up a large part of defining the humanitarian sector and its relation towards information security. The aim of this chapter is to describe how different humanitarian actors interact and how interactions is influenced. The MAIA conceptualization and agent-based model (Chapter 5 and Chapter 6) focusses on modelling humanitarian interaction to inspire better information security awareness and this chapter aims to lay the foundation of knowledge on what drives these interactions. Hereby, the focus lies on which actors seek interaction with each other and what characteristics determine with whom interaction is sought. Paragraph 3.1 discusses the different characteristics for the different selected actors. Paragraph 3.2 discusses different policy options that could be initiated to improve information security. Paragraph 3.3 provides selection of characteristics that is used in the MAIA conceptualization and agent-based model. This selection is based on knowledge obtained in the previous sections. Finally, paragraph 3.4 provide a preliminary conclusion of the chapter.

(Habekuss & Schmitt, 2015)

3.1 Characteristics that influence interaction in the humanitarian sector

In this section, the characteristic of interaction in the humanitarian sector will be discussed. It follows the structure used in Chapter 2 and largely follows the same actors. However, two of these actors play a negligible role when it comes to the improvement of information security and will therefore not be considered anymore.

The actors that is no longer considered is the aid recipients. This decision is made due to two reasons. First, this group is relatively powerless. Although, the research is about their data that must be protected, the group itself is fully dependent on the humanitarian sector and therefor do not play a role in enforcing information security standards (Donnelly, 1993; Sandvik, 2016). Second, the humanitarian sector increasingly utilizes surveillance systems as satellite imagery, sensors, and drones (Sandvik & Raymond, 2017). These systems do not require cooperation or approval to gather data. The utility of these systems removes the little power aid recipients currently hold. With this perspective on the future and the current power relations, aid recipients are not considered the group that will enforce change in the humanitarian sector.

Second, the hostile non-governmental forces are described as a group to visualize the threats that aid recipients and humanitarian organizations face from other actors than governments. Since they only oppose threat, they can be perceived as an external factor. The humanitarian system does not influence this type of actor, but this type of actor influences behaviour within the humanitarian system by threating them or the aid recipients. Therefore, hostile non-governmental forces are not considered to enforce change via cooperation or policy. They merely provide one of the reasons for protection.

3.1.1 Local and National NGOs

NGOs are often dependent on larger international organisations or donors for resources or other NGOs for cooperation. Characteristics of the NGO, INGO, and donors determine if they can build cooperation and achieve their individual goals. Looking at NGOs in a generalizable fashion, there are four characteristics that determine if and how cooperation is shaped: Culture, reputation, legal playfield, access, and capacity (Balcik, et al., 2010; Eisinger, 2002; Suarez & Marshall, 2014). These concepts are explained in this section and summarized in Table 3 1.

The behaviour of an NGO is firstly determined by its organizational culture. Although the specific of organizational cultures are considered too specific to fall in the scope of this research, it is important to note. Literature often mentions culture as one of the most important characteristics for successful interactions between humanitarian organizations (Balcik, et al., 2010). Culture entails, among many other things, hierarchy, language, religion, and innovative mindset. Although the specifics of culture are considered outside the scope of the research, culture itself is taken into account as part of the identity of an NGO.

The second characteristic is reputation. Every organization holds a reputation that attracts or repels other organizations. A reputation can be harmed if – for example – a data breach occurs or corruption is reported (Goodhand, 2000). Again, the details of reputation are considered outside the scope of the research. The third characteristic that determines an NGO behaviour is capacity. A lot has been written about capacity building within the humanitarian sector, but there is little agreement on what capacity building in the humanitarian sector entails (Suarez & Marshall, 2014). According to Eisinger (2002), capacity is a set of attributes that help or enable an organization to fulfil its mission in the broad sense of the term. Meaning that capacity can entail different things for different NGOs in different circumstances.

However, there are two concepts that are mentioned often in literate about capacity in the humanitarian sector: resources and efficiency. Resources are determined by a NGOs access to resources and its efficiency. Resources can be money, supplies, labour, and people and are initially provided by donors or via partnership with UN agencies and INGOs (Suarez & Marshall, 2014).

Efficiency – as part of capacity- is important for an NGO in order to achieve its goals. It describes how much of the NGOs resources are spend on not directly charitable expenses (Nunnenkamp & Öhler, 2012). Not directly charitable expenses can be costs for administration, management, or fundraising. Costs for information management and security are part of not directly charitable expenses and are therefore seen as activities that negatively influence efficiency.

In addition to characteristics that determine the behaviour of an NGO, there are characteristics that influences interaction between NGOs, INGOS, UN-agencies, and donors. The characteristics that are most mentioned in literature related to humanitarian interaction are degree of competition, trust, and the existence of a coordination mechanism. These characteristics are explained below and summarized in Table 3-1 (Balcik, et al., 2010; Bergen, 2014; Haverkamp, 2010; Kemp, 2017; Stephenson & Schnitzer, 2006).

The degree of competition is mentioned by many authors as one of the most influencing factors within interactions between humanitarian organizations. The degree of competition describes similarity between humanitarian organizations and therefor how much competition exist over the limited available resources. One has to take into account that competition for funding has multiple consequences. First, donors have to decide who to provide for and who to exclude from resources, which often results in resource scarcity by all organizations. Second, competition reduces cooperation, which can accelerate the resource scarcity. Organizations works for themselves and funds are spent multiple times at the same things by different organizations. Finally, a high degree of competition decreases coordination efforts because humanitarians are less willing to share information and best practises (Balcik, et al., 2010; Kent, 2004; Stephenson & Schnitzer, 2006). Another – often mentioned – characteristics that influences the interaction between humanitarian organizations is trust (Thomas & Fritz, 2006; Bergen, 2014; Haverkamp, 2010). Trust is determined by the duration of partnerships, a shared culture, and the reputation of the other party. The duration of their partnership shows that trust is built over time. A shared culture symbolises the fact that organizations understand each other, speak the same language (both literally and figuratively), and hold the same values. Although organizations do not have to be very similar, some common ground is needed. Finally, reputation also influences trust and is therefore important.

The third characteristic that influences the interaction between humanitarian organizations is the existence of a coordination mechanisms (Stephenson & Schnitzer, 2006). Historically, humanitarians operate separately due to competition between NGOs. However, over the years there have been many coordinating efforts of which some have succeeded. The – in literature described – most successful form of coordination is the existence of an independent umbrella organization because it preserves the independence of the organizations (Balcik, et al., 2010; Stephenson & Schnitzer, 2006).

Table 3-1: Overview of characteristics that influence
behaviour of NGOs

Characteristics	Determined by	Sources
Culture	Hierarchy Language Religion Innovative mindset	(Balcik, et al., 2010)
Reputation		(Goodhand, 2000)
Capacity	Resources Efficiency	(Eisinger, 2002) (Suarez & Marshall, 2014)
Degree of competition	Number of humanitarian organizations Degree of similarity between humanitarian organizations	(Balcik, et al., 2010) (Kent, 2004) (Stephenson & Schnitzer, 2006)
Trust	Time Culture Reputation	(Bergen, 2014) (Haverkamp, 2010) (Thomas & Fritz, 2006)
Coordination	Structure Trust Competition	(Kemp, 2008) (Stephenson & Schnitzer, 2006) (Balcik, et al., 2010)
Access	Resources Labour Knowledge	(Development Initiatives, 2017)

3.1.2 INGOs

INGOs and NGOs have a lot in common. The characteristics assigned to NGOs and described in the previous paragraph also apply on INGOs. Therefore, characteristics that determine the interactions of INGOs are considered the same as for NGOs and can be found in Table 3-1.

However, there are differences: The availability of donations. Due to the fact that only 0.3% of the worldwide available funds for international humanitarian organizations go directly to NGOs (Development Initiatives, 2017), their

interactions with donors is not taken into account. This creates an extra function and interactions characteristic for INGOs: availability of donations. Furthermore, the access to resources means different things for INGOs, since they have money, labour, and knowledge but lack access to areas, local people, and governing bodies. For access to these resources INGOs are largely dependent on cooperation with NGOs.

The characteristic that is part of the INGOs is the donor interaction. INGOs receive funds from donors and UN agencies to spend either directly or use to outsource humanitarian assistance to local and national NGOs. The interaction between INGO and donor or INGO and NGO is there for different. Looking at donor and INGO interaction, it is largely based on the characteristics described in Table 3 1. Degree of competition, trust, and the presence of a coordination mechanisms all determine to a large extend if donors are willing to fund an INGO. However, there is an extra characteristic that influences the willingness to make funds available: Earmarked or Unearmarked donations (Ülkü, et al., 2015). Which provides the option for a donor to influence in the behaviour and choices of the receiving INGO. On the other hand, the INGO has the option not to engage with certain donors if they cannot or are not willing to meet the demand of the donors. Table 3 2 shows the overview of the additional characteristics that influences behaviour of INGOs.

Table 3-2: Overview of the characteristics that influence interaction of INGOs

Characteristics	Determined by	Sources

Donation availability	Earmarked
	Unearmarked
	  • Possibility to meet demands
	  • Willingness to meet demands
		(WFP, 2017b)
		(Ülkü, et al., 2015)

Access	People Areas Governmental bodies	(Development Initiatives, 2017)

3.1.3 Donors

Donors are a very different actors than the NGOs and the INGOs. Therefore, some of the characteristics that define (I)NGOS are also considered part of donors and some are not. The characteristics that are part of the donors are culture, capacity and donation preference and are summarized in Table 3 3.

Donors are assumed to hold culture and capacity. Donors are more likely to provide funds for organizations with the same or a similar culture (Ülkü, et al., 2015). Capacity is considered the funds they make available for the humanitarian sector. The final characteristic is defined as donation preference and determines if donations are earmarked or not. This characteristic closely relates to 'donation availability' as described in the previous section.

Table 3-3: Overview of the influencing identity
characteristics of donors

Characteristics	Determined by	Sources
Culture		(Balcik, et al., 2010) (Ülkü, et al., 2015)
Capacity	Resources	(Balcik, et al., 2010) (Ülkü, et al., 2015)
Donation preference	Earmarked Unearmarked	(WFP, 2017b) (Ülkü, et al., 2015)

The interaction donors seek with the humanitarian sector can be described by the characteristics of Table 3 2. The degree of competition between INGOs, trust between donor and INGO, and the existence of a coordination mechanisms all contribute to how donors and INGOs interact which echoer.

3.1.4 Governments

Governments are the fourth type of actor that is part of the humanitarian sector. As described in Chapter 2, governments hold a unique position where they are able to exercise power but often lack the capacity to do so. Within the scope of the management and protection of humanitarian data, governments have two

roles and three positions regarding data management. The government can either be the host government of a foreign (I)NGO or it is the government of the home country (Haverkamp, 2010). Furthermore, the government can have three types of information security laws in place. The law can be non-existent, hostile towards protection, and protective towards data. Hostile towards protection means that the government has certain laws in place that forces companies to share sensitive data or that allows the government to monitor and analyse certain data infrastructures. More detail about the different laws governments can have in place are considered outside the scope of this research. Table 3 4 provide an overview of the characteristics as identified for governments (Harvey, 2009).

As described in Chapter 2, governments can de donors as well. However, if they are, they are considered donors and the characteristics described in paragraph 3.1.3 apply.

Table 3-4: Overview of the identity of governments

Characteristics	Determined by	Sources
Role	Host Home	((Haverkamp, 2010) (Harvey, 2009) (Balcik, et al., 2010)
Law	Non-existent Hostile Protective	(Haverkamp, 2010) (Harvey, 2009) (Balcik, et al., 2010)

3.1.5 UN agencies

The UN agencies play similar roles as the INGOs. They are large, international corporations who often cooperate with local or national NGOs to execute their tasks. However, there are some differences. The first difference is that – during this research – the resources of the UN agencies are assumed their own. The competition within the UN for funding or the dynamics with UN donors is considered not part of the research. The second characteristic that is different is that the roles and tasks of the different UN agencies are assumed clearly demarcated. Meaning that the degree of competition is assumed not to play a role between the UN agencies. It does have a role when the UN agencies seek cooperation with local and national NGOs, however, that is considered to be a dynamic of the local and national NGOs.

3.2 Policies to influence interaction in the humanitarian sector

In the previous paragraphs, the characteristics that influence the behaviour of the humanitarian sector are discussed. The next step is to identify how these characteristics can be influenced via policy. Policy is a broad overarching concept that can exist in an infinite number of forms, especially when looking towards a sector with multiple accountabilities and jurisdictions. Therefore, a range of possible policy measures must be taken into account that represent the different actions and power differences.

After a distinct literature study, seven different policy measures are selected based on how actors interact with each other. Some are based on trust between actors while others focus on accountability mechanisms. Furthermore, the selection is based on policy options that have been presented as a solution for problems in the humanitarian sector or other sectors that deal with similar complexities. Finally, there are policy options selected that assume initiative from different actors. There are policy options with donors, (I)NGOs, the UN, or new institutions in the leading role. These selection criteria have resulted in the seven policy options that will be described in the following paragraphs.

3.2.1 Self-regulation – current situation

The first policy option that is presented describes the current situation of self-regulation. The leading actors of this policy option are the individual organizations self. Over the past decades, the humanitarian sector has experienced a significant growth in the use of voluntary codes of conduct to strengthen accountability and promise responsibility (Lloyd, 2005). If a topic becomes more important to society, donors will provide funds to the organizations that execute and implement the same values.

There are 4 main arguments for self-regulation of processes in the humanitarian sector. The first is that humanitarian organizations have taken over processes in many countries that are traditionally government responsibility. Therefore, humanitarians are closer to their aid recipients and are more familiar and in a better position to assess their needs (Andrew & Cortese, 2011).

Second, since humanitarian organizations have taken over government jobs, they have come to question the legitimacy of these governments regarding the

regulation of humanitarian assistance. If governments are unable to provide for their citizens, why should they be considered able to regulate those who have taken over their responsibility (Lloyd, 2005)?

The third argument is one addressed before. The humanitarian sector is a global sector that operates simultaneously in many different jurisdictions. Regulation of the sector will therefore be ineffective. Furthermore, many governments lack the resources to enforce regulation which contributes to the ineffectiveness of the regulation (ibid).

Finally, self-regulation is driven by the need to attract a diverse range of donors. Self-regulation is a means for humanitarian organizations to prove their effectiveness and legitimacy on various aspects. Top down regulation is much slower than self-regulation and will only decrease efficiency (Andrew & Cortese, 2011).

On the other side, there are many downsides to self-regulation. The main argument is that important issues will not be taken into account if they hold no direct gain for the organization. Al Gore expressed this very well in his movie An Inconvenient Truth (2006): "It is difficult to get a man to understand something when his salary depends on not understanding it". Although he meant this quote in a context of climate change and the oil- and gas industry, it is applicable to many situations. As long as nobody with power is affected by poor information security, it serves nobody to draw attention to the situation since it will only negatively affect the reputation of the humanitarian organizations and the donors who have contributed to this situation. Therefore, there are many arguments for self-regulation. However, in the end no real change will occurs as long as the powerful actors hold a comfortable position (Kemp, 2008).

3.2.2 Quality marks

Quality marks are the second policy option and closely related to self-regulation, mainly due to the fact that the leading actor are the humanitarian organizations self. A quality mark is a logo that indicates that a product, service, or organisation meet the requirements associated with that quality mark. The aim of quality marks is that it helps businesses and consumers make the right choices when it comes to consumption or partnerships. One of the main advantages of quality marks over self-regulation is that it clarifies the common standard and what is understood with accepted behaviour. Therefore, it also guides the humanitarian organizations (Lloyd, 2005).

Quality marks add to the reputation of organisations because they provide

evidence of a certain standard. However, how much a quality mark is worth depends on the owner. The organisation or organisations that own the quality mark and set the required standards are responsible for the negotiation and enforcement of the quality mark. A quality mark does guarantee a certain quality, but it is not necessarily the right quality (Clarke & Ramalingam, 2018).

In sum, quality marks can be effective when it comes to increasing trust and accountability. In a competitive sector, if a lot of the competition have quality marks to provide proof of their effectiveness others cannot stay behind. Donors and other humanitarian organizations looking for partnership seek accountably and quality marks can – to some extent – provide that. However, one must always take into account the quality of the quality mark itself.

3.2.3 (I)NGO-private partnerships

The third policy measure is an increase in (I)NGO-private partnerships. The leading actors in this policy options are both humanitarian organizations and private (security) organizations. This is based on the Single-Company Philanthropic partnership as described by Thomas & Fritz (2006). Here, companies and (often) INGOs engage in a long-term partnership. In case of information security, companies can offer knowledge, audits, or advice to INGOs to increase their information security awareness instead of donating money.

Although this is deemed a very successful way if improving information security on a company level, from a sector perspective it is less effective. Companies often engage with one INGO. With a limited number of companies specialized in information security and over a million humanitarian organizations worldwide, this will have a negligible effect on a sector level (Miraftab, 2004). Furthermore, these partnerships are often the result of government encouragement or single social responsibility policy of one company.

3.2.4 One single coordinating organization/umbrella organization

In the humanitarian sector, most coordination is done horizontal without a coordinating organization. However, there are many examples where the support of an umbrella organization has provided an incentive for humanitarian organizations to voluntarily join an effort to solve problems. An umbrella organization that takes the lead in a coordinated effort can make it easier for

organizations with different cultures or little relationship experience to make a joint effort. It can set the boundaries for negotiation structure the formalities of the cooperation (Balcik & Beamon, 2008). The most famous example of an umbrella organization is UN OCHA (UN, 2018a). The leading actor in this policy options is an UN-agency, similar to UN OCHA, but focussed on information security.

However, the existence of an umbrella organization is not directly a recipe for success. There are many examples where the umbrella organization failed, was deemed ineffective, or was accused of excluding local NGOs. One has to keep in mind that the same mechanisms that determine cooperation are at work. Trust, reputation, and culture are – for example – still factors that determine if cooperation will be effective. An umbrella organization might ease the way an improve information flow, but there are still difficulties to overcome (Balcik, et al., 2010).

3.2.5 Ombudsman

There have been multiple attempts to install an ombudsman for the humanitarian sector (Mitchell & Doane, 2002; Barnett, 2015). An ombudsman is an independent organization that holds organizations accountable in systems where individuals are not able to speak for themselves or have the power to fight large organizations or governments. An ombudsman will solve many of the accountability issues that the humanitarian sector faces, due to the prioritization of donor accountability and the many standards and protocols that rely on voluntary compliance only (Kemp, 2008).

An ombudsman will bridge the accountability gaps in the sector and therefore can be an extremely effective policy measure. However, theory and practise are two different things. Previous attempts failed because of multiple reasons. First, humanitarian organizations are not willing to give up their position of voluntary compliance. They do not gain anything by formalizing accountability measures, meaning that initiative will not come from the sector itself. Second, the issue of international jurisdiction. What is legal in one country is illegal in the next. Finding an international legal framework that is both binding and agreed upon is deemed near to impossible (Mitchell & Doane, 2002). Finally, the legitimacy of an ombudsman relies upon accessibility for those who are represented. A large international organization will not be effective enough to cover all or most of the abuses on local level(ibid).

3.2.6 Earmarked donations

Donors are very powerful players in the humanitarian sector since they determine what humanitarian assistance can be provided. Many public donors use humanitarian aid to pursue their own agenda and thereby force humanitarians to work within the boundaries set by the donors. This has often a negative influence on how humanitarian assistance is provided. However, there are examples where donors have united to inspire change in a positive way. In 2003, a group of donor organizations established the Good Humanitarian Donorship Initiative (DFID). This initiative was based on principles that determine good donorship and dictated that members could only donate to humanitarian organizations that could provide prove of the implementation of these principles (Clarke & Ramalingam, 2018).

This policy option is based on this principle in the form of positively earmarked donations. Donors engage only in partner- and donorships if there is evidence of good information security practises. This policy measure will require donors to shift their criteria from efficiency or own agenda towards the need of the aid recipients in terms of effectiveness and protection. This will require a lot of media attention and training on many levels (Ülkü, et al., 2015). Therefore, it could be a realistic policy option, but it has to be long term.

3.3 Selection of characteristics and policy options

The previous sections have described different characteristics that influence humanitarian interaction for different actors, with the aim to use these characteristics as input for the MAIA conceptualization and agent-based model. However, due to limited time, resources, and knowledge about how these characteristics relate to each other, a selection of characteristics has to be made. During the selection process, both the focus on actors as the way the policy measures are visualized were taken into account.

Starting from the interaction between Donors, INGOs, and NGOs, many characteristics are identified and a selection is incorporated in the model. The characteristics that are identified as leading are: Culture, legislation, language, reputation, efficiency, competition, capacity, the existence of a coordination mechanism, information, history, access to resources, access to areas, access to governing and legislative organs, trust, current relationships, and religion. Due to the many characteristics, a simplification of these characteristics is made to

incorporate in the model. The simplifications are:

- Culture is general concepts that includes language, trust, religion, and other related concepts.
- Any form of access is considered region dependent and therefor considered outside the scope of the model.
- Resources are considered tangible assists as money, supplies or labour. Resources and capacity are considered the same and therefor only resources are taken into account.
- History is not taken into account, only the differences between current partners and potential partners.
- Information security awareness is added to the model to serve the current case of information security improvement sector-wide.
- The coordination mechanism is taken into account as one of the policy options.
- Governments are not taken into account as entities, but as a legislation property attached to donors, INGOs, and NGOs.
- Private companies are not incorporated in the model, meaning that the policy option (I)NGO-private partnerships is not taken into account.

3.4 Conclusion humanitarian interactions

This chapter has provided insight in different humanitarian actors interact and how interactions is influenced. The selected characteristics are culture, reputation, degree of competition, legislation, reputation, information, efficiency, competition, and current relationships. The next step is to take the insights provided by Chapter 2 and Chapter 3 and combine them with the theoretical foundation of the IAD framework and the MAIA methodology. The next chapter will therefore focus on the what the IAD framework and the MAIA methodology are and how they can be used to model interactions within the humanitarian sector.

04

The theoretical framework: MAIA

The goal of this chapter is to approach the humanitarian sector and its defined interactions from an institutional perspective as an introduction to the modelling section of the research. The institutional perspective will be set forth via the IAD framework and the MAIA methodology. This chapter includes the basic explanations of the IAD framework and MAIA, however, a more detailed explanation of MAIA can be found in Appendix A. This Appendix includes the step-by-step explanation of all the MAIA concepts, while this chapter focusses on the general explanation needed to understand the conceptualization of humanitarian interaction using MAIA that is described in the next chapter. In this chapter, first the IAD framework is described in paragraph 4.1 and second the MAIA methodology is discussed in paragraph 4.2. Paragraph 4.3 provides the preliminary conclusion of this chapter.

(Pearce, 2017)

4.1 The IAD framework

The IAD framework is part of the institutional analysis body of literature. Institutional analysis is a part of social science that – by studying institutions, structures, and mechanisms – aims to study and understand collective behaviour. It deals with how institutions are constructed and how these institutions influence individuals and society, thereby looking at political, social, historical, and many other aspects that needs to be taken into account (Scott, 2008). It is designed to capture and analyse human behaviour and explain social processes. It offers guidance to researchers who attempt to analyse social processes and increase their prescriptive capabilities of the systems they analyse (Ostrom, 2005. p.29). As explained in paragraph 1.4.2 of this thesis, this framework is an ideal approach to analyse the humanitarian sector.

The explanation of the IAD framework starts with the definition of the concepts of Institutions, Analysis and Development as defined and used by Ostrom. She describes institutions as "the prescriptions that humans use to organize all forms of repetitive and structured interactions" (Ostrom, 2005. p.3). Meaning that institutions are formalizations of participants, rules, and interactions that shape the processes in which individuals, groups, or organisations make decisions about their behaviour.

Analysis refers to the decomposition of these institutions and their context to increase understanding of how institutions shape choices and behaviour (Mcginnis, 2011). It facilitates the process of understanding the institutions and the relevant institutional context.

Finally, the Development part of the framework refers to the understanding of how institutions change over time due to external factors and the consequences that are attached to the choices made in earlier stages. The acknowledgement of these movements and growth of a system enables the researcher to analyse how these movements affect the system. This knowledge can provide insight in how policy can alter the system towards more desired situation (Ostrom, 2005).

Figure 4-1 shows a visualization of the IAD framework (Ostrom, 2005. p.15). In blue, the interpretation of the different components is added, to understand how the three concepts of the framework relate to its components. The orange square marks the Action Arena, which is the point in the analysis where everything comes together.

Explaining the components of Figure 4-1 and how they can be applied approaches
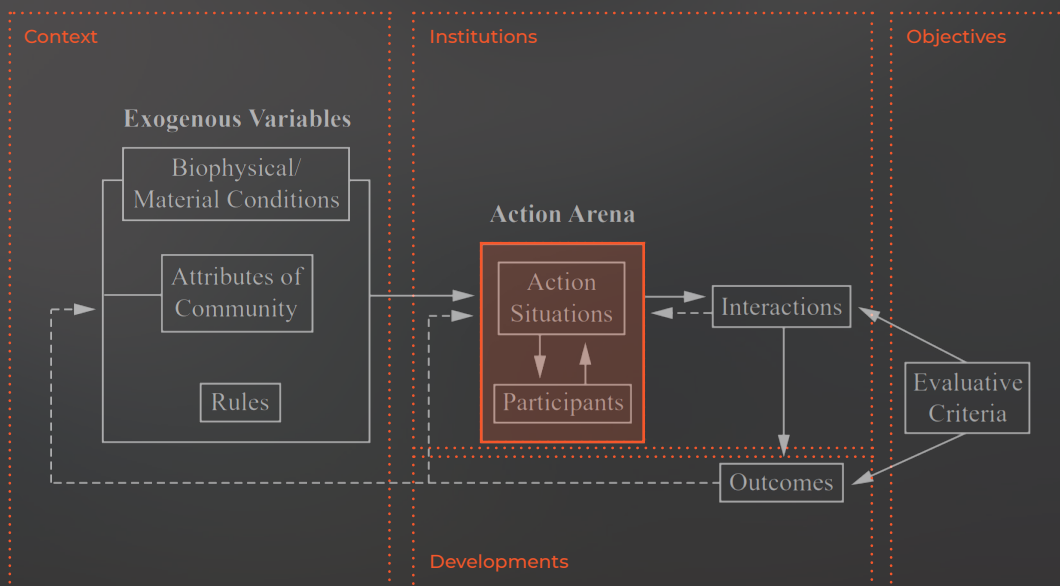
Figure 4-1: The framework for institutional analysis
(Ostrom, 2005. p.15)
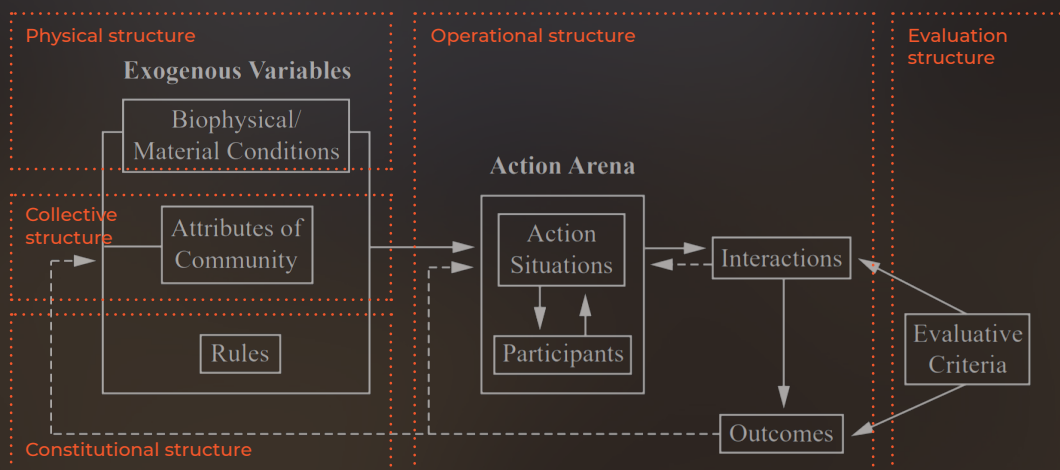
Figure 4-2: A visualization of how the MAIA components
follow the IAD framework

the level of detail needed to work with this framework. Therefore, a more detailed explanation will be provided in the next paragraph via the MAIA methodology.

4.2 MAIA

The MAIA methodology is developed by Amineh Ghorbai as a method to translate a real-world system into an agent-based model, using the IAD framework as developed by Elenor Ostrom. However, according to Ghorbani, et al. (2013) the IAD framework is not "sufficiently unambiguous" to translate the insights into a computer simulation. In order to create a more straight forward method that can be used as the foundation of a computer simulation, Ghorbani, et al. (2013) have clarified and redefined some of the concepts used in the IAD framework as presented in Figure 4-1.

The result is an extensive step-by-step approach to translate all aspects of the system in components that can be modelled and interpreted. As with the IAD framework, the focus of the research lies in the Action Arena where the interaction between participants functions as the engine of the system. Translated in MAIA, participants are called agents who can take up roles and follow institutions. By defining roles, the MAIA methodology acknowledged the fact that people show different behaviour when being confronted with different situations. For example, an INGO receives resources from donors and in that role will try to form itself towards the desires of its donors. However, when interacting with local NGOs, the INGO has the role of donor and will ask the NGOs to adapt according to the desires and needs of the INGO.

The MAIA approach includes five steps that are considered necessary to decompose and capture systems that are dependent social processes. The five steps are (Ghorbani, et al., 2013):

- The collective structure – actors and their attributes
- Constitutional structure – the social context
- Physical structure – the physical aspects of the system
- Operational structure – dynamics and interactions
- Evaluative structure – the performance indicators that are used to validate and measure the systems outcome

Figure 4-2 provides a visualization of the five steps and how these steps follow the IAD framework. The next sections will explain each step and in a detailed level and discuss all the components of each step.

Figure 4 2: A visualization of how the MAIA components follow the IAD framework The MAIA methodology comes with a toolkit to build agent-based models. However, for this research, Netlogo is used as the tool to build the agent-based model and MAIA functions as the backbone structure to design it. This decision has been made based on two arguments. The first argument is a personal one. Both tools are suitable, however, the researcher is more comfortable with Netlogo and therefor has a preference for this tool. Second, the MAIA methodology is more extensive than this research requires. Therefore Netlogo is deemed a suitable substitution for the toolkit.

4.2.1 The Collective structure

The first step of using MAIA to decompose and understand a system is starting at its core: the collective structure of the systems agents. The collective structure entails the specification of the attributes of all agents in the system (Ghorbani, et al., 2013). Agents represent entities that can make decisions about how to behave. Dependent on the level of aggregation, agents can be individuals, groups of people, or companies. For example, when looking at families, agents can be mothers, fathers, children, grandparents and so forth. However, when modelling a neighbourhood or a village, agents can represent families without the need to specify which roles are actually present in these families or how many people are considered part of it. This visualizes the importance of the very first step when using MAIA, deciding on the agents and the level of analysis.

However, naming the agents s not enough to complete this. Agents need to be decomposed to define them and distinguish them from other agents. Agents can hold belonging, can have access to certain information others have not, they have values, and make decisions according to those values. By defining who they are, what they have, what they know, and how they behave, the first step towards understanding and defining a system is made (ibid). A more detailed explanation of the collective structure can be found in Appendix A1.

4.2.2 The Constitutional structure

Agents are part of a society, where they can act differently in different interactions and situations. Looking back at Figure 4-2, one sees that the Constitutional Structure of MAIA lies over the Rules of the IAD framework, meaning that the Constitutional Structure dictates the (formal) institutions in the framework. This part of MAIA enables the researcher to formalize the interactions between actors.

Agents can take up different roles when confronted with different action situations and behave differently according to the rules that fit the current role. Taking the example of family, a woman can be -among other roles - a mother, sister, and daughter. Neither one of these roles excludes the other, but every role requires different behaviour.

Institutions are the rules that determine behaviour of agents and are one of the core ingredients of MAIA and the IAD framework (ibid). Looking back at the family example, the rule can be that the children have to go to bed at 9 PM. Children have to follow this rule, however, if they decide not to they may face consequences. An extensive explanation of the Constitutional structure can be found in Appendix A2.

4.2.3 The Physical structure

The physical structure represents the physical world in which the community is embedded and plays an important role in the system. It represents the flow of goods, money, resources, and products through the system. As with agents, the physical components are distinguished by their properties and characteristics. Furthermore, physical components can be fenced, meaning that they are restricted and only available for those with permission (ibid). A more detailed explanation of the Physical structure can be found in Appendix A3.

4.2.4 The Operational structure

The Operational structure describes the dynamics of the Action Arena. It is a way to describe all the actions that can take place in the arena every time step of a simulation. It is important to note that in the operational structure, there is -apart from the action name - nothing new added to the system. It uses the earlier defined components to formulate which actors undertake which (inter)actions, why, and how (ibid). A more detailed explanation of the Operational structure can be found in Appendix A4.

4.2.5 The Evaluative structure

The evaluative structure is the part of the model where the variables that measure the outcome are defined. Ideally, these variables are used by the agents as well to change and adapt behaviour. However, the focus of this structure lies on which

parts of the model will be used by the researcher to measure performance and model outcomes. It provides the concepts that indicate patterns of interactions and that reflect the interest of the researcher. The evaluative structure functions as the foundation of the verification, validation, and usability checks of the model (ibid).

4.3 Conclusion

This chapter was a theoretical introduction to the MAIA methodology that will be used to analyse interaction in the humanitarian sector with the aim to understand humanitarian interaction and how this knowledge can be used towards more and better information security. The five structures that form MAIA are described so that they can be applied to the humanitarian sector. These structures are:

- The collective structure – actors and their attributes
- Constitutional structure – the social context
- Physical structure – the physical aspects of the system
- Operational structure – dynamics and interactions
- Evaluative structure – the performance indicators that are used to validate and measure the systems outcome

In the next chapter, the five MAIA structures are applied to the humanitarian sector to build a conceptual model about humanitarian interactions that serves as the input for the agent-based model.

05

Conceptualization of the humanitarian sector using MAIA

The previous chapter has provided the information needed to build a conceptual model of the humanitarian sector using MAIA. Thereby, the information provided in Chapter 2 and Chapter 3 is used as the input of the conceptualization. The goal of this chapter is to provide insight in how the agent-based model is designed, actors are shaped, interactions take place and under what circumstances. Section 5.1 – 5.6 focus on the basic model conceptualization using MAIA as introduced in the previous chapter. Section 5.7 uses the same structure to explain how the policy options changes the basic model. Finally, section 5.8 brings everything together in a visualization of the conceptual model. This chapter does not have a concluding section, due to the fact that it is descriptive and does not work towards a conclusion. After this chapter, the model implementation is discussed in Chapter 6.

(IEEE, 2016)

5.1 Modelling assumptions

The first step of the conceptualization consists of the modelling assumptions that forms its foundation. Based on the literature study in Chapter 2 and Chapter 3, five assumptions are made about interaction in the humanitarian sector. These assumptions are the basis on which decisions about what - and how - to include in the conceptualization are made. These assumptions are:

Assumption 1: When scouting the field for new partnerships with other humanitarian organisations, the culture of each organisation is very important. An organisation looks for similarity in their potential partner because they deem them to be more trustworthy than others.

This assumption is based on the literature used for section 3.1.1, 3.1.2, and 3.1.3 that describes the importance of culture to build trust-relationships. The sources that are used to make assumptions are Balcik, et al. 2010), Haverkamp (2010), and Ülkü, et al. (2015).

Assumption 2: Humanitarian organisations will not cooperate with organizations or regimes that are deemed illegal or are not supported by their home government. This assumption is based on literature used for section 2.2. although all sources used in this section underline the assumption, the two sources that are regarded highest are Cochrane (2017) and Goodhand (2000).

Assumption 3: Organisations prefer to re-instate a former partnership with another organisation over new ones. Better image and higher level of transparency of these "new" ones do not influence this preference.

This assumption is based on the literature used for section 3.1.1 and 3.1.2 that describes the that trusts is built over time and that organizations are more likely to seek each other if they already have a trust relationship Balcik, et al. 2010).

Assumption 4: Humanitarian organisations base their priorities on the preferences of their donors. When donors explicitly prefer well-ordered information security in their organisation of choice, humanitarian organisations will spend more of their resources to get this done.
This assumption is based on the literature used to write section 2.1.6 and the two most regarded sources are Fishstein & Wilder (2012), Lloyd (2005), and Lutz, et al. (2017).

Assumption 5: Humanitarian organizations base their choice of new partnership on the reputation of their potential partners and how transparent they spend their resources.

This assumption is based on the literature used for section 3.1.1, 3.1.2, and 3.1.3 that describes the importance of reputation to select relationships. The sources that are leading for this assumption are Goodhand (2000) and Thomas & Fritz (2006).

5.2 The Constitutional structure

The constitutional structure discusses information on roles, actors, institutions, and dependencies between roles and groups. These topics will be discussed in the same order.

5.2.1 Actors

The actors that are considered in the basic model are: Donors, INGOs, and NGOs, Different actors can play different roles the system dependent on the situation they are in. However, they have a general position in the system, which is displayed in Table 5-1.

Table 5-1: The actors and their general position in the modelled humanitarian sector

Actor	Position
Donors	Provide resources to the system
INGOs	Receive money from donors and provide care, often via local partnerships
NGOs	Receive money from INGOs and provide care to aid recipients.
Market forces	Keep the system going by creating new (I)NGOs if desired

5.2.2 Institutions

Institutions are often the rule of law but also social norms on how to interact with each other and what is considered acceptable behaviour. It includes what actors are not allowed to do, what they must do, and what they choose to do. In the humanitarian sector, there are three institutions selected that determine behaviour of the actors in the system. These institutions are selected based on the assumed top-down flow of resources and the hierarchical interactions of the humanitarian sector. The institutions are displayed in Table 5-2.

Table 5-2: The three identified institutions

Actor	Position	Aim	Condition	Or else
Legislation	Provider Inspirer Receiver	Follow rules of government	Every action situation that contain money transfers	They get fined or are shut down by their home government
Culture	Provider Inspirer Receiver	Actors seek partnerships with other actors who share their culture due to trust and communication issues	This rule holds for every action situation involving connecting with others	
Need for funding	Receiver	(I)NGOs must always try to optimize themselves to gain funding	This holds for all action situations	If receivers don't get funding they seize to exist.

5.2.3 Dependencies

While pursuing their own goals, actors are often dependent on each other. The humanitarian sector is a hierarchical and complex sector with many dependencies. The dependencies that are taken into account in the model of the humanitarian sector are displayed in Table 5-3.

Table 5-3: The dependencies between actors

Actor	Dpendency on	Relation
INGO	Donor	Dependent on donor for receiving resources
INGO	NGO	Dependent on NGO to provide aid on a local level
INGO	NGO	Dependent on the NGO for information about the NGO
INGO	Government	Dependent on the legal obligations and regulatory boundaries
INGO	Aid recipient	Dependent on Aid recipients for purpose.
Aid recipient	INGO	Dependent on NGO for aid.
Donor	INGO	Dependent on information about the INGO
NGO	INGO	Dependent on INGO to provide resources
NGO	NGO	Dependent on other NGOs for partnerships
NGO	NGO	Dependent on other NGO for information t
NGO	Aid recipient	Dependent on Aid recipients for purpose.
Aid recipient	NGO	Dependent on NGO for aid.

5.3 The Physical structure

The physical structure that is part of the model are the resources and information that are transferred between the actors. Information is not physical in a sense that it is tangible. However, it is included as a physical "object" because there is a flow of information that moves through the system and the physical structure is therefore the most suitable structure to describe role of information is the model. The physical components are displayed in Table 5-4. It is assumed that resources flow down through the system while information flows up.

Table 5-4: The physical components of the modelled humanitarian system

Physical component	Properties	Type	Behaviour
Resources	Value (relative)	Fenced	Can be used to build partnerships or provide aid. Resources are transferred between actors.
Information		Open	Used to make decisions about partnerships or investments. Can be about the sector or specific organisations.

5.4 The Collective structure

The actor description contains the properties, values, available information, physical components they use, roles, capabilities and decision-making behaviour. Due to the fact that these tables are extensive and decrease the readability of the chapter, this chapter is limited to the core actor description and the tables can be found in Appendix B1.

- Donors: are the driving forces behind the system since they provide the resources that flow through the system. Donors aim to facilitate aid for people in need and try to find suitable humanitarian organizations who can provide this. Within their search for suitable partners they have to find organizations whose legislation and culture are compatible to theirs. Furthermore, donors might value certain characteristics of humanitarian organizations and aim to find partners who have these characteristics. These can be a good reputation, high efficiency, or much information security awareness. When they have partnered with organizations, donors will try to influence the organization to invest in the valued characteristic.

- INGOs: are considered the middle layer in the conceptualized humanitarian system. They try to optimize themselves in such a way that they receive as much resources from donors as possible while looking for NGOs who can implement humanitarian aid locally. Within their search for suitable partners they have to find organizations whose legislation and culture are compatible to theirs. INGOs look at the priorities of their donors and set their own priorities according to them. Furthermore, based on these priorities they decide if they want to invest to in these topics.

• NGOs: are the local implementing partners who are responsible for most of the direct aid that is provided. To do this, they are dependent on the resources they receive from INGOs. Although their nature is local, their mechanisms are the same as INGOs. They base their priorities on the priorities of their donors, they seek local partners within their legislation and culture if necessary. And invest if they have the priorities and resources to do so.

• Market Forces: this is an external actor that does not have values or properties. It looks at donors and INGOs and sees if there are donors/INGOs who are seeking more partnerships that they currently have. If so, a new (I) NGO is founded.

5.5 The Operational structure

Due to the extensive amount of information that must be provided in the operational structure, all the tables with the detailed information about this step can be found in appendix B2. This section will focus on the action sequence and explanation and will provide a visualization of the action sequence. The choices of these action structures are predominantly based on the core assumptions (section 5.1), the actor's goals and values (Table 5-1 and Appendix B2), the actor dependencies (Table 5-3), and the assumed resource- and information flows (section 5.3).

• Donors grant resources: In this action situation, Donors seek partnerships with INGOs to provide them with resources. To do so, they asses their current partners and look for new ones.

• Set priorities INGOs: INGOs have received resources and now must determine their first and second priority.

• INGOs build partnerships: INGOs seek partnerships with NGOs to provide them with resources so that they can be their operational partners. Partnerships are built by assessing their current partners, find new ones and pick those who are best suited according to priorities.

• INGOs invest: During this action situation INGOs decide if they want and have the resources to invest in information security awareness/efficiency. If they do, they invest.

- INGOs stop to exist: During this action situations, INGOs determine if they have had income the past year. If not, they stop to exist.

- NGOs set priorities: INGOs have received resources and now must determine their first and second priority.

- NGOs build partnerships: NGOs seek partnerships with NGOs to provide them with resources so that they can be their operational partners. Partnerships are built by assessing their current partners, find new ones and pick those who are best suited according to priorities.

- NGOs invest: During this action situation NGOs decide if they want and have the resources to invest in information security awareness/efficiency. If they do, they invest.

- NGOs stop to exist: During this action situations, NGOs determine if they have had income the past year. If not, they stop to exist.

- Market forces: In this final action situation, it is determined if Donors want more INGOs to provide for and if INGOs want more NGOs to provide for. If so, new (I)NGOs are founded.

The actions are visualized in Figure 5-1. The colours represent in chronological order Donors, INGOs, NGOs, and Market forces.

5.6 The Evaluative structure

The evaluative structure contains the variables that are used to measure performance and model outcomes. The key variables are displayed in Table 5-5. The second column of the table shows if the variables are part of the evaluative structure of the agents and/or the modeller. The first means that agents change behaviour or internal variable values due to the values of these variables. The variables that are only part of the modellers evaluative structure are not used by agents to measure performance. However, they are perceived as a performance indicator for the model as a whole.

The selected variables will be measured and compared over the different policy options to determine the impact of the policy options on these performance indicators.

Figure 5-1: A visualization of the action sequence

Table 5-5: The key variables that form the Evaluative structure

Variable	Evaluative structure of
(Average) INGOs information security awareness	Agents and modeller
(Average) NGOs information security awareness	Agents and modeller
(Average) INGOs efficiency	Agents and modeller
(Average) NGOs efficiency	Agents and modeller
(Average) INGOs reputation	Agents and modeller
(Average) NGOs reputation	Agents and modeller
Number of INGOs	Modeller
Number of NGOs	Modeller
Resources	Modeller

5.7 Change for the policy options

This paragraph describes the design of the proposed policy options in the model via the changes in the MAIA methodology. This will be done per policy option. The policy options that are used are described in Chapter 3.2. Only the structures that are changed are described in the following sections.

5.7.1 Quality Mark

The aim of quality marks is that it helps donors make the right choices when it comes to partnerships. One of the main advantages of quality marks over self-regulation is that it clarifies the common standard and what is understood with accepted behaviour. The changes take place on liferent levels:

In the **Constitutional structure** the actors, roles, and dependencies stay the same. However, there is an extra institution that helps shape interactions. This institution is shown in Table 5-6.

Table 5 6: The additional institution for the Quality Mark

Institution	Position	Aim	Condition	Or else
Quality mark	Receiver	(I)NGOs must reach a certain level of information security awareness before they can obtain the quality mark	During investment stage	They are not able to obtain the quality mark

The **Collective structure** holds the change in decision-making criteria. The tables with every changed decision-making criteria is displayed in Appendix B3. As with the description of the collective structure in paragraph 5.4, this section is limited to the description of the change of behaviour of different actors.

• Donors have no structural change in their behaviour. However, they have a change in their decision-making criteria when they prefer information security awareness level. Quality marks are seen as substitutes for culture when it comes to trust. Therefore, if information security awareness is preferred, donors will look for partners with the same legislation and a quality mark instead of the same culture.

• INGOs have no structural change in their behaviour as well, however, their decision making when it comes to building partnerships when information security is preferred changed the same way as Donors. They are able to substitute culture with the quality mark as trust mechanism. Furthermore, when INGOs come in the investment phase, they will try to obtain the quality mark by investing more (if possible) in information security awareness.

• NGOs have the same decision-making structure as the INGOs when it comes to building partnerships and investment.

The **Operational structure** entails the adapted action situations. The extensive description of the action sequences can be found in Appendix B4. Furthermore, Paragraph 5.7.5 provides the extended actions sequence diagram with the actions of all the policy options included. For the policy option quality mark, no

extra action situations are included, however, some exiting are changed:

- Donors grant resources is changed in a way that the institution culture is no longer part of the action if the focus lies on information security awareness and there are suitable partners with the quality mark.

- INGOs build partnerships is changed in a way that the institution culture is no longer part of the action if the focus lies on information security awareness and there are suitable partners with the quality mark.

- INGOs invest has a new possibility where the quality mark can be obtained.

- NGOs build partnerships is changed in a way that the institution culture is no longer part of the action if the focus lies on information security awareness and there are suitable partners with the quality mark.

- NGOs invest has a new possibility where the quality mark can be obtained.

5.7.2 Earmarked Donations

In this policy options nothing is changed in the MAIA structure. The focus lies on the donors and the change is the percentage of donors who prefer information security awareness.

5.7.3 UN as umbrella organization

An umbrella organization taking the lead in a coordinated effort can make it easier for organizations with different cultures or little relationship experience to make a joint effort. It can set the boundaries for negotiation structure and the formalities of the cooperation. Looking at the MAIA structures, much changes in this policy option. The tables with the detailed information about these changes can be found in Appendix B3 (Collective structure) and Appendix B4 (Operational structure).

The **Constitutional structure** knows extra roles and dependencies due to the introduction of a new player: The UN agency (Table 5-7).

Table 5-7: The new actor for the policy option umbrella organization

Actor	Position	Type
UN agency	Aims to coordinate joint efforts to increase information security awareness.	Institutional

With the introduction of the new actor, two new roles arise. The first is the role of facilitator, a role that only the UN agency can adopt the organization who facilitates the coordinated effort to increase information security awareness in the sector. The second role is the role of participant and can be adopted by NGOs and INGOs who join the coordinated effort to find agreement for information security awareness investments. Due to these new roles and actor, new dependencies arise as well. These can be found in Table 5-8.

Table 5-8: The new dependencies for the policy option Umbrella organization

Actor	Dependency on	Relation
UN	INGOs	Dependent on the INGOs to join the effort and make it a success.
UN	NGOs	Dependent on the NGOs to join the effort and make it a success.
INGOs	UN	Dependent on the UN to organize and coordinate the effort.
NGOs	UN	Dependent on the UN to organize and coordinate the effort.

The **Collective structure** knows two changes in actor behaviour. For this policy option, the change is collective structure of the INGOs and the NGOs is described under the same bullet point since their behaviour is exactly the same.

• The UN agency starts an effort every year where it invites all the organizations to join and come to an agreement. If there are too many organizations who join, random organizations are asked to leave. The aim of the UN agency is to increase information security throughout the sector, regardless the culture, legislation, or preference of organizations.

• The (I)NGOs decide to join the coordinated effort based on their criteria and can leave throughout the process due to different reasons.

The **Operational structure** of this policy option entails two new action situations:

• Connect to UN: all the (I)NGOs determine if they want to join and if there is still space. Their decision is based on their priority and chance.

• Find agreement: Where all the organizations who joined try find common ground and agreement about standards and investment. This is also the phase where they leave if the group composition is perceived to be unworkable.

5.7.4 Ombusman

The **Constitutional structure** of the ombudsman knows changes in actors, roles, institutions and dependencies. The new actor is the ombudsman, or its organization. Thereby, two new roles emerge, the role of inspector (ombudsman) and the role of inspected (NGOs and INGOs). To be able to formalize these interactions, a new institution is needed:

Table 5-9: The additional institution for the Ombudsman

Institution	Position	Aim	Condition	Or else
Ombudsman standards	Inspected	(I)NGOs must comply to the information security standards set by the sector and ombudsman	When information security standards are low	Reputational loss

There are two new dependencies, where the ombudsman is dependent on the information of the inspected (I)NGO and the (I)NGO is dependent on the research of the ombudsman.

The **Collective structure** knows one additional component since there is an extra actor in the field.

- The ombudsman selects a NGO or an INGO with a low information security awareness level and checks if there are data breaches or other incompliances with the information security standards set. If so, that organization faces reputational loss.

The **Operational structure** of this policy option entails two new action situations:

- The ombudsman selects and checks an organization.

- Organizations who are similar to the checked organization invest in information security awareness.

5.7.5 The adapted action sequence

Figure 5-2 shows the adapted action sequence. Although all the actions are visualized in one diagram, they do not have to be in place simultaneously. The colours represent in chronological order Donors, INGOs, NGOs, the UN agency, the market forces, and the ombudsman.

5.8 Visualization of the conceptualization

This section shows the visualization of the conceptual model including the policy options. Figure 5-3 shows the visualization.

Figure 5-2: A visualization of the adapted action sequence

Physical aspects

- Resources
- Information

Interactions

- Build partnerships
- Set priorities
- Invest
- Grant resources
- Stop to exist
- Be created

Attributes

- Information security awareness
- Reputation
- Efficiency
- Competition

Action situations

Performance indicators

- Information security awareness
- Efficiency
- Reputation
- Numbers
- Resources

Participants

- Donors
- INGOs
- NGOs
- UN agencies
- Governments
- Ombudsman

Social context

- Legislation
- Culture
- Resource dependency

Model outcomes

Figure 5-3: Conceptualization of the humanitarian sector using MAIA

06

Netlogo implementation and verification

The previous chapter has provided everything necessary to build the model. This chapter gives an overview of how the model is formalized, its core mechanisms, and the interface of the model itself. Furthermore, the second part of the chapter provides the model verification. The verification will show if the model implementation was done right and if the model works according to expectation.

(Parsons, 2015)

6.1 Model variables and model storyline

The implementation of the conceptual model is done in multiple stages. First the action steps that are part of the action sequence as presented in Figure 5 3 are worked out in detailed flowcharts. These flowcharts show the different steps taken by the different actors, their decision moments, and decision-making criteria. The flow charts are constructed per actor and policy option and can be found in Appendix C1.2.

The flow charts form the basis of the formalization of the detailed decision-making behaviour as part of the MAIA conceptualization. This is written in pseudocode and can be found in the tables in Appendix B1. This is the point where the decisions are made about how partners are selected and on which values decisions are based.

Based on these decisions, different variables are constructed. Table 11-27 in Appendix C1.1 shows an overview of the variables used in the model. These variables will be often mentioned in the verification, experimental design, and data analysis and it is therefore recommended to look at this if one is interested in the details of the modelling process.

The final step after the model is built, is the combining of the action sequence, flow charts, and decision-making variables into a diagram that can be used to display the model steps. This is done in a detailed action sequence diagram that is displayed in Figure 6-1. There are multiple important components visible in the diagram. The first are the actors and links between them that are positioned on top of the diagram. During the implementation, the decision is made to use a link-structure to enable the agents to communicate. This is visualized via de "Links between" boxes on top of the diagram. Information from one agent to the other is passed via the links.

Time is represented on the vertical axis of the diagram and works from the top down. The further down, the further the process is. The action sequence represents the actions taken during one time-step. Furthermore, the arrows present the actions per agent and can be requests for information, the movement of physical objects, the creation of breaking of a link, or the setting of a variable value. Finally, the coloured boxes on the dotted lines represent the moments were the agents or links are active and either act or react on actions initiated by others.
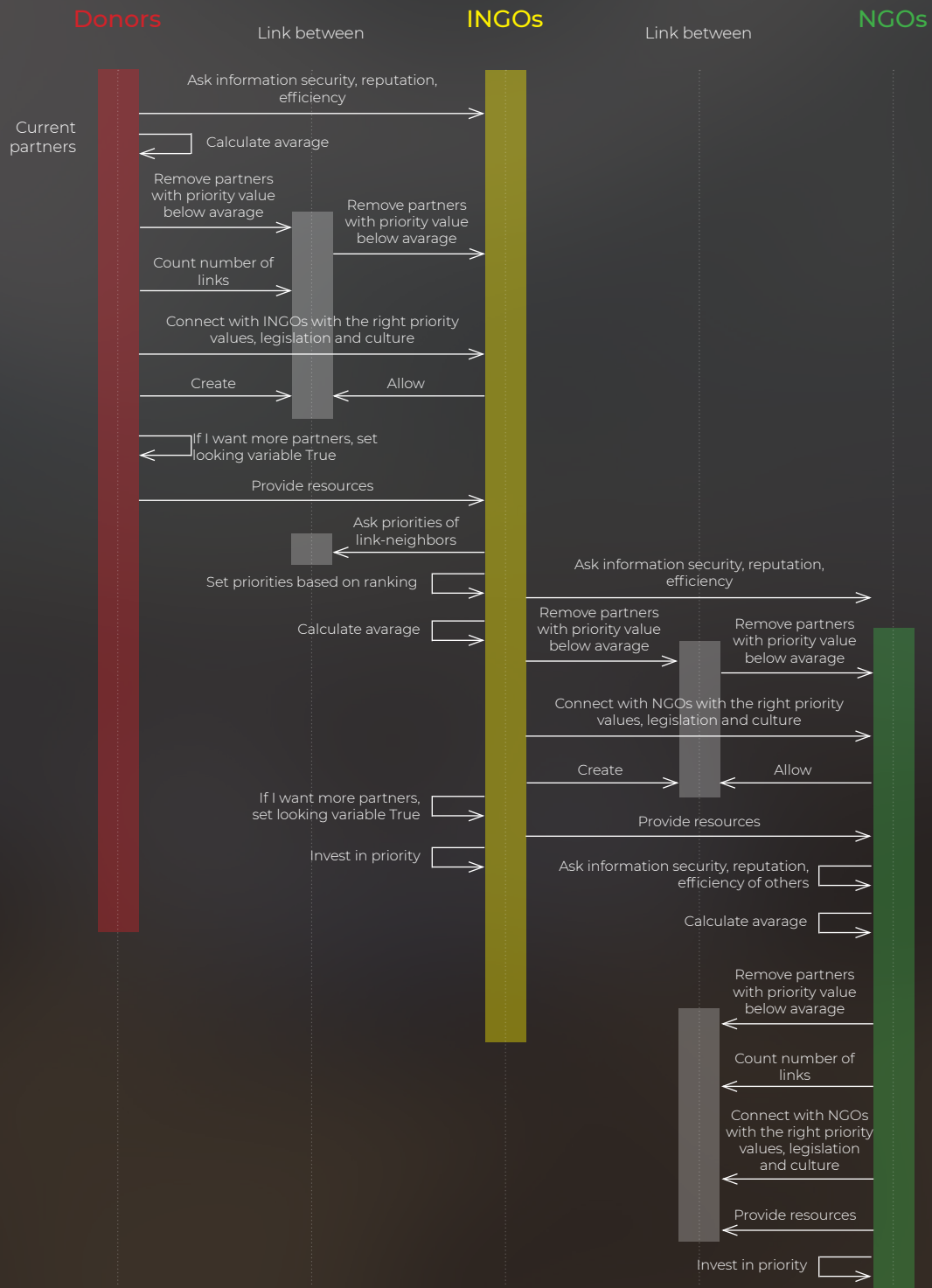
Figure 6-1: The action sequence as implemented in Netlogo

6.2 Data, values and assumptions

The model is designed using the structures provided by the MAIA methodology. The information found in the second and third chapter has been translated into variables and actions are designed. These variables need values for the model to work. This is the most difficult part of this research since there is little data available in literature. Furthermore, the three most important output variables are expressed in percentages. It has been decided to use percentages for these variables to be able to compare the values and interpreted the direction of the trends. One must take into account that the variables have lost their absolute value and only the behaviour increasing and decreasing values can be taken into account. On the other hand, there is no data found in the first place that provided information about these variables. Therefore, the absolute value of these variables was never valuable to begin with. The tables with variable values and (if available) sources can be found in Appendix C2.1.

Due to the lack of data, much is assumed about how the interaction between humanitarian organizations takes place. All these assumptions are listed in Appendix C2.2.

6.3 Interface

Figure 6-2 shows the interface of the model on a random moment during a baseline run. Baseline run means that the settings are set on representatives' values and no policy option is enabled. There are roughly four parts one can distinguish in the interface: The centre screen, the sliders left of the centre screen, the buttons and slider right of the centre screen, and the graphs below the centre screen.

The centre screen shows a visualization of what is happening during the run. There are three types of agents (coloured arrows) visible and the links between them are visible as well. The red arrows represent Donors, the green INGOs and the yellow arrows represent NGOs. The lines between certain agents represent the partnership they have built and enables them to communicate. If donors do not have links, they have not found any suitable partner INGO. The same goes to INGOs, if they have no links with NGOs, there are no suitable partners.

The sliders left from the centre screen are the input variables who are used to set the initial settings of the run. It determines how many agents there will be and how much resources they provide to their partners.
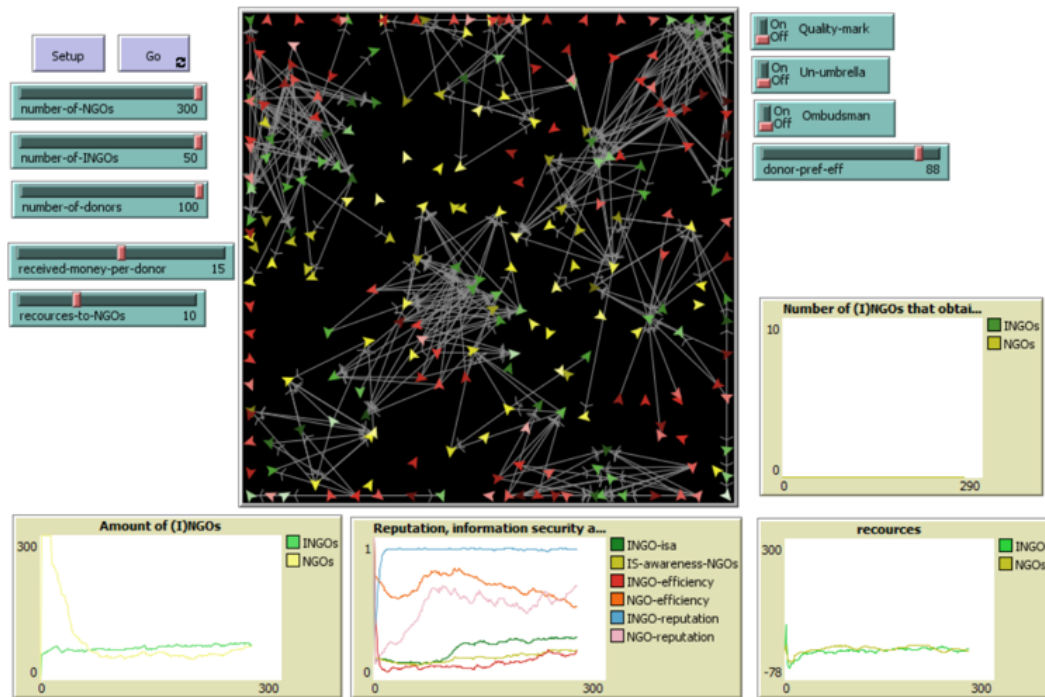
Figure 6-2: Snapshot of model interface

The graphs under the screen show the key output and state variables who are used to visualize the behaviour of the agents during the run. The first graph (left) shows the number of INGOs and NGOs since this fluctuates based on demand. The middle graph shows the key output variables. These are the average level of information security awareness, efficiency, and reputation of the INGOs and NGOs. The third graph (bottom-right) shows the average number of resources the INGOs and NGOs own. The fourth graph (upper-right) shows the number of INGOs and NGOs that have obtained the quality mark if this policy option is enabled. Since it is not enabled during the baseline run, the values are zero.

Finally, the buttons and slider right of the centre graph represent the policy options. The policy options quality mark, UN umbrella organization, and ombudsman can be enabled. The policy option earmarked donations is a slider because it focusses on the percentage of donors who prefer information security awareness. The policy options quality mark and UN umbrella organization come with a visual change in the interface when they are enabled. When the quality mark policy option is enabled, the graph upper-right has values different from zero. When the option UN umbrella organization is enabled, there is a blue agent added to the centre screen that represent the UN agency. The captures of these

interfaces can be found in Appendix C3. The other two policy options do not bring a visual change in the interface.

6.4 Verification

The goal of verification is to make sure that the conceptual model is correctly formalized. During the building phase of the model, every process, agent, and partnership has been carefully checked. Therefore, most errors have been corrected during the process. However, a well-structured verification process makes sure that every aspect of the model's behaviour has been examined before the model's results are used and interpreted. The verification method that is used to verify the model follows the verification steps as described by Nikolic, et al. (2013). A detailed step-by-step explanation and the results of the process can be found in Appendix D. The conducted verificat steps ares:

- Recording and tracking agent behaviour
- Single agent testing
    - o   Theoretical Prediction and Sanity Checks
    - o   Breaking the Agent
- Interaction testing limited to minimal model
- Multi-agent testing
    - o   Theoretical Prediction and Sanity Checks
    - o   Breaking the Agent
    - o   Variability testing
    - o   Timeline example

A detailed description of what the verification steps entail can be found in Appendix D1. Table 6-1 shows the key variables identified in the evaluative structure that are being monitored during the different verification tests. All variables are tested over a minimum of 5 runs.

Table 6-1: The key variables that are being monitored during verification

Variable type	Variable
Key input variables	Numbers of donors, INGOs and NGOs
	Received money per donor
	Resources to NGO
Key output variables	(Average) information security awareness
	(Average) reputation
	(Average) efficiency
	Numbers of donors, INGOs and NGOs
Key state variables	Resources
	Degree of competition
	Number-of-links
	Possible partners

6.4.1 Recording and tracking agent behaviour

The modeller monitors relevant output, input, and state variables to check if the model is operating as expected and intended. During this step, small mistakes have been found in the "to Update-numbers" and "to Update-numbers-NGO" code. One of these mistakes was due to copy-pasting lines of code. When this mistake was discovered, the other code that has been copy-pasted was checked extra carefully but no other mistakes were found. All the assumptions about how the model should behave that are checked for this part of the validation can be found in Appendix D2.1.

6.4.2 Single agent testing

There are two types of tests that can be done when performing a Single agent test step. The first – Theoretical Prediction and Sanity Checks – focuses on the behaviour of the agent under normal parameter conditions. It checks whether the behaviour matches the indented behaviour. The second test – breaking the agent – monitors under which parameter conditions the agent stops behaving normally. The lists with verified assumptions for this test about how the model should behave can be found in Appendix D2.2.

First, theoretical prediction and sanity checks. This broke the system immediately for every other option than one NGO. These numbers are expected, however, they must be mentioned because they do break the agent's possibility to perform. Both Donors and INGOs determine their choice of partners based on the average values of the INGOs and NGOs. In the case of the Donor, if there is no INGO the average value is calculated by a division trough zero and that is mathematically impossible. This problem does not occur if there is only a single NGO. NGOs also base their choice of partners on average values, however, the NGO needs to be present to determine the average of NGOs and therefore the calculation is not divided by zero. The NGO seized to exist after 12 ticks due to lack of income and no new agents are founded after that.

Second, breaking the agent. There are two input variables that have a value that breaks the agents:

- "*Amount of INGOs*" = 0 while "Amount of donors" > 0
- "*Amount of NGOs*" = 0 while "Amount of INGOs" > 0

Although noticed, nothing is changed in the model. The only thing that must be taken into account is that zero INGOs or NGOs cannot be part of the experimental design. However, a scenario without one of the three main agents is not intended or deemed useful so this will not be a problem for the experimental design or model results.

6.4.3 Minimal agent testing

There are four sets of minimal agent tests that work without the system breaking due to the division trough zero-error found during the Single agent tests:

- One Donor and one INGO
- One Donor, one INGO, and one NGO
- One INGO, and one NGO
- One NGO

For all scenarios, the agents, variable values, and behaviour was as expected. There was a quick rise in the number of INGOs and NGOs during the runs where one Donor was present. The run where no Donors where present, the number of NGOs increased over the first 12 ticks, then the INGO seized to exist due to lack of income and 12 ticks later the last NGO died as well.

6.4.4 Multiple agent testing

Multi-agent testing consists of the same tests as Single-agent testing and two additional tests. The first additional test is Variable testing. This is done by running the model a large amount of times to see what kind of behaviour occurs via statistical analyses. Second a Timeline Sanity check is performed to see if there is unexpected behaviour that occurs during a complete run. These tests can be found in Appendix D2.4.

For the first tests – theoretical prediction and sanity checks – the same variables are tested as in paragraph 6.4.1 (Recording and tracking agent behaviour) and are all confirmed with an increasing number of agents and slider values.

The second test – breaking the agent – showed only two ways to break the agents during multiple agent testing. The system breaks if the UN-agency button is activated during a run. The UN agency is built during the setup phase, meaning that no UN-agency will arise when the button is activated. Agents are asked to connect with a non-existing agent and an error will occur. Although this must be taken into account, this will not influence the experimentation outcomes because the policies are selected during the Setup-phase.

The second way to break the agents is to find settings that remove the INGOs and/or NGOs from the system. This can be done by setting the resource flow 0 or let de organizations default immediately by setting the default time equal to 0 ticks.

The third test - variability testing - showed that the distribution of the number of NGOs was a bit off. However, no abnormalities where found in the code and the other variables showed no abnormal behaviour. Therefore, the number of repetitions was probably too small to cover the entire behaviour space of the

NGOs. Because this was not the case for the other variables, it has been decided not to test again with a larger number of repetitions. Furthermore, the values chosen for the variable *received-money-per-dono*r was not as representable as expected. This value must be higher and that will be taken into account during the experimental design.

The Timeline sanity check that is performed for this model was a 10 times replicated run with 10.000 step runtime. The settings of the input variables where considered representable and the output variables as presented in Table 6-1 where validated. There are no errors found or unexpected behaviour identified during this verification test. The test can be found in Appendix D2.5.

6.5 Conclusion Netlogo implementation and verification

In this chapter the Netlogo implementation and verification are discussed. The implementation showed the most important variables and their meaning, and it showed the interface of the Netlogo model. The second part of the chapter consists of the verification. All the verification steps are conducted and multiple errors are found. The errors that influence the model outcomes have been corrected. Some of the errors are considered insignificant because they do not influence the model outcomes if the model is used as intended and therefore these errors are not changed. The model is considered verified and can be used for data analysis. The next chapter consist of the construction of the experimental design that will form the foundation of the data analysis and the model validation.
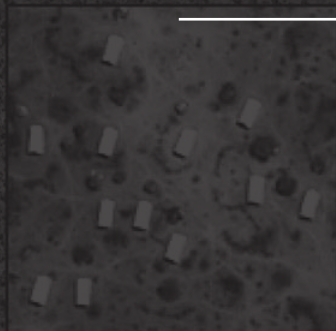
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Exploring the model's behaviour: experimentation and validation

In this chapter the model behaviour is analysed with the aim to build an experimental design that will form the foundation of the data analysis and the conclusions. Furthermore, the conceptual model will be validated using expert validation. The decision to validate the conceptual model is based on two reasons. First, the experts are not familiar with the specifics of agent-based modelling and are more able to provide insights based on the conceptual decisions. Second, a conceptual model is a better starting point for further research. Therefore, the included characteristics and assumptions are prioritized over the actual model and code.

This chapter consists of multiple steps. The first step is to explore the model's behaviour, this is done in section 7.1. Section 7.2 contains the process of designing the experimental design. The model is validated in section 7.3 and section 7.4. Finally, section 7.5 entails the conclusion of the chapter.

(UNHCR, 2011)

7.1 Exploring the model's behaviour

Exploring the model's behaviour is an important step towards understanding the model and the influence of the different parameters. Due to the uncertainty of almost all aspects of the model, the explorative nature of the research, and the limited time and resources of the research it is undesirable to build the experimental design without understanding the core mechanism that influence the model's behaviour. By understanding which parameters have a significantly higher influence on the model's behaviour, an efficient experimental design can be built where the whole range of these influences can be utilized. The verification conducted in the previous chapter already showed the influence that the flow of resources had on the model. This is something that will be taken into account during the model exploration, however, more of these mechanisms might exist.

The model exploration consists of three steps. First the exploration setup is discussed. Second, the exploration results are visualized and discussed. Finally, the implication of the model exploration is discussed to show how the findings of the model exploration contributes to the experimental design and the result of the model. A detailed description of the method that is used to select the variables of the model exploration and the experimental design can be found in Appendix E1.

7.1.1 Model exploration setup

The model exploration setup is the first step for the experimental design. It differentiates from the Behaviour Space used during the verification because some issues with the chosen values have been found during the verification and are therefore adjusted. There are two different model explorations that are done in this chapter and both require a different setup. The first step is the exploration of the behaviour space values. For this test, a relatively wide range of variables values is selected and run for 10 repetitions over 360 ticks. As explained in Appendix E1, the variable values are semi-random selected based on the modeller's insight of the model's behaviour under different circumstances. The values are:

- donor-pref-eff = 100
- number-of-donors = 10 30 60
- number-of-INGOs = 50 10
- number-of-NGOs = 20 40
- received-money-per-donor 25 40 60
- resources-to-NGOs = 5 12 20

The second exploration is the exploration over timespan. This exploration will help determine the number of ticks that will be used in the final experimental design. This exploration is similar to the Timeline Sanity check of the validation. However, other parameter values are used to obtained insight in how some of the parameter values influence the system. The decision to use different parameter values than for the first exploration is due to the runtime of the model. Setting an extremely long run length and differentiating between values will make the runtime of the exploration experiment too long.

The runtime is set on 6000 ticks due to insight in behaviour obtained during the Timeline Sanity test. This test showed that the system stabilizes around a 1000 ticks and that 10.000 ticks is not necessary to test model behaviour. The decision for 6000 ticks is based on the fact that the parameters settings are different and therefor it might take longer for the system to stabilize. As explained in Appendix E1, the settings for the second exploration again semi-random selected based on the modeller's insight of the model's behaviour under different circumstances:

- donor-pref-eff = 100
- number-of-donors = 30
- number-of-INGOs = 50
- number-of-NGOs = 40
- received-money-per-donor = 40
- resources-to-NGOs = 10

The results of both explorations are used to determine experimental design that functions as input for the model results. All the variable values are assumed and therefor an explorative experimental design can be constructed by the researcher.

7.1.2 Model exploration results

Due to the fact that market forces are accounted for in the model, the initial number of INGOs and NGOs have little influence in the model's behaviour. After 12 timesteps, the INGOs and NGOs start to disappear if they do not receive enough resources. Furthermore, new INGOs and NGOs are being founded every timestep as long as there are donors and INGOs who seek more partnerships. Therefore, the first three input variables that are being investigated are: "number-of-donors", *"received-money-per-donor"*, and *"resources-to-NGO"*. The most important results are discussed in this chapter. The full model exploration results can be found Appendix E2.1. The results are discussed based on how the processes are modelled and if the outcome is believed to be consistent with reality.

The first result is shown in Figure 7-1 and shows the number of INGOs and NGOs explained by the initial number of donors. Two observations can be made.

First, the number of INGOs and NGOs increases with an increase in the number of donors. Looking at how the model is built, this is in line with expectations. The model is built in a way that donors can provide for a random number of INGOs that lie between 3 and 15. Every extra Donor will therefore increase the number of desired INGOs, who on their turn seek partnerships with different NGOs. However, the mechanism that determines the number of desired NGOs is a bit more complicated. The number of desired partner NGOs is modelled in a way that it depends on the amount of resources that INGOs has at that particular time-step. This fluctuates highly due to the current number of partners (partners costs resources), the current efficiency level, the investments made, the desires of the donors (if efficiency is prioritized, the INGO desires less partners), and the competition (more competition means more desired partners). The number of desired NGOs changes every tick and this influences the number of NGOs that appear or disappear in the model. Furthermore, the newly found NGOs have their properties randomly assigned and are not found based on demand, which increases the NGO fluctuations because many undesired NGOs are founded and will disappear after 12 ticks.

Looking at Figure 7-1, the results can be explained due to the different mechanism between donors and INGOs and INGOs and NGOs. Both the INGOs and NGOs rise due to a rise in donors. However, the variance of the NGOs increases as well, due to the more complex and dynamic mechanism behind the desired number of NGOs.

It is difficult to say if this is consistent with reality. There are a lot more NGOs than INGOs so that part can be confirmed. However, one can question the speed of the partnership formation. It is not likely that partnerships are assessed every month-or-so and changed with the same speed. The duration of humanitarian partnerships is not taken into account during the modelling phase and therefore no substantiated link to reality can be provided here. Furthermore, the mechanism of random property assignment to the newly founded NGOs is considered not be consistent with reality because it defies the theory of supply and demand. However, this decision is deliberately made because it greatly reduced the complexity of this part of the model and is considered one of the reductions to keep the model feasible.

Second, the outliers of the NGOs are all above the boxplots. There must be ideal values in the model that cause an especially high demand of NGOs. Furthermore, the number of outliers decreases with an increase in donors and therefor an

increase in variance. Looking at how the model is built, this can be explained by the way partnerships are built and which factors play a role in these dynamics. There are three options for culture, three for legislation, and three options as first priority that determine who is selected. Furthermore, efficiency and competition can increase or decrease the number of desired partnerships. With a low number of donors, it is not likely that all possible combinations of options occur. The runs with the highest number of NGOs include high competition, high efficiency, a high value of *"received-money-per-donor"*, and a low value of *"resources-to-NGOs"* (these variables influence the resources an INGO has and therefor the number of desired NGOs). With a high number of donors, this combination of factors is more likely to occur and is therefore not seen as an outlier anymore.

It is believed that this is in line with reality. There are situations where more resources are available and more partnerships can and will be built and situations where the demand for local partners is lower due to lack in resource. The model reflects different situations and that reflect the current situation of the humanitarian sector. Furthermore, this shows the importance of the *"received-money-per-donor"* and *"resources-to-NGOs"* variables. The influence of these variables on the number of INGOs and NGOs is analysed as well, however, no additional insights were obtained. This analysis can be found in Appendix E2.1.

The second step is to analyse the influence of the variables *"amount of donors"*, *"received-money-per-donor"*, and *"resources-to-NGOs"* on the information security awareness levels of INGOs and NGOs. These results are show in Figure 7-2 and Figure 7-3.

Looking at Figure 7-2 and Figure 7-3, one can see that the information security awareness levels of INGOs are much higher than the information security awareness levels of NGOs. Furthermore, the variance of the information security awareness levels of the INGOs is much smaller than the same levels for the NGOs. There are two mechanism in the model that cause this behaviour.

First, the initial information security awareness levels of NGOs and the desired number of NGOs and INGOs. As the previous analysis showed, the number of INGOs is more stable and this does not require much new INGOs to be found once this state is reached. However, this does not hold for the NGOs. The demand for NGO highly fluctuated which causes a constant rise and fall of the number of NGOs. The initial level of information security awareness of NGOs is set between 0.05 and 0.15, which is much lower than the average information security awareness level of the NGOs. It is believed that the initial level of information security awareness in combination with the dynamics of the desired number of NGOs has much influence on the difference in results in Figure 7-2 and Figure 7-3.

Figure 7-1: The number of INGOs and NGOs for the initial
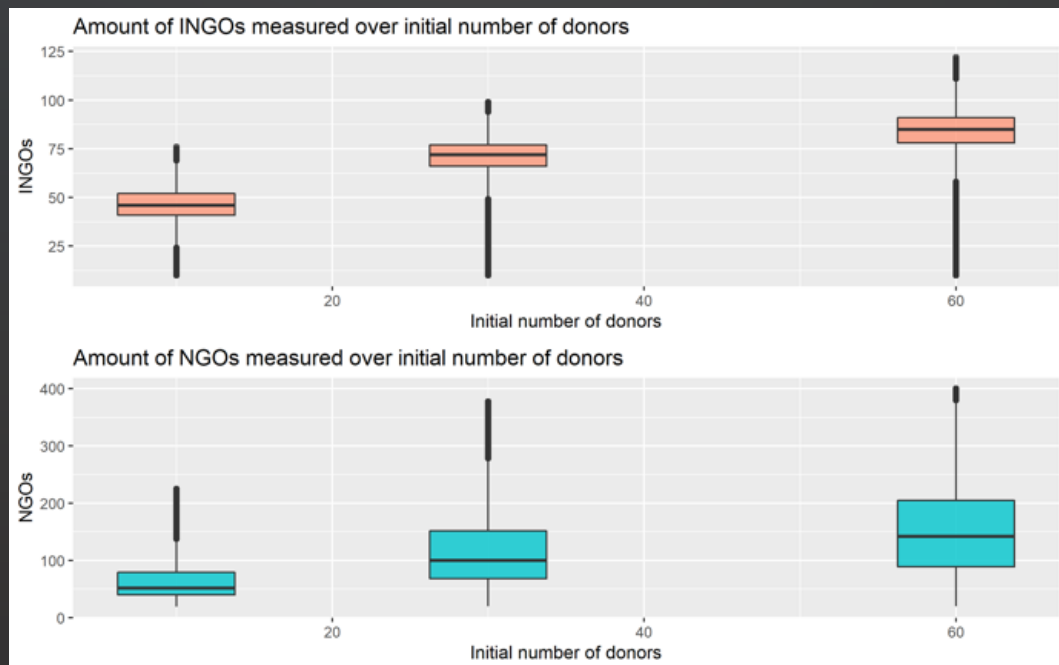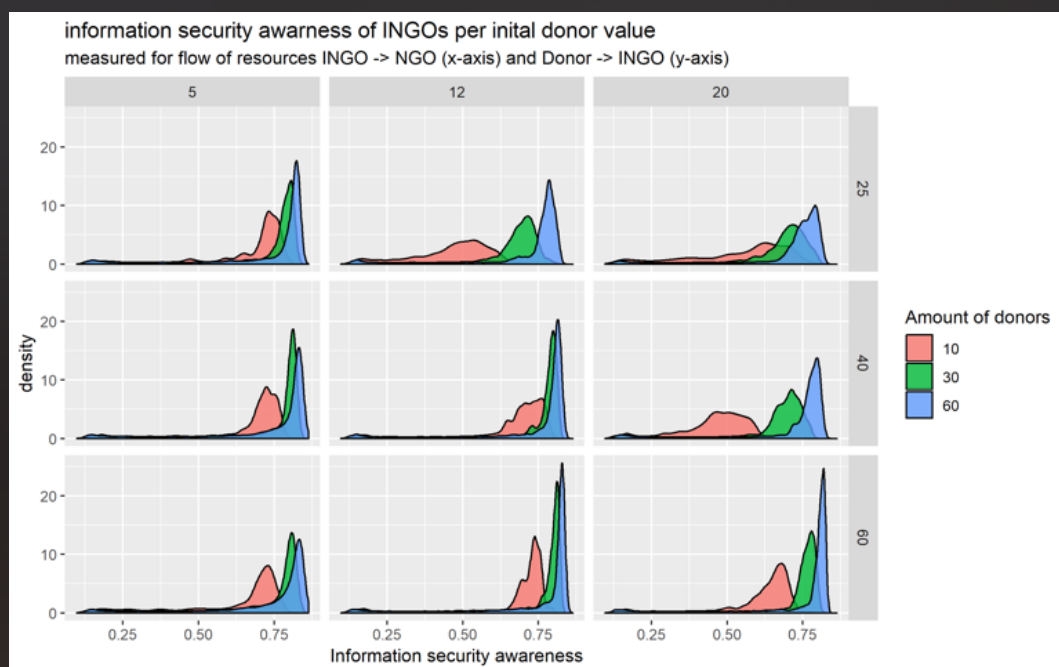number of donors

Figure 7-2: Information security awareness over donor value,
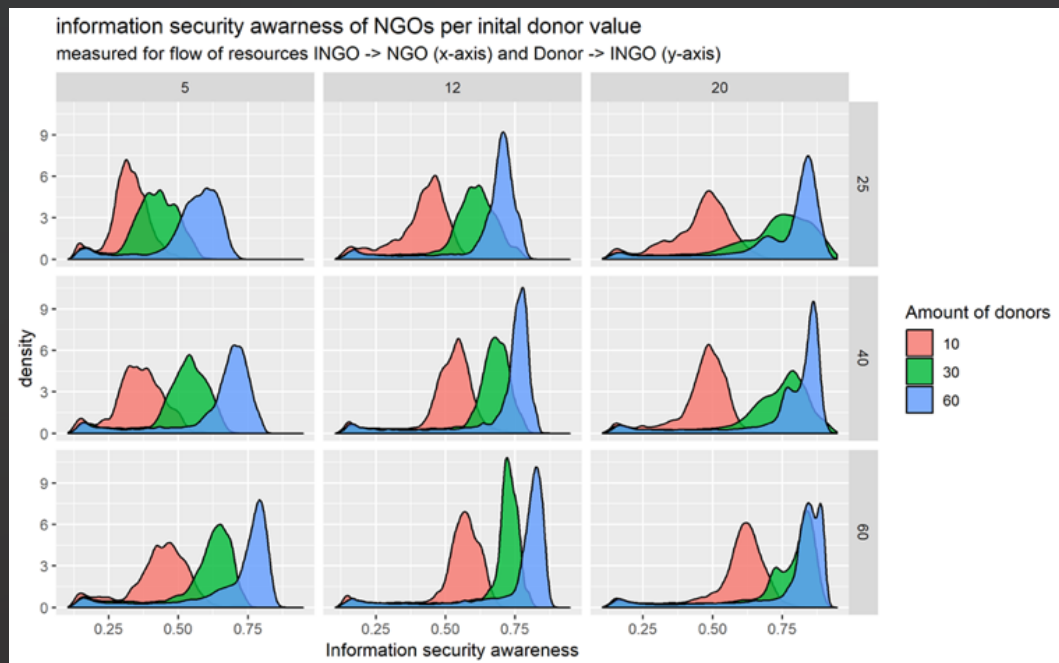number of resources to NGOs(x), and resources from Donors(y)

Figure 7-3: Information security awareness over donor value, number of resources to NGOs(x), and resources from Donors(y)
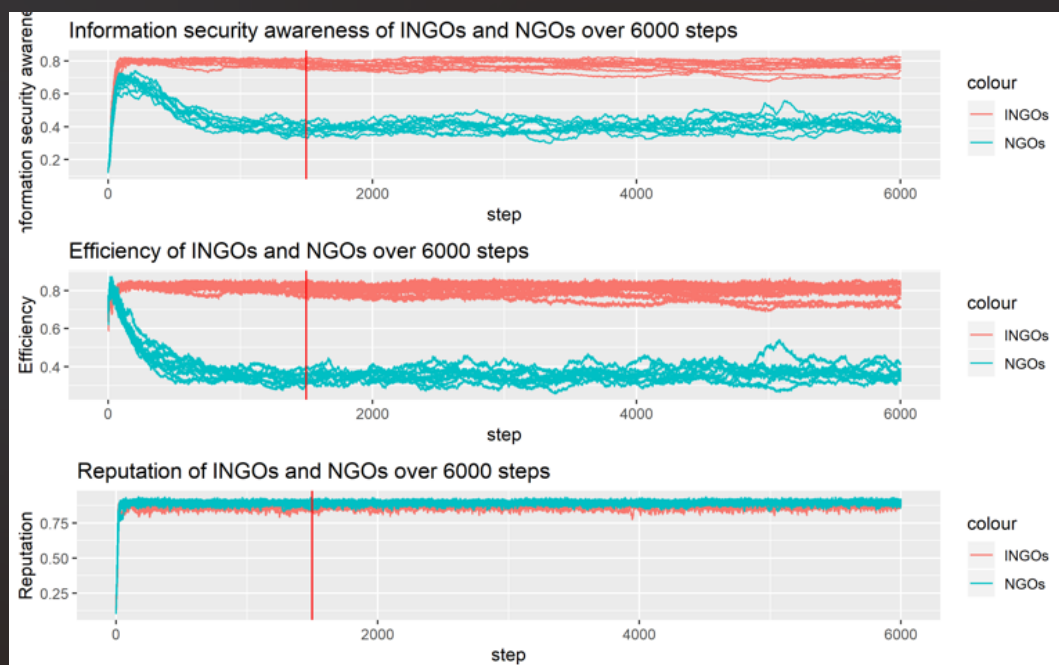

Figure 7-4: The boundary of 1500 timestep runtime for information security awareness, efficiency, and reputation

Second, the INGOs have much more access to resources than the NGOs and have more opportunities to invest. Resources provided by donors go through an INGO where it is reduced by the efficiency level of that INGO and invested if required. The average efficiency level of INGOs is around 80% (Figure 7-4) which does have an influence on the amount of resources NGOs receive. However, it does not stop there. Once the resources are at the NGOs, their efficiency levels also cause resources to deplete. Looking at Figure 7-4, the average efficiency levels of NGOs lie around 35%, which has a huge impact on the amount of resources available for investment.

The question arises if this is in line with reality. The first mechanism is believed to be. Expertise is built over time and requires investment. It is expected that even if information security is prioritized by the humanitarian sector, it requires time before it is actually achieved on the INGO level and even more time before the NGOs are on board. The results of the second is also believed to be in line with reality, since the humanitarian sector is known for its inefficiency regarding resources (Stoddard, et al., 2017; Miliband & Gurumurthy, 2018). However, the smaller the organization, the more efficient it should be. Which is not visible in the exploration results. Taking into account a many new NGOs are founded and their initial efficiency level lies between 55 and 95%, many NGOs who exist longer must have an extremely low efficiency level. This can be explained by the resource flow as well. NGOs do not have enough resources to invest in both information security as efficiency, while the INGOs do have these resources.

The final exploration that is discussed in this section is the outcome of the timeline exploration. The most important outcomes are discussed trough Figure 7-4. This figure shows the information security awareness, efficiency, and reputation levels of INGOs and NGOs over 6000-time steps. The figure shows that information security awareness and efficiency levels need some time before they stabilize, while reputation almost stabilizes immediately. Reputation levels rise faster than Information security and efficiency because reputation is something that is assumed not to require investment, while the others are dependent on the resources available for investment.

The time the system needs to stabilize is dependent on the time donors need to find their maximum amount of suitable INGOs. The selected runtime must take this into account, otherwise conclusions about behaviour can be drawn without taking all information into account. It is decided to set the run length of the experimental design to 1500 ticks. In the figure, this is indicated with the vertical red line. Appendix E2.2 shows the timeline exploration for the amount of resources of both INGOs and NGOs and the timeline exploration for the number of INGOs and NGOs. However, these analyses have confirmed the conclusions

drawn in this section and did not provide additional insights.

7.1.3 Model exploration implications

There are two types of implications that are discussed in this section. First the insights that are obtained about the model that will be used as the foundation for the experimental design. Second, the insights obtained what mechanism drive the model and how this reflects on the humanitarian sector discussed. These insights will be used as starting point to interpret the model results.

First, the influence of the variables *"number-of-donors"*, *"received-money-per-donor"* and *"resources-to-NGOs"*. These variables have the largest influence on the system and must be varied over a wide range to enable the different mechanisms described in the previous section to influence the system. However, due to the resource depletion in the system, the values of the *"received-money-per-donor"* variable must be larger than the *"resources-to-NGOs"* variable. Furthermore, the model shows that it needs time to stabilize. To make sure that the results will not only reflect the results of the model when it is still stabilizing, the run time will be 1500.

Second, the mechanism that drives the model and what can be said about the humanitarian sector based on this mechanism. The most complex and dynamic interaction that is observed lies with the INGOs and the NGOs. While the INGOs show stable behaviour and investments, the NGOs fluctuate more and show to be more susceptible to the changes of the INGOs. The NGOs are more vulnerable and dependent and this shows in their information security and efficiency levels. They often do not have the resources to invest because their position is at the end of the resource supply chain.

Looking at how these insights reflect on the humanitarian sector as it is today, some insights are obtained from the model exploration. First, information security is assumed to be on the agenda in the model while it is questionable if this is the case in reality. Even so, it takes the model some time to reach high information security awareness levels. This means that proper information security in the humanitarian sector is not yet there, and it probably will take a long time before it part of the daily practise of humanitarian organizations. Second, due to the dynamics on the local level, information security results are likely to be gained at het international level. The INGO level is more stable and has more access to resources which will make the investments needed to increase information security more likely to happen.

However, these are the observations made about the humanitarian sector based on the model of its interactions and partnership formation. The next step is to see if policy interventions can change the situation or accelerate the process.

7.2 Designing the experimental design

The model exploration provided insight into the model's behaviour and the influence of the input variables. This section brings this together in the experimental design. This design shows the values of the input variables and the strategy for the incorporation of the policy options in the experimental design. First, the values are presented. The values are partly based on the insights obtained about how the model works and which variables have the most influence (section 7.1.2 and section 7.1.3). The input settings are as follows:

- donor-pref-eff = 100
- number-of-donors = 5 15 45 60
- number-of-INGOs = 75
- number-of-NGOs = 150
- received-money-per-donor = 25 40 55 70
- resources-to-NGOs = 5 10 15 20

The incorporation of the policy options brings one assumption as well. The assumption is that only one policy option per run is selected. Different policy options can therefore not be enabled at the same time. The current situation is also taken into account as a policy option, which makes the total number of possible policy options 5:

- Current situation
- Quality mark
- Earmarked donations
- Umbrella organization
- Ombudsman

To make sure that these policy options cannot be enabled together, one of these policy options is selected randomly per run. To increase the change that all policy options are selected eat least once during every possible combination of variables, the number of repetitions per run is set to 20.

7.3 Validation

In this stage of the modelling process, the model needs to be evaluated to assess whether the model reflects the needs of the research. The validation method that is selected for this research is expert validation. The motivation behind this decision can be found in Appendix F1.

To structure the validation process, the model validation process as described by Beecham, et al. (2005) is used. This approach is selected because of three reasons: first, it is designed especially for modelling and therefore covers all needed aspects. Second, it can be easily be adjusted so it fits the particular form of modelling that is used during one's own research. Final, it is specifically focussed on expert validation, which is the selected validation method of this research.

Beecham, et al. (2005) describe an eight-step approach to validate a model using an expert panel. However, these steps are designed especially for their Requirements Capability Maturity Model. To make sure these steps fit the validation process of an agent-based model, one adjustment has been made: Beecham, et al. (2005) define a list of criteria to define if their model is implemented successfully, the so-called success criteria. In the validation approach for this research, the success criteria are replaced by the core assumptions introduced in Chapter 5.1. Therefore, instead of validating the model trough success criteria, the core assumptions of the model are validated trough the same eight-step approach. These steps are:

1. Highlight the objectives for building the model
2. List the core assumptions identified during the initial stages of model development
3. Explore alternative methods for testing how the core assumptions are reflected in the model
4. Design a validation instrument to test the core assumptions
5. Select an expert panel to reflect the population of experts
6. Present results of the validation instrument
7. Relate results to the core assumptions to gain an impression of strengths and weaknesses
8. Discuss how these strengths and weaknesses might affect our objectives

The first 5 steps have resulted in a survey that can be found in Appendix F2. The sixth step is considered too large to be presented in this document and is therefore added to the repository as a separate document. However, a summary of the answers per question given in the survey is provided in Appendix F4. Conclusions and statements made in this section are drawn from the answers of the expert

panel. They can be perceived as direct or unscientific, however they reflect the experiences, expertise, and opinions of the expert panel. Step 7 and step 8 are presented in this section via three topics of validation. First the core assumptions are validated. Second, the assumed top-down flow of resources and a bottom-up flow of information that forms the backbone of the model is validated. Finally, the method of modelling is validated for being the right method for the purpose of the research.

7.3.1 Validation of the core assumptions

In this section, the expert validation of the core assumptions is discussed. This validation step is to make sure that the assumptions are rightly subtracted from literature and in line with practise.

Looking at the responses of the expert panel, four out of five assumptions are – to some extent – positively validated. These are the assumption regarding culture, the preference for current partners over new partners, the influence of donors, and the influence of reputation (respectively assumption 1, 3, 4, and 5.) These assumptions are partially positively validated because they are not perceived as wrong by the expert panel but are deemed not complete enough. For example, the expert panel agrees on the importance of culture, but disagrees with the assumption that culture functions as a driver for trust. Shared culture makes it – in practise – easier to communicate, while trust is perceived as something personal and not institutional. Organizations do not trust, people populating organizations trust each other and build organizational partnerships based on personal trust-relations.

Furthermore, the model underestimates the need of access. In Chapter 3, access to resources is found as one of the drivers of humanitarian interactions but it was considered outside the scope of the model. However, the experts underline the access as one of the main drivers of humanitarian interaction. According to them, access it not limited to resources alone. A distinction is made between access to resources, area, communities, politicians, and complementary humanitarian services. Access is important for the donor- INGO, INGO – NGO, and the NGO – NGO relationships, because all actors base their choice of partner largely on how much access they provide in an area where there currently is limited access for that organization.

The third – and final – main remark about the partially positively validated assumptions is that history plays an important role. The assumption that current partners are held to lower standards than new partners is deemed true, however,

this also applies on former relations if these relationships are ended positively. History is not considered in the model and only the current partners experience an advantage.

The second assumption is the only assumption that is completely rejected by the expert panel. Legislation and position of home government are factors that are taken into account but are definitely not leading in making decisions about partnerships. Again, access is mentioned here as one of the leading decision-making criteria. According to the expert panel, this plays at every level in the humanitarian sector. Governments try to pursue their own agenda, thereby (potentially) supporting other governments, rebel groups, or organizations that are branded as terrorist organizations by other. On the level of INGOs and NGOs, partnerships can be built between humanitarian organizations and organizations that are branded illegitimate by their home government if that means the humanitarian organizations can get safe access to those who require assistance.

To conclude, the assumptions are largely validated positively, although not complete enough. The second assumption about the reluctance of humanitarian organizations to cooperate with organizations or governments or are not supported by their home government is rejected. The implications of this validation will be discussed in section 7.4.

7.3.2 Validation of the model backbone structure

The expert panel agrees with this top-down perspective to some extent. Especially the top-down approach of resources is in general positively validated. However, it is emphasised that the direct Donor - local NGO should not have been assumed non-existent. According to literature, only 0.3 percent of the total donated money goes direct to local NGOs. Considering the fact that the humanitarian sector is a multi-billion dollar industry, 0.3 percent is still a number reaching far in the millions of dollars. This is a large number that has an impact on many lives and processes.

The main critique that the experts express is the difference between global and local partnership building. Globally, the backbone structure is positively validated and it is agreed upon that it is a hierarchical top-down structure following the resources. Locally, however, partnership building is a more networked and bottom-up process where religion, ethnicity, (political) alliances, access, and personal relationships play a role as well.

In sum, the backbone structure of the model is partially positively validated.

However, a distinction must be made between global and local processes and the ties between large donors and local NGOs must not be underestimated.

7.3.3 Validation of the model backbone structure

Finally, the validation of the method as a way to conduct research is validated. In general, the expert panel agreed on using modelling and simulation to gain insight in how humanitarian interactions word and to identify the missing information. However, most of the experts underline this to be a first step in research. Modelling can identify the missing knowledge, but for this method to contribute it should be extended with interviews, case studies, and - in an ideal situation- field research. The research and the research results must therefore be treated as a first step in a larger process and not valued as conclusive.

7.4 Implications of the validation

This section represents the final step of the eight-step validation approach as described by (Beecham, et al., 2005). In this step the implication of the validation results is discussed on two levels. First, the implication for the model and the model results are discussed in order to see to what extent the model can be considered useful for the purpose of this research. Second, the implications for the research goals and method are discussed to look at the relevance of the research considering these new insights.

Starting with the implications of the validation for the conceptual model and the model results. The four main conclusions that can be drawn from the validation:

- Most of the assumptions and structures are in the right direction,
- Legislation as one of the main decision-making criteria is rejected and a gap between literature and practise is identified.
- The decision-making criteria that are taken into account in the model are too limited to be generalizable,
- A clear distinction between the local and the global level must be made to show a more accurate picture of the sector.

Looking at the validation results, the model can be considered to be a promising – but limited – first step in the research of conceptualizing humanitarian interaction. Taking into account that no research has been found that focusses on conceptualizing and understanding how humanitarian interaction takes place,

some useful insights are obtained, conceptualized, modelled, and validated.

The validation results provide an angle from where the model results can be perceived and analysed. Looking at the validation results and the context provided by the used literature, the model results can be perceived as generally representable. Meaning that the behaviour that is the outcome of the model can be used to draw first conclusions but hold no numerical or conclusive value. Since the research is explorative of nature, this is not considered a problem but rather the desired outcome of the research process.

However, the validation showed that the decision-making criteria – reputation, efficiency, information security awareness, legislation, and culture - used by de agents are too limited. Therefore, it must be taken into account that the results of the model might differ if additional factors – like access, personal relationships of other forms of security – are incorporated in the model. This is something that will also be considered in Chapter 10 that contains the further research.

Furthermore, the second assumption is completely rejected by the expert panel. This is an interesting outcome because it shows a gap between literature and guidelines on one side and practise and reality on the other side. Since the foundation of this research lies in literature and no additional interviews or published journals of humanitarian workers are used to support the model's theoretical foundation. Therefore, at this point it cannot be said if the assumption can be completely rejected. However, this identified gap between literature and practise sparks interest and should be investigated further. This is done in Chapter 10.

The second part of the validation is the validation of the method used for this research. The expert panel regarded modelling and simulation as the right method for the research. However, thereby underlining that it is a useful first step, but should be extended with different kinds of research. The research method and used methodology are both suitable for these proposed extensions. Data obtained from case studies and interviews can be included in the form of insight in how interactions work and input data to increase the quantitative validity of the model. Furthermore, the framework that is used to conceptualize the model is suitable for the proposed research extensions. Due to the possibility of different roles, different kinds of dependencies, and situational decision-making criteria the global and local distinction can be incorporated in the model. As well as personal relationships and history. Finally, due to the insight in how the humanitarian sector works on multiple levels, the specifics of how information security is part of the humanitarian organizations can be better incorporated in the model when the insight in how the humanitarian sector works is improved.

7.5 Conclusion experimentation and validation

In this chapter, the model exploration, the experimental design, and the model validation are discussed. The model exploration showed that the three most important input variables are: "number-of-donors", "received-money-per-donor", and "resources-to-NGOs". Due to the importance of these three variables, the input settings for the main experiment are as follows:

- donor-pref-eff = 100
- number-of-donors = 5 15 45 60
- number-of-INGOs = 75
- number-of-NGOs = 150
- received-money-per-donor = 25 40 55 70
- resources-to-NGOs = 5 10 15 20

The validation showed that conclusions about the model and the model results must be made carefully, taking into account the (quantitative) shortcomings of the model. However, most of the assumptions and directions are positively validated and form a good start in the identification of further research steps. The method that is selected for this research and research goal is positively validated, taking into account both the current research and the possible implementation of future research as defined in the research goal.

08

Model results

The aim of this chapter is to discuss if there is a significant difference between the different policy options and to relate these results to the findings of validation results and literature study. Paragraph 8.1 shows the different results per input variable and policy options, while paragraph 8.2 and 8.3 focus on the interpretation of the results. Appendix G1 includes an in-depth explanation of the influence of the different measured variables as introduced in section 5.6. This appendix is used to support the conclusions drawn from the results presented in section 8.1. The results are discussed per policy option.

8.1 Model results

Information security awareness is the main focus of the thesis. Therefore, the influence of the different policy options on the information security awareness levels is discussed first. Figure 8 1 shows the results for the INGOs and Figure 8-2 for the NGOs. The results for the NGOs show more influence of the policy options, especially for the Quality mark, that scores significantly lower. However, because the differences between the policy options seem negligible, this does not mean that conclusions cannot be drawn or policy options cannot be recommended or rejected. Therefore, this section focusses on the results, how the model structure caused these results, if the model structure can be considered representative for the humanitarian sector, and what conclusions can be drawn from these results regarding the humanitarian sector. De mechanisms behind the baseline policy option is discussed in section 7.1.2 and is therefore not in-depth explained in this section but only taken into account in the conclusions drawn from the model results.

8.1.1 The policy option Quality mark

The policy options Quality mark shows very different results for the INGOs and the NGOs. Looking at the model's code, this can be explained by processes that were not anticipated on during the building phase and the construction of the experimental design. In the experimental design, the variable donor-pref-eff is set on 100%, meaning that there are no donors who prioritize information security. Therefore, INGOs are not rewarded if they obtain the quality mark and donors stay within their culture group. However, due to the existence of unearmarked donations – donors who do not demand a certain priority – INGOs can have their first priority set on information security. If a donor does not demand a priority, the INGOs sets the first priority equal to the variable with the smallest value, which is often information security awareness. Information security awareness has the lowest initial value and is the only value that decreases over time which makes it the lowest value in almost all cases.

Due to the fact that some INGOs prioritize information security, the quality mark mechanism works for the INGOs – NGOs dynamics. However, the results are disappointing for the information security awareness of NGOs. The reason for this result lies with the resource scarcity as explained in Appendix G1.2. The quality mark requires investment for which most NGOs do not have the resources. This result in a very small group of NGOs that obtained the quality mark and are suitable for the INGOs to build a partnership with. If an INGO can maintain 10
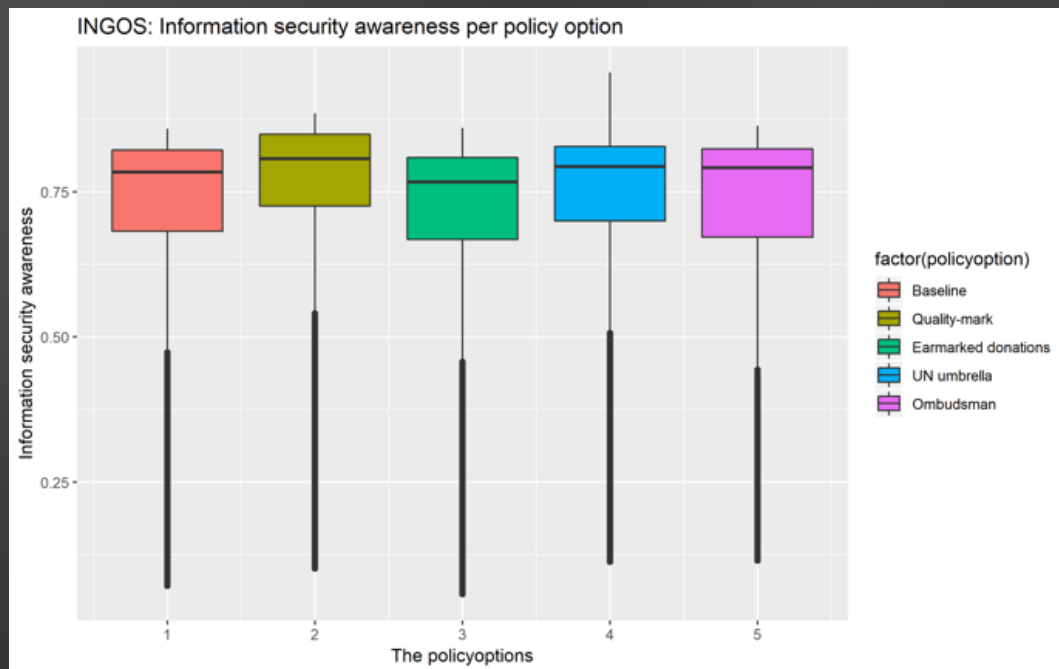
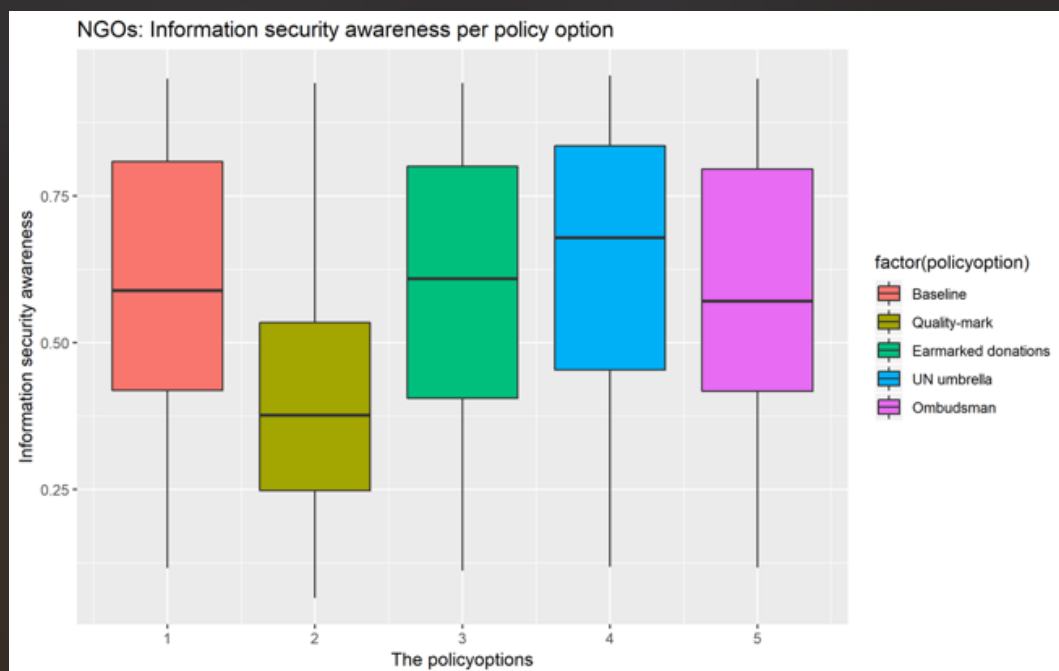Figure 8-1: Information security awareness per policy option for INGOs

Figure 8-2: Information security awareness per policy option for NGOs

partnerships and only 3 NGOs obtained the quality mark, 7 possible partnerships are not utilized and 7 NGOs do not receive resources. This mechanism only enlarges the resource gap between INGOs and NGOs and this is visible in the results. Due to the fact that INGOs spent less money on partnerships, they have the resources to invest in information security. This leads to less money available for NGOs and less investment in the NGO level.

The question remains, are these mechanism in line with reality and what lessons can be drawn from the model results? Starting with the Donor – INGO dynamics, it is believed that this result is indeed in line with reality. It shows that a quality mark does not hold any additional value if the donors do not value information security. It would only be a viable solution if donors are actively looking for organizations that have their information security in place.

The INGO – NGO dynamics hold two different things to consider. Does the existence of a quality mark really obstruct the resource flow? And, are the resources needed to obtain a quality mark a threshold for NGOs?

Staring with the first, this is not believed to be consistent with reality. Looking at the validation results, the experts showed that the guidelines and reality are not always consistent. Therefore, if there are no local partners found with the quality mark and work needs to be done, INGOs will seek partnerships with NGOs without the quality mark. Second, it is believed to be in line with reality. If a quality mark is expensive to obtain or if it requires much investment and effort to keep, it will be less appealing for smaller and local NGOs to try to obtain it, regardless its value.

Looking at the mechanisms behind the Quality mark policy option, one can conclude that this option is not recommendable. It requires that organizations already value information security, which is not necessarily the current situation. Although it provides promising results on INGO level, it does not seem feasibly on NGO level due to its resource intensity and the belief that the existence of the quality mark will not change the way local partnerships are built.

8.1.2 The policy options Earmarked donations

This policy options provides exactly the same results as the Baseline policy option. However, one must be careful with the conclusion that donors therefore hold no power when it comes to encouraging more information security.

The percentage of donors that value information security is set on 12%, which turns out, is not enough to counteract some of the mechanisms of the model.

With the variable "number-of-donors" set on 5, 15, 45 and 60, the number of donors that value information security will be between 0 and 8. Not enough to make a significant difference, especially because the percentage of earmarked donations is set on 14. The improvements regarding information security due to the different priorities of donors, will be counteracted by the same number of INGOs that - due to their unearmarked donations- will choose to invest in efficiency. This decision will be based on the lower value of efficiency due to the need to invest in information security awareness.

Because the change inspired by this policy measure is counteracted by the unearmarked donation mechanisms of the model, the INGO level does not experience a change in results. This means that the NGO level does not experience change either, which clearly shows in Figure 8-2.

These results are not believed to be in line with reality. The agent-based model entails a small number of possibilities to set priorities compared with the choices organizations in the sector face. The effect of donors who change priorities will not be directly counteracted by the need to compensate the lowest – of three - values of priorities.

Looking at literature and the expert validation, this policy options seemed to be a promising solution. However, looking at the mechanisms behind the Earmarked donations policy option, one can conclude that this option is not recommendable due to the unknown effects. It is possible that with a higher percentage of donors who prioritize information security more will be invested on INGO and NGO level. However, no conclusions can be drawn about this or how much of the donors need to switch priorities before results are booked.

8.1.3 The policy option UN umbrella agency

This policy option shows higher results than the Baseline policy option on both the INGO and the NGO level. This is due to the fact that the UN umbrella organization works on both levels, instead of directly on the INGO and indirectly on the NGO level.

This policy option starts from the assumption that reputation and maintaining a network is important. Therefore, organizations that value their reputation or information security have a higher change to participate in the coordinated effort increase information security. Per session, there is a maximum number of participants and the sessions are twice per year. Participants can stop their participation if they believe the effort to be biased or unproductive and they

base their choice on the relative number of NGOs or INGOs, the representation of culture, and the competition between the participants. The percentage of participants that withdraws from participating decreases the changes of a successful effort and investment by the participants. If the effort is successful, investment is only made by the participants who have the resources to do so.

The results are positive for both the INGOs and the NGOs, due to the fact that information security is linked to reputation and the fact that the works directly on both levels. These are relatively big changes with some results, however, the results are not significantly different on INGO level. These results are believed to be in line with reality because they show that by targeting different levels of the humanitarian sector, different results can be gained. However, it also shows that the results that can be booked by targeting the NGO level are relatively small, due to the resource scarcity. Appendix G1.2 and G1.3 show that the results on the NGO level for this policy option are indeed susceptible for changes in resource flow and that with the right amount of resources, this policy options shows even more promising results. As Appendix G1.1 and G1.2 show, INGOs do have to resources to invest, and for them it is more a matter of priority.

Looking at the results, this policy option is recommended. Results are positive and provide enough information to draw conclusion. Especially the fact that the directly targeting of NGOs shows significant positive results fuels the believe that this is a feasible option.

8.1.4 The policy option Ombudsman

This policy options shows a slightly – but not significant – increase in the information security values of the INGOs. This can be explained based on one value that is used in this policy option. If an organization is reprimanded by the Ombudsman, this reprimand is noticed by others. Similar organizations will invest in their information security to discourage the Ombudsman from visiting their organization. However, these investments are set on a 0.1 improvement for 10 resources while regular investment is 0.2 information security increase for 10 resources. This investment can be perceived as a bad investment, depleting the resources of organizations for a lesser return. However, it is a very small difference, which explains the slightly lower values of information security for the INGOs and the NGOs.

Appendix G1.1 shows that the amount of resources owned by INGOs and NGOs is lightly lower than the baseline options, which confirms the conclusions drawn in this section. Furthermore, appendix G1.2 shows that the resource depleting

effect show less for the most beneficial resource flow values for INGOs or NGOs. Meaning that with more resources available for these organizations, the costs of the Ombudsman is additional to the investment in information security that can be made as well. The information security values in these scenarios are higher than the baseline option.

Looking at this policy options, it is believed to be in line with reality. Reprimands and loss in reputation will encourage others to secure their reputation by investing in information security. Taking into account that the information security values are likely to be higher if the investment values are not halved, this policy options shows promising results. It shows that by closing the accountability gap as described in section 2.1.8, humanitarian organizations are more likely to invest in information security. Therefore, this policy option is recommended. However, with the notion that the UN umbrella organizations provided more conclusive results and that this recommendation is provided under the assumption that the results would be better if the Ombudsman investment was set equal to the regular investment.

8.2 Model results linked to literature

This section focusses on how the model result correspond with the used literature. The results are discussed per policy options, starting with the policy option representing the current situation.

The used literature is both positive and negative about self-regulation to address pressing issues. Andrew & Cortese (2011) describe self-regulation as effective if the issue is already on the agenda end prioritized. If the issue has not found its way on the agenda yet, this is not an effective policy measure at all since the process of getting prioritized can take years. Especially in complex and multi-level environments such as the humanitarian sector.

In the model, the current situation seems to be effective. This in in line with literature, since investment in information security awareness is one of the investment options. Therefore information security is already on the agenda and results are achieved. However, one has to keep in mind that this issue is currently not prominently visible on international humanitarian agenda. Furthermore, information security awareness is one of the two investment options while in reality there are numerous. Meaning that the model outcomes are still in line with literature, but also too simplistic.

The adoption of an information security quality mark is - according to literature - a relative effective method to strengthen trust. The main issues with quality marks are therefore not their effectiveness, but their content and whose decisions it is to set the rules that come with the quality mark (Lloyd, 2005). In the model, this increase in trust does not show the expected results. The chosen variable values and the high dependency on the number of NGOs with a quality mark influence the model results negatively. Furthermore, this policy option showed two important limits that are also identified in literature. First a resource threshold to obtain the quality mark for NGOs, which will discourage them from investing. Second, it showed that without this issue being on the international humanitarian agenda, a quality mark will not have any added value.

Earmarked donations is a policy options that comes out very positive in literature studies. Donors are among the most powerful players of the humanitarian sector and their influences can move humanitarian organizations and shift priorities (Clarke & Ramalingam, 2018). Therefore, it was expected that this was one of the best scoring policy options. Since the influence of this policy options is deemed inconclusive, it cannot be said if these results are in line with literature.

The fourth policy options – UN umbrella organization- is the policy option that scores best and is regarded positively in literature. Furthermore, this policy option is already used in this sector and therefore considered likely to be viable. Furthermore, studied literature has marked the absence of a coordination mechanism one of the main reasons why humanitarian efforts fail and the implementation of a coordination mechanisms as one of directions that increases the likelihood of success (Balcik, et al., 2010; Kabra, et al., 2015; Thomas & Fritz, 2006). The results of this policy option are therefor in line with the expectations drawn from literature.

The final policy option – the Ombudsman – is regarded as a feasible, but a difficult to implement solution to many problems that plaque the humanitarian sector. The effectiveness of the ombudsman is dependent on the scale of the problems it addresses. In the model, the ombudsman takes the middle position, with two policies generating better and two generating lesser results. There is no example of an ombudsman that has an international mandate and attempts to implement this policy option is discouraged by the sector itself. This raises additional questions of feasibility and effectiveness when this policy measure is implemented.

8.3 Conclusion of model results

Figure 8-1, Figure 8-2, and the variable analysis in Appendix G have provided insight in how the policy options influence the information security awareness of INGOs and NGOs. Together with the lessons obtained by literature study, conclusion can be drawn about which policy options are considered the answer of the research question. The policy options are listed and discussed based on how positive their results are:

1. The policy option UN umbrella organization. This policy options causes the best results for both the INGOs and the NGOs. Furthermore, it tackles the problem on both the INGO and the NGO level and is positively regarded by literature.
2. The baseline option provides the second-best policy solution. This is convenient since it shows that the sector will eventually invest in information security awareness. However, this is a long-term solution since no further incentives are provided to put this issue on the international humanitarian agenda.
3. The third option is the policy option Ombudsman. Closing the accountability gap shows positive results. However, much considerations must be taken into account with this policy option regarding the feasibility and effectiveness of the implementation of an Ombudsman.
4. The fourth policy option is the earmarked donations. Due to the inconclusive - but not directly negative - results, this policy option is ranked fourth and is not recommended.
5. The last policy option is the Quality mark. Information security is not on the international humanitarian agenda, it will be difficult for NGOs to obtain the quality mark, and it will not change partnership formation on the ground. Therefore, this policy option is not recommended.

09

Conclusion and reflection

This chapter offers the final conclusion of the research, thereby taking into account how the given scope, limitations, and valuation of the model have contributed to further knowledge about humanitarian interaction and how this can be used to improve information security. This chapter starts with the answer to the research question and sub questions. Second a reflection on the research method and approach is presented. The further research is discussed in the next chapter.

(UNICEF, 2016)

9.1 Model results

This thesis aims to answer the following research question:

What are the characteristics of humanitarian interaction and how can this be used to gain insight in which policy measures will help the humanitarian sector to improve information security?

To be able to provide an answer to this research question, to following sub questions are formulated:

1. Which characteristics and policy interventions can be identified that influence humanitarian interaction?
2. How can the identified characteristics of humanitarian interaction and policy interventions be conceptualized using MAIA?
3. How can the implementation of the conceptual model into an agent-based model provide insight on how humanitarian interaction can be used to improve information security?

To answer the main research questions, first the sub questions are individually answered. The insights obtained from the sub questions and their main contributions together form the basis of the answer for the main research question.

9.1.1 First sub question

The focus of this study lies with the interactions between Donors, INGOs, and NGOs, thereby taking into account the influence of governments. The aim of this research question is to identify the factors that help built partnerships in the humanitarian sector and identify policy options that can influence the utility of these partnerships. Furthermore, this insight is used as the input and foundation of the next research steps. The main contribution of this research question is the overview of characteristics that influence humanitarian interaction, since little research has found about this topic.

Starting from the interaction between Donors, INGOs, and NGOs, many characteristics are identified and a selection is incorporated in the model. The characteristics that are identified as leading are: Culture, legislation, language, reputation, efficiency, competition, capacity, the existence of a coordination mechanism, history, access, trust, current relationships, and religion. Due to

the many characteristics, a simplification of these characteristics is made to incorporate in the model. The simplifications are:

- Culture is general concepts that includes language, trust, religion, and other related concepts.
- Any form of access is considered region dependent and therefor considered outside the scope of the model.
- Resources are considered tangible assists as money, supplies or labour. Resources and capacity are considered the same and therefor only resources are taken into account.
- History is not taken into account, only the differences between current partners and potential partners.
- Information security awareness is added to the model to serve the current case of information security improvement sector-wide.
- The coordination mechanism is taken into account as one of the policy options.
- Governments are not taken into account as entities, but as a legislation property attached to donors, INGOs, and NGOs.

The second step is the identification of policy options that can influence these characteristics. The policy options are selected to focus on different problems identified in the structure of the humanitarian sector and perceived as the starting point for a research direction towards better information security in the humanitarian sector. There are five policy options selected. First the current situation of self-regulation where responsibility lies with the organizations itself. Second, quality mark as policy options is selected to bridge trust issues between organizations with different cultures and values. Third, the earmarked donations as a policy option is selected. In this policy option, the donors take initiative and a percentage only provides resources to organizations with high information security awareness. Fourth, the UN umbrella organization. This policy options includes a UN OCHA-like structure where one UN based agency aims to coordinate efforts to increase information security and set common standards. The final policy option is the implementation of an Ombudsman organization that closes the accountability loop that forms one of the main problems of the humanitarian sector.

9.1.2 Second sub question

During the literature study, no conceptualization of humanitarian interaction was found. The goal for this research question therefor was to build a conceptual model and use the structure to identify missing knowledge that can form

input for future research. The latter can be found in Chapter 10. As theoretical foundation for the conceptual model MAIA is used. The MAIA methodology is a method to translate a real-world system into an agent-based model, using the IAD framework. MAIA consists of five structures that together provide a consistent and complete overview of the humanitarian sector within the given scope.

The conceptualization is displayed in Figure 9-1 and shows all the components that are taken into account in the model. One of the main advantages of the use of MAIA for this conceptualization, is that it is easy to understand using the visualization and that it is easy to extent during or on the basis of further research. The characteristics identified in the previous sub question are used as the foundation of the Physical, collective, and Constitutional structure.

9.1.3 Third sub question

The third sub question focusses on the results of the agent-based model. The aim of this sub question is to interpret both the modelling process and the model results. There are two main insights obtained during the formalization and analysis of the model.

First, the use of agent-based modelling as a method to look at the problems of information security in the humanitarian sector. Especially combined with MAIA it provides a structured way to understand different aspects of the sector and its problems. However, this research method alone is not enough to obtain the desired data and information to actually build the model. Many factors must be assumed and quantitative relationships must be extracted from qualitative findings of other studies.

The second lesson that can be taken from the agent-based model regard the results that are the output of the agent-based simulations. The model results point towards the policy recommendation UN umbrella organization that coordinates efforts to spread information security awareness in the humanitarian sector and works towards a coordinated set of common standards regarding information security. This option provided the most positive because it works on both the INGO and the NGO level and is backed by research that is predominantly positive about the possibilities of an umbrella organization.

However, apart from the identification of a policy option, insights about information security in the humanitarian sector are obtained that can help research to improve the current situation. First, the process of improving information security will be a long-term process. In the model, information security is assumed to be

Physical aspects

Resources

Information

Interactions

Build partnerships

Grant resources

Set priorities

Stop to exist

Invest

Be created

Attributes

Information security awareness

Reputation

Efficiency

Competition

Action situations

Performance indicators

Information security awareness

Efficiency

Reputation

Numbers

Resources

Participants

Donors

INGOs

NGOs

Governments

Social context

Legislation

Culture
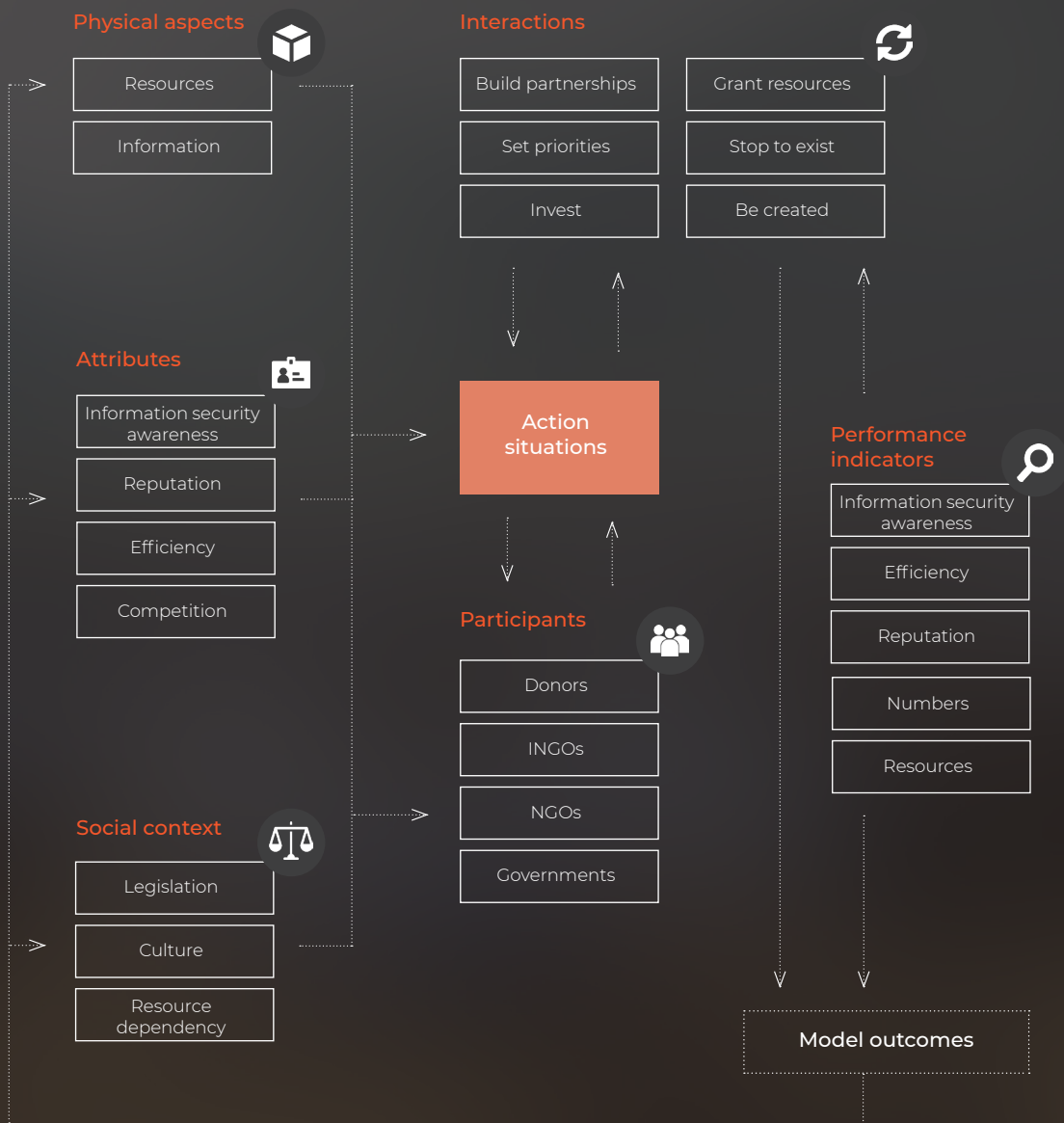
Resource dependency

Model outcomes

Figure 9-1: The visualization of the humanitarian sector

on the humanitarian agenda and even then, it took the policy options some time to improve the information security levels. Considering that this topic is not – yet – regarded as pressing, no big improvements are expected in the short term.

Second, the NGO level is more complex and dynamic than the INGO level. Therefore, it is more likely that results are gained if the focus lies on the INGO level. INGOs have less resource scarcity and are more stable in terms of the number INGOs so that competition is less. The NGO level knows more dynamics, dependencies, and resource scarcity. Adding that to the notion that information security expertise demand resources and time, which decreases the likelihood of satisfying results on the NGO level.

However, the third insight shows that the policy options including both Donor – INGO and INGO – NGO levels show the most promising results. This lesson and the second lesson might seem contradictive, but they do not need to be. Results are more likely to be booked if INGOs and NGOs are included in the process, however, the NGO level needs more attention and resources to book the same results as INGOs.

9.1.4 Main research question

The main research question consists of two part. The first part asks which characteristics influence humanitarian interactions and the second part focusses on how policy measures can influence this to improve information security.

Looking the first part, this is answered by the first sub question and the characteristics can be found in section 9.1.1. This research showed that interactions are built based on many different characteristics, however, the resource flow determines how successful these interactions can be in terms of informant security.

The model results showed that a preferable by the UN umbrella organization that coordinates both joint efforts to increase information security in the sector and set common standards is the policy measure with the most impact. An umbrella organization that takes the lead in a coordinated effort can make it easier for organizations with different cultures or little relationship experience to make a joint effort. It can set the boundaries for the negotiation structure and determine the formalities of the cooperation and convince other parties to join.

9.2 Limitations of the thesis

During every research, compromises have to be made to keep the research within scope, understandable, and feasible. During this research, many decisions and simplifications where made which influences the usability and added value of the research. In this section, these compromises are discussed. Furthermore, a conclusion is made about if these choices where the right choices or that other choices might have affected the research differently and in a better way.

9.2.1 Limitations of perspective

The chosen perspective on the humanitarian sector is global and resource oriented. Global means that the humanitarian sector is researched in a generalizable way and the focus lies not with specific scenarios or regions. This perspective is chosen because information security is not a regional or scenario specific problem, therefor, focussing on one or some case studies was deemed not sufficient. On the other hand, the global perspective is highly abstract and does not provide directly usable insights.

One of the consequences of this perspective is that the model only knows different types of organizations, while the people populating the organizations are the ones driving change. This holds for humanitarian interactions who are -according to the validation expert panel – largely based on personal values, connections, and networks. Furthermore, this also holds for information security awareness, how it spreads, and is implemented on organizational level. Therefore, a more organizational oriented perspective would probably have resulted in more insight than the current generalized global perspective. MAIA is perfectly adequate to capture both the personal network as the organizational network perspective so it would have made the model more interesting. Assuming that literature about organizational theory would have provided more data and information that the currently used body of literature.

However, the change of perspective would have resulted in a completely different thesis with different results and insights. Therefore, the perspective is not considered wrong, but the possibilities of other perspective must be mentioned.

9.2.2 Limitations of conceptualization

MAIA is a well-defined, easy to work with conceptualization method that offers

the researchers many different perspectives and concepts to capture the components of the problem. It is considered suitable for the type of problem and has provided guidance to bring the knowledge obtained in the literature study down to a workable conceptualization that can be formalized using Netlogo. However, in the researcher's opinion, MAIA is better suited for a larger scoped project than a master thesis because a master thesis is too short in time and resources to fully utilize the possibilities of insight that MAIA provides.

The only downside of the conceptualization of the humanitarian system as it is used in this research is that the decision to use MAIA was made in a relatively late stage of the research while another conceptualization and formalization was already partly done. The decisions made while using the other conceptualization where written down using MAIA. These earlier made decisions resulted in the fact that the possibilities provided by MAIA are not fully utilized. For example, MAIA knows institutions, norms, and shared strategies. If something is an institution, agents can still decide not to comply knowing there is a possibility they face consequences. While defining how priorities are based on the preferences of the organizations that provide resources, these structures could have approximated reality better since people and organizations tend to be opportunistic and this is not captured in the model. The model – and probably the results – would have been more interesting if MAIA was used from the beginning.

9.2.3 Limitations of scope

Modelling is an abstraction of reality. Furthermore, the model is an abstraction based on the observers view of published literature over the humanitarian sector. This knowledge raises question about how representative the model is for the system it attempts to capture. Are all the necessary parts present in the model to be able to reflect on the humanitarian sector in a generalizable way? The short answer to that question is: No, it is not. The model validation shows that many of the assumptions made are not incorrect, but too limited to be representable. Furthermore, the validation shows that the aspects that are taken into account are – again – not wrong, but that there are many more as important that are not taken into account.

This indicates that the model is scoped too tightly and that a wider scope would have resulted in much more insight. Although this is true, some things must be taken into account while this conclusion is drawn. First, there is not much literature and even less data available about humanitarian interaction. Therefore, the extension of the model would not have resulted in more generalizable results if these extensions are not backed by data. Second, the agent-based model is

already relatively large. The more aspects that are taken into account, the more complex and large the model becomes. To provide an example, the collective structure knows four factors: information security awareness, reputation, efficiency, and competition. These could have been extended with factors as access and trust to make the set of decision-making factors more complete. However, there are no relationships or data found about the influence of these factors. Therefore, these factors would have made the conceptualization more complete, but the results not more accurate while the formalization would have been more complex.

Therefore, given the limits set on the research regarding time and scope, it is believed that the right scope is used for the research. There is definitely room for improvement and with the aforementioned knowledge other decisions would probably be made, however, with the knowledge obtained during the scoping process it is believed that the right choices were made.

9.2.4 Limitations of the modelling tool

For the formalization the modelling tool Netlogo is used, mainly due to the familiarity of the researcher with this program and the fact that Netlogo is an easy to understand and easy to use modelling tool. However, one of the experienced limitations of Netlogo is the fact that it is very inflexible. One of the main reasons that this research was unable to exploit the possibilities of MAIA was the fact that a part of the model was already built in Netlogo, thereby forcing the researcher to stay in the chosen path or start over. Netlogo is not flexible enough to easily allow an incremental work method where discoveries in a later stage can still influence the structure of the model.

For further research, it is advised to look at the tool that is built for MAIA. Because it is developed for MAIA is it easier to link the model implementation to the formalization which will probably make it easier to adapt the model as well. However, the researcher's knowledge about the MAIA application is limited so it cannot be said for certain if the tool will provide more flexibility, however, it certainly must be taken into consideration.

9.2.5 Limitations of verification

The goal of verification is to make sure that the conceptual model is correctly formalized. To verify the model, eight steps are described by Nikolic, et al. (2013). These steps are followed and the important errors that where found are fixed.

Due to the fact that all four tests are conducted and provided useful insights, it is believed the the verification is done well.

9.2.6 Limitations of experimentation setup

The experimentation setup is an important step in the modelling process and has much influence on the outcomes of a research. The aim of this section is to reflect on the experimental setup and weight the consequences of the decisions made.

Out of the four possible ways to build the experimental design, the least statistical substantiated method – by the researcher selected input parameters - was used. This decision was made under great consideration and with much hesitance because it reduced the credibility of the research. However, due to the fact that the model's quantification is solely based on assumptions, the validity of the model was already questioned. Statistical valid input parameters would not have increased the validity of the model or the model outcomes, but it would have cost much time and computation power. Furthermore, in the beginning of the thesis, the decision is made to take a global perspective and to consider different (local) scenarios and situations out of scope. Therefore, building an experimental setup that is based on real-life situation and scenarios would be contradicted to that decision and influence the consistency of the thesis. The choice to select the model parameters of the experimental design is therefore considered a valid one. However, it is also considered to be one of the main limitations of the thesis.

9.2.7 Limitations of validation

There are four types of validation methods, due to the lack of data only expert validation is conducted. The model output is also validated using literature validation. However, this is considered to be part of the model output and is discussed in the next section. This section focusses how the expert validation is conducted and the added value of the expert validation. It does not focus on the choice of validation method because there was little choice since the other options were not feasible for this research. First the method of the validation is discussed, second the content, and finally the choice to validate the conceptualization instead of the model.

First, the expert validation was done via a survey instead of interviews. The decision to use a survey has implications that are both positive and negative. The positive points of the survey are that it is efficient, structured, and all the respondents

answer the same questions in the same context. Meaning that the answers can be compared and combined to draw conclusions. The efficiency is in the fact that the respondents can answer the questions in their own time and there is no need to transcribe the interview.

However, there are some negative points to the choice of a survey as well. The main disadvantage is that the respondents are asked to reflect on a uniform set of questions, meaning that most of the advantages of their experience and expertise are left unutilized. Taking into account the fact that the group of respondents entailed three scholars with different field of expertise and two people who work in the field, the validation could have provided many more insights than it already has. Furthermore, working with people means working with bias. Experts are often biased towards their own field of expertise and find it difficult to validate or agree with things that fall outside their comfort zone (Nikolic, et al., 2013). It is taken into account that their comments are routed in experience, but not necessarily the only true view on the matter.

Looking at the choice made to use a survey, it is believed to be the right one. It has provided many insights, mainly due to the enthusiasm of the respondents and the extensive answers they have provided by each question. The consequences of the use of a survey are considered, however, for the purpose of model validation these consequences are insignificant.

The insights the survey provided have definitely increased the understanding of the contexts that surrounds the humanitarian sector and have helped put the model in context as well. Due to the added value of the validation, the researcher regrets not interviewing experts during the first stages of the thesis. Literature study provided much insights, however, it is believed that the model would have been more relevant if it was complemented with interviews.

Second, the validation content. The model assumptions, the model structure, and the research method are validated. It is believed that these three topics are important to take into account during the validation process, especially if a model depends as much on assumptions as the model used in this thesis. These three validation steps have increased understanding of humanitarian interaction in a broader way than just the validation of the modelling decisions. It is believed that the choice of these three validation steps has provided the information needed to conduct a sufficient validation.

Finally, it has been decided to validate the conceptualization of the model instead of the agent-based model itself. This decision is based on the assumption that most people are not familiar with agent-based modelling and that by staying in

the experts' comfort zones, they would provide more information. It is believed that this was the right choice, however, the timing of the validation is regretted. The validation of the conceptualization would have been more valuable if was done after the conceptualization phase, so that the insights of the validation could have been incorporated in the agent-based model. It is believed that this would have increased the added value of the agent-based model.

9.2.8 Limitations of model output

Due to the assumptions that form the basis of the model, the values and outcomes of the model must not be overvalued. However, this was known before he model was build and anticipated on. Therefore, the fact that the model output cannot be used directly, was known beforehand and therefore not seen as a vulnerability of the model output.

Looking at the model output, the different policy options did not differ much. This is also an interesting finding, because it indicates that the humanitarian sector is not easily changed or moved. Furthermore, much of the model results are caused by settings or mechanisms that were not anticipated on during the building or setup phase. An extra simulation round can shine more light on how robust the model results are. However, the results are believed to be usable to draw first conclusion and construct a research agenda. Therefore, the extra simulation should not be given priority and can also done after the model is improved.

9.2.9 Limitations of societal contribution

The humanitarian sector is a different sector than most due to regulatory difficulties and the current accountability structure. Furthermore, it is a multi-billion dollar industry on which more and more people rely on every day (WFP, 2017b). Conflicts are on the rise and the number of climate-change affected refugees is growing every day (Nissen, 2017; Piguet, et al., 2011). Furthermore, more data is gathered about people in need of aid through satellite images, biometrics, surveys, social media, and many more, documenting where they are, who they are, and what their network is. Adding new insights in how the awareness of information security can be increase in the humanitarian sector holds a significant societal value due to the protection of these people. The thesis itself is too small and isolated to inspire any change, however, if the findings can contribute to other research in this topic it already holds value.

9.2.10 Limitations of scientific contribution

Although the contributions of the current research are relevant, the research started with the aim to use the overarching system perspective to outgrow the highly conceptual level that determines the current body of literature and add more concrete findings. This is mostly done by providing a list of characteristics that are hypothesized to be influential and can be taken into account during further research. However, the aim to produce concrete findings about which characteristics or policy measure are most influential and a substantiated policy advise turned out be not feasible with the available time and data and the current scope of the thesis. Therefore, this thesis stayed within the highly conceptual level that was aimed to avoid, which reduced the usability of the research.

However, taking into account that this is the first research found on this topic, it is believed that this research is a contribution to the current body of literature. However, it is believed that this research can function as the first step in research about humanitarian interactions. Recommendations for the next steps are discussed in the next chapter.

10

Further research

The aim of this chapter is to lay out a research agenda where the missing information and identified knowledge gaps are addressed and to propose research to fill these gaps. The proposed further research focusses on three areas: data gathering, model extension, and policy research. .

(Weaver & Russell, 2017)

10.1 Further research regarding data gathering

Looking at the research, two types of data where missing: data about relations in het humanitarian sector and data about information security in the humanitarian sector. For both gaps a research is proposed.

10.1.1 How do humanitarians interact?

The current research has identified over 20 characteristics that influence how humanitarians interact, with whom partnerships are sought and why. However, that is where research stops. Therefore, the first proposed research is a combination of literature research from published humanitarian journals and a large survey among humanitarians that will focus on which characteristics do influence their choices of cooperation and why. The aim of the research will be to find a qualitative answer to which characteristics influence humanitarian interactions and how.

During the research, some distinctions must be made to make sure the data is usable and mistakes made in the current research are not repeated. First, different scenarios and situations must be taken into account. Working with boat refugees who just arrived in Greece is different than working in a large long-term refugee Kamp. Furthermore, there is a difference between working locally providing help, working locally to gain resources, or working internationally to influence agenda setting. All these differences must be distinguished in a survey and literature study.

10.1.2 What is the current state of information security in the humanitarian sector

This part of the recommendations of further research focusses on information security in the humanitarian sector. The current body of literature is does not cover the current state of information security implementation in the different humanitarian organizations. No research has been found about what information security means for organizations, what their rules are, how they are implemented, the budgets that are available, or wat their strategies are for both the social and technical aspect of information security. The aim of this research is to quantify the current state of information security in the sector.

During the research, two levels must be covered to provide a clear picture of the current state of information security. The first level that is recommended to study is the CISO level. It is recommended to conduct a range of interviews with CISO or the people responsible for information security of different humanitarian organizations on both local and international level. This will provide insight in the strategy, the priority, and the desired implementation of information security. The second level to study is the awareness on the ground. Hereby, the focus of study are the people who work with data to provide humanitarian assistance. What are the protocols, what kind of information security is used, and under what considerations is data shared or accesses provided? Due to the secrecy that surrounds most security related issues and the aim to map the current state of information security in the humanitarian sector, it is recommended to base this research on interviews.

10.2 Further research focussed on extensions of current research

Looking at the current research, two extensions are proposed as further research. The first focusses on the better utilization of the possibilities provided by MAIA, which was one of the identified limitations of the current research. Second, it is recommended to conduct research on how informant security awareness is perceived on organizational level and if coordination and cooperation between organizations effectively influences information security awareness in an organization.

10.2.1 The utilization of MAIA

The research, the model process, and the validation have provided many insights on both the content and methodological level. However, due to time and scope, many of these insights were not implemented and many possibilities of the used method were not utilized. Therefore, it is recommended conduct another round of research with the aim to extend and deepen the model scope to improve the model and the insights that are part of the results.

The focus of the knowledge and model extension must lie with the constitutional and operation structures MAIA. The information can be obtained via the study of published journals of humanitarians and interviews with humanitarians who are currently working in the field. The first step will focus on the institutional structure,

looking at the roles, institutions, and dependencies in the field. Resources and information are the only components that determine dependencies in the current model, however, there are many more currently unidentified.

The second step is the focus of the action sequence of the operational structure. Currently the action sequence is focussed on building partnerships and invest in information security while these are hardly the only actions humanitarian organizations undertake. By focussing on the action sequence, a better understanding of why choices are made and behaviour occurs can be obtained. Finally, it must be noted that this research will increase insight in how humanitarian interactions takes place. However, this research and model extension will have little added value without the research proposed in section 10.1.1 (How do humanitarians interact?). Without data to support the research and modelling process, no valid conclusions can be drawn.

10.2.2 The spread of information security awareness

One of the identified limitations of the research is that the global perspective is the wrong level to be when talking about information security. Information security is more effectively studied on organizational and interactional level. Therefore, in this proposed research the system is not perceived top-down but bottom up. Determine how information security awareness can spread from personal interactions, to the different layers of the organization level, and finally to the sector level. It must look what causes information security awareness to spread, how it spreads and how this process can be positively influenced.

For this research, multiple tools can be used. However, it is recommended to combine literature study, agent-based modelling, and interviews if necessary data or knowledge is unavailable. The research can use organizational theory combined with insight form earlier agent-based modelling projects. There are many agent-based models available that focus on building networks and the spreading through networks that can be used as the foundation of the research. Furthermore, literature about the effectives of different information security awareness measures must be taken into account to safeguard the validity of the model.

10.3 Further research in humanitarian policy

The model outcomes points towards the UN umbrella organization to inspire

a rise in information's security awareness. However, the used policy options are too limited in depth and scope to be recommended as an actual policy option. Therefore, three researches are recommended to gain more insight in humanitarian policy. The first will focus on the policy in the humanitarian sector and the second will focus on the feasibility of an umbrella organization to inspire information security. Finally, the in the validation identified knowledge gap between humanitarian literature and practise regarding legislation will be discussed.

10.3.1 Humanitarian policy

This recommended research focusses on the history of policy and policy attempts in the humanitarian sector with the aim to identify why they were enacted, how they were implemented, by whom, and why they failed or succeeded. The aim of the current research is to find policies that help inspire the humanitarian sector and the policies used where sufficient for this research. However, if one wants to use these forms of incentive to inspire the humanitarian sector, one has to know what is already tried, what worked under what circumstances, and why. For this research, a literature study will suffice.

10.3.2 An umbrella organization to inspire information security in the humanitarian sector

The outcome of the current research points towards an umbrella organization that coordinates information security efforts in the humanitarian sector. Therefore, it is recommended to conduct a feasibility study of this policy options for the problem of information security. This research will know three steps.

The first step closely related to the study recommended in section 10.3.1 and focusses on the identification of the factors that made earlier attempts to initiate an umbrella organization successful or not. This can be done via a literature study. Second, these factors must be linked to the current situation regarding information security to see if the policy option is feasible. The final step is to design the umbrella organization in terms of purpose, actions, and scope, this can be done via literature study and interviews.

10.3.3 The gap between literature and practise

During the validation, the assumption regarding legislation was rejected by every expert in the panel indicating that if rules must be bent to guarantee access to people or places, they will be. However, literature, guidelines, and laws that were used to substantiate the assumption that humanitarian organisations will not cooperate with organizations or regimes that are deemed illegal or are not supported by their home government did not deviate between desired and practical implementation. The proposed research aims to find the gap between desired and practical implementation in the humanitarian sector. It focusses on if this gap exists and if so, why and how does it show.

For this research, many interviews must be conducted and compared with legislation, rules, and guidelines formulated by governments and humanitarian organizations. Different situations and different types of rules must be taken into account to see under what circumstances this difference occurs.

11. Bibliography

Abbott Fund, 2018. Our Partners - American Red Cross. [Online]
Available at: http://www.abbottfund.org/partners/64
[Accessed 08 05 2018].

Acimovic, J. & Goentzel, J., 2016. Models and metrics to assess humanitarian response capacity. Journal of Operations Management, Volume 45, pp. 11-29.

Ahmed, S. R., Amer, M. M. & Killawi, A., 2017. The ecosystems perspective in social work: Implications for culturally competent practice with American Muslims. Journal of Religion & Spirituality in Social Work: Social Thought, 36(1-2), pp. 48-72.

Al Jazeera, 2018. Rohingya 'ethnic cleansing in Myanmar continues'. Al Jazeera, 06 03.

An inconvenient truth. 2006. [Film] Directed by Al Gore. USA: Lawrence Bender Productions : 100 min.

Andrew, J. & Cortese, C., 2011. Accounting for climate change and the self-regulation of carbon disclosures. Elsevier - Accounting Forum, Volume 35, pp. 130-138.

Axelrod, R., 2006. Advancing the art of simulation in the social sciences. Handbook of Research on Nature Inspired Computing for Economy and Management, 12(3), pp. 90-100.

Bagshaw, S., 2012. What are Humanitarian Principles?, New York: OCHA.

Balcik, B. & Beamon, B. M., 2008. Facility location in humanitarian relief. International Journal of Logistics, 11(2), pp. 101-121.

Balcik, B. et al., 2010. Coordination in humanitarian relief chains: Practices, challenges and opportunities. Elsevier Int. J.Production Economics, Volume 126, pp. 22-34.

Barnett, M., 2015. Accountability and global governance: The view from paternalism. Regulation & Governance, 10(2), p. 134–148.

BBC, 2018. Why is there a war in Syria?. BBCNews, 15 03.

Beecham, S. et al., 2005. Using an expert panel to validate a requirements process improvement model. The Journal of Systems and Software, Volume 76, pp. 251 - 275.

Behl, A. & Dutta, P., 2018. Humanitarian supply chain management: a thematic literature review and future directions of research. Annals of Operations Research, 19 March.p. 44.

Belliveau, J., 2016. Humanitarian access and technology: opportunities and applications. Humanitarian Technology: Science, Systems and Global Impac, Volume 159, pp. 300-306.

Bergen, A., 2014. List of resources and process suggestions to help NGOs deal with data requests from researchers, Ottawa, Ontario: Community First: Impacts of Community Engagement.

Bonabeau, E., 2002. Agent-based modeling: methods and techniques for simulating human systems.. Proceedings of the national academy of sciences, Volume 99, p. 7280–7287.

Boonmee, C., Arimura, M. & Asada, T., 2017. Facility location optimization model for emergency humanitarian logistics. International Journal of Disaster Risk Reduction, Volume 24, pp. 485-498.

Bulgurcu, B., Cavusoglu, H. & Benbasat, I., 2010. Information security policy compliance: an empirical study of rationality-based beliefs and information security awareness. MIS Quarterly, 34(3), pp. 523-548.

Cambridge Dictionary, 2018. conflict. [Online]
Available at: https://dictionary.cambridge.org/dictionary/english/conflict
[Accessed 11 04 2018].

Carson, J., 1986. Convincing users of models validity is challenging aspect of modellers job. Industrial Engineering, 18(6), pp. 74-86.

Chen, D. & Zhao, H., 2012. Data Security and Privacy Protection Issues in Cloud Computing. Shenyang, International Conference on Computer Science and Electronics Engineering.

Clarke, P. & Ramalingam, B., 2018. Organisational change in the humanitarian sector. In: ALNAP Review of Humanitarian Action. London: ALNAP, pp. 21-82.

Cochrane, P., 2017. Accounting for NGOs in conflict areas. International edition of Accounting and Business magazine, October.

Cormier, D. & Magnan, M., 1999. Corporate Environmental Disclosure Strategies: Determinants, Costs and Benefits.. Journal of Accounting, Auditing and Finance,, 14(4), pp. 429-454.

Crawford, J., 2012. Brownlie's Principles of Public International Law. Oxford University Press, Volume 8, p. 488.

de Bruin, R. & Solms, S. H. v., 2017. Humanitarian Perspective of Cybersecurity and Cybersecurity Governance. Johannesburg, IIMC International Information Management Corporation.

Development Initiatives, 2017. global humanitarian assistance report 2017, Bristol: Development Initiatives.

DHnetwork, 2018. Andrej Verity. [Online]
Available at: http://digitalhumanitarians.com/team/andrej-verity
[Accessed 29 08 2018].

Donnelly, J., 1993. Human Rights, Humanitarian Crisis, and Humanitarian Intervention. International Journal, Volume 4, pp. 607-640.

Duffield, 2013. Disaster-Resilience in the Network Age Access-Denial and the Rise of Cyber-Humanitarianism. DIIS Working Paper, Issue 23, p. 32.

Edmonds, B. & Moss, S., 2004. From KISS to KIDS - An 'anti-simplistic' modelling approach. In: Multi-Agent and Multi-Agent-Based Simulation. New York: Springer Berlin Heidelberg, pp. 130-144.

Eisinger, P., 2002. Organizational capacity and organizational effectiveness among street-level foodassistance programs. Nonprofit and Voluntary Sector Quarterly, 15(1), pp. 115-130.

Engine Room, T., 2016. The hand-book of the modenr development specialist. First ed. s.l.:Responsible Data Forum.

Eramus University, 2018. (Dr.Shyamika Smits) S.M.S. Jayasundara. [Online]
Available at: https://www.eur.nl/people/dr-shyamika-smits-jayasundara
[Accessed 29 08 2018].

Erasmus University, 2018. dr. (Helen) H.M. Hintjens. [Online]
Available at: https://www.eur.nl/people/helen-hintjens
[Accessed 29 08 2018].

EU, 2017. Recital 112 EU GDPR. [Online]
Available at: https://www.privacy-regulation.eu/en/r112.htm
[Accessed 2018 04 2018].

European Comission, 2018. Ship recycling. [Online]
Available at: http://ec.europa.eu/environment/waste/ships/
[Accessed 23 04 2018].

European Parliament, 2016. EUR-Lex - 32016R0679 - EN. [Online]
Available at: http://eur-lex.europa.eu/legal-content/EN/
TXT/?uri=CELEX:32016R0679
[Accessed 24 04 2018].

Fadiyaa, S. O., Saydamb, S. & Zirac, V. V., 2014. Advancing big data for humanitarian needs. Elsevier, pp. 88-95.

Fast, L., 2017. Diverging Data: Exploring the Epistemologies of Data Collection and Use among Those Working on and in Conflict. International Peacekeeping, 24(5), pp. 706-732.

Fishstein, P. & Wilder, A., 2012. Winning Hearts and Minds? Examining the Relationship between Aid and Security in Afghanistan, Somerville: Feinstein International Center | Tufts University.

Fleck, D., 2013. The legal status of personnel involved in United Nations peace operations. International Review of the Red Cross, 95(Multinational operations and the law), pp. 613 - 636.

Franke, U. & Brynielsson, J., 2014. Cyber situational awareness e A systematic review of the literature. Elsevier - Computers & Security, Volume 46, pp. 18-31.

Gatewood, J. C., 2014. District of Columbia Jones and the Mosaic Theory - In Search of a Public Right of Privacy: The Equilibrium Effect of the Mosaic Theory. Nebraska Law Review, 92(3), pp. 504 - 536.

Ghorbani, A., 2013. Structuring Socio-technical Complexity: Modelling Agent Systems using Institutional Analysis, Delft: Technische Universiteit Delft.

Ghorbani, A., Bots, P., Dignum, V. & Dijkema, G., 2013. MAIA: a Framework for Developing Agent-Based Social Simulations. Journal of Artificial Societies and Social Simulation, 16(2), p. 9.

Gilman, D., Llorente, R. V. & Wall, I., 2014. Cyber-Warfare and Humanitarian Space, London: European Interagency Security Forum.

Goodhand, J., 2000. Research in conflict zones: ethics and accountability. Forced Migration, August, Volume 8, p. 4.

Greenleaf, G., 2017. Countries with Data Privacy Laws – By Year 1973-2016 (Tables) (2017). 146 Privacy Laws & Business International Report, 2 April, Volume 18, p. 2.

GSMA, 2013. Towards a Code of Conduct: Guidelines for the Use of SMS in Natural Disasters, London: GSMA - Mobile for Humanitarian Innovation .

Habekuß, F. & Schmitt, S., 2015. Why do you need a mobile phone?. [Online] [Accessed 11 09 2018].

Habib, M. S., Lee, Y. H. & Memon, M. S., 2016. Mathematical models in humanitarian supply chain management: A systematic literature review. Mathematical Problems in Engineering, p. 20.

Hansen, L. & Nissenbaum, H., 2009. Digital Disaster, Cyber Security, and the Copenhagen School. International Studies Quarterly, Volume 53, pp. 1155-1175.

Harris, M., 2016. Aid Groups Say Refugees Need Internet as Much as Food. [Online] Available at: https://greece.greekreporter.com/2016/07/22/aid-groups-say-refugees-need-internet-as-much-as-food/
[Accessed 10 09 2018].

Harvey, P., 2009. HPG Policy Brief 37: Towards good Humanitarian Government, London: Humanitarian Policy Group.

Hassan, S., Antunes, L., Pavon, J. & Gilbert, N., 2008. Stepping on Earth: A Roadmap for Data-driven Agent-Based Modelling. In Proceedings of the 5th conference of the european social simulation association (essa08), pp. 1-12.

Haverkamp, C., 2010. NGOs and the Role of the State in Humanitarian Aid, Cambridge: Harvard humanitarian Initiative | Humanitarian Academy at Harvard.

Herta, P. & Papakonstantinou, V., 2014. The Council of Europe Data Protection

Convention reform: Analysis of the new text and critical comment on its global ambition. Computer Law & Security Review, 30(6), pp. 633-642.

ICRC, 2016. The ICRC and data protection. [Online]
Available at: https://www.icrc.org/en/document/data-protection
[Accessed 12 04 2018].

ICRC, 2018. The seven Fundamental Principles. [Online]
Available at: http://www.ifrc.org/en/who-we-are/vision-and-mission/the-seven-fundamental-principles/
[Accessed 23 04 2018].

IEEE, 2016. How to start with Humanitarian Activity. [Online]
Available at: https://www.syp-regensburg.de/ws-slides/SIGHT_workshop.pdf
[Accessed 11 09 2018].

IFRC, 2013. World Disasters Report Focus on technology and the future of humanitarian action, Geneva: International Federation of Red Cross and Red Crescent Societies.

Ismailova, R. & Muhametjanova, G., 2016. Cyber crime risk awareness in Kyrgyz Republic. Information Security Journal: A Global Perspective, 25(1-3), pp. 32-38.

ISO/IEC, 2012. ISO/IEC 27007: information technology - security techniques - guidelines for cybersecurity, Geneva, Switzerland: ISO/IEC; 2012.

ITU, 2017. Definition of cybersecurity. [Online]
Available at: https://www.itu.int/en/ITU-T/studygroups/2013-2016/17/Pages/cybersecurity.aspx
[Accessed 04 04 2018].

Jacobsen, K. L., Sandvik, K. B. & McDonald, S. M., 2017. Do no harm: A taxonomy of the challenges of humanitarian experimentation. International Review of the Red Cross, p. 26.

Kabra, G. & Ramesh, A., 2015a. Analyzing ICT Issues in Humanitarian Supply Chain Management: A SAP-LAP Linkages Framework. Global Journal of Flexible Systems Management, 16(2), p. 157–171.

Kabra, G. & Ramesh, A., 2015b. Segmenting critical factors for enhancing the use of IT in humanitarian supply chain management. Social and Behavioral Sciences, Volume 189, p. 144 – 152.

Kabra, G. & Ramesh, A., 2016. Information Technology, Mutual Trust, Flexibility, Agility,Adaptability: Understanding Their Linkages and Impacton Humanitarian Supply Chain Management Performance. Risk, Hazards & Crisis in Public Policy, 7(2), pp. 79-103.

Kabra, G., Ramesh, A., Akhtar, P. & Dash, M. K., 2017. Understanding behavioural intention to use information technology: Insights from humanitarian practitioners. Telematics and Informatics, Volume 34, pp. 1250-1261.

Kabra, G., Ramesh, A. & Arshinder, K., 2015. Identification and prioritization of coordination barriers in humanitarian supply chain management. International Journal of Disaster Risk Reduction, Volume 13, p. 128–138.

Kemp, R. B., 2008. Humanitarian relief standards as information policy. Proceedings of the Association for Information Science and Technology, 44(1), p. 11.

Kemp, S., 2017. Digital in 2017. [Online]
Available at: https://wearesocial.com/special-reports/digital-in-2017-global-overview
[Accessed 20 03 2018].

Kent, R. C., 2004. The United Nations' humanitarian pillar: refocusing the UN's disaster and emergency roles and responsibilities. Disasters, 28(2), pp. 216-233.

Knapp, K. J., Morris, R. F., Marshall, T. E. & Byrd, T. A., 2009. Information security policy: An organizational-level process model. Computers & Security, 28(7), pp. 493-508.

Kotenko, I., 2007. Multi-agent Modelling and Simulation of Cyber-Attacks and Cyber-Defense for Homeland Security. Dortmund, Germany, IEEE Xplore.

Kundur, D. et al., 2011. Towards modelling the impact of cyber attacks on a smart grid. International Journal of Security and Networks, 6(1), p. 2–13.

Kuner, C., 2018. International Organizations and the EU General Data Protection Regulation. Legal Studies Research Paper Series, Volume 20, p. 33.

Kwakkel, J. H. & Pruyt, E., 2013. xploratory Modeling and Analysis, an approach for model-based foresight under deep uncertainty. Technological Forecasting and Social Change, 80(3), pp. 419-431.

Leiras, A. d. B. I., Queiroz Peres, E., Rejane Bertazzo, T. & Tsugunobu Yoshida

Yoshizaki, H., 2014. Literature review of humanitarian logistics research: Trends and challenges. Journal of Humanitarian Logistics and Supply Chain Managemen, 4(1), pp. 95-130.

Le, N. T. & Hoang, D. B., 2016. Can maturity models support cyber security?. Las Vegas, NV, USA, IEEE.

LinkedIn, 2018. Nontas Papadimitriou. [Online]
Available at: https://www.linkedin.com/in/npapadimitriou/
[Accessed 29 08 2018].

Lloyd, R., 2005. The Role of NGO Self-Regulation in Increasing Stakeholder Accountability, London: One World Trust.

Lutz, A. et al., 2017. Data Protection, Privacy and Security for Humanitarian & Development Programs, Federal Way, Washington: World Vision.

Manzo, G., 2014. The Potential and Limitations of Agent-based Simulation. Revue française de sociologie, Volume 55, pp. 653 - 688.

Marsi, F., 2015. Lebanon lacks data protection laws. Pressreader, 15 Aug, p. 3.
McCrohan, K. F., Engel, K. & Harvey, J. W., 2010. Influence of Awareness and Training on Cyber Security. Journal of Internet Commerce, 9(1), pp. 23-41.

McCrohan, K. F., Engel, K. & Harvey, J. W., 2010. Influence of Awareness and Training on Cyber Security. Journal of Internet Commerce, 9(1), pp. 23-41.

Mcginnis, M. D., 2011. An Introduction to IAD and the Language of the Ostrom Workshop: A Simple Guide to a Complex Framework. Policy Studies Journal, 39(1), pp. 169-183.

Meier, P., 2015. Chapter 1 and 2. In: Digital Humanitarians. Boca Raton: CRC Press, pp. 1 - 46 .

Miliband, D. & Gurumurthy, R., 2018. Improving Humanitarian Aid - How to Make Relief More Efficient and Effective. [Online]
Available at: https://www.foreignaffairs.com/articles/2015-06-16/improving-humanitarian-aid
[Accessed 31 08 2018].

Miraftab, F., 2004. Public-Private Partnerships The Trojan Horse of Neoliberal Development?. Journal of Planning Education and Research, 24(1), pp. 89-101.

Mitchell, J. & Doane, D., 2002. An Ombudsman for Humanitarian Assistance?. Disasters, 23(2), pp. 115-124.

Mitnick, K. & Simon, W., 2002. The art of deception: controlling the human element of security. first edition ed. s.l.:Wiley Publishing.

Muhametjanova, R. I. &. G., 2016. Cyber crime risk awareness in Kyrgyz Republic. Information Security Journal: A Global Perspective, 25(1-3), pp. 32-38.

Naglič, M., 2016. Begunci in odpadki. [Online]
Available at: http://arhiv.gorenjskiglas.si/article/20160110/C/160119997/begunci-in-odpadki
[Accessed 11 09 2018].

Nikolic, I., Dam, K. v. & Lukszo, Z., 2013. Agent-Based Modelling of Socio-Technical System. 9 ed. Dordrecht: Springer.

Nikolic, I. & Kasmire, J., 2013. Theory. In: Agent-based modelling of socio-technical systems. Dordrecht:: Springer Science & Business Media., p. 11–68.

Nikolic, I., van Dam, K. H. & & Kasmire, J., 2013. Practice. In: Agent-based modelling of socio-technical systems. 9th ed ed. Dordrecht: Springer Science & Business Media, p. 73–135.

Nikolic, I., van Dam, K. H. & Lukszo, Z., 2013. Setp 6: Model Verification. In: Agent-Based MOdelling of Socio-Technical Systems. Dordrecht: Springer Science + Business, pp. 98-104.

Nissen, L. P., 2017. CRISIS OVERVIEW 2016 - humanitarian trends and risks for 2017. acaps.

Nunnenkamp, P. & Öhler, H., 2012. Funding, Competition and the Efficiency of NGOs: An Empirical Analysis of Non-charitable Expenditure of US NGOs Engaged in Foreign Aid. Kyklos International Review for Social Sciences, 65(1), pp. 81-110.

OCHA, 2012. Huanitarianism in the Nework Age, s.l.: United Nations Office for the Coordination of Humanitarian Affairs - OCHA Policy and Studies Series.

OCHA, 2014. Humanitarianism in the Age of Cyber-warfare: Towards the Principled and Secure Use of Information in Humanitarian Emergencies, New York: OCHA Policy Development and Studies Branch .

OCHA, 2015. Fit for the Future Series - An end in sight: Multi-year planning to meet and reduce humanitarian needs in protracted crises, Geneve: OCHA Policy Development and Studies Branch (PDSB).

OCHA, 2016. Building data responsibility into humanitarian action, Geneve: OCHA Policy Development and Studies Branch.

OCHA, U., 2018. Humanitarian Networks and Partnerships Week (HNPW). [Online]
Available at: https://www.unocha.org/humanitarian-networks-and-partnerships-week-hnpw
[Accessed 20 07 2018].

Oloruntoba, R. & Gray, R., 2006. Humanitarian aid: An agile supply chain?. Supply Chain Management: An International Journal, 11(2), pp. 115-120.

Ostrom, E., 2005. Understanding institutional diversity. first edition ed. New Jersey: Princeton University Press.

Ostrom, E., 2010. Beyond Markets and States: Polycentric Governance of Complex Economic Systems. AMERICAN ECONOMIC REVIEW, 100(3), pp. 641-72.

OXFAM, 2015. Responsible Program Data Policy, Brussel: OXFAM Policy & Practice.
Oxford dictionary, 2018. Prevention/protection. [Online]

Available at: https://en.oxforddictionaries.com/definition/prevention/protection
[Accessed 04 04 2018].

Parker, B., 2018a. EXCLUSIVE: Audit exposes UN food agency's poor data-handling. IRIN - The inside story on emergencies, 18 Jan.

Parker, B., 2018b. Aid agencies rethink personal data as new EU rules loom. IRIN, 18 01.

Parsons, C., 2015. A Drone by Any Other Name.... [Online]
Available at: http://relentless.tv/a-drone-by-any-other-name/
[Accessed 11 09 2018].

Parsons, K. et al., 2017. The Human Aspects of Information Security Questionnaire (HAIS-Q): Two further validation studies. Computers & Security, 66(1), pp. 40-51.

Pearce, J., 2017. Volunteer Handbook - Phone Credit for Refugees and Displaced People, s.l.: Phone Credit for Refugees.

Peffers, K., Tuunanen, T., Rothenberger, M. A. & Chatterjee, S., 2007. A Design Science Research Methodology for Information Systems Research.. Journal of Management Information Systems, 24(3), pp. 45-77.

Petersen, M. J., 2010. International Religious NGOs at The United Nations: A Study of a Group of Religious Organizations. The Journal of Humanitarian Assistance, 17 November.

Pidd, M. et al., 2010. Discrete-event simulation is dead, long live agent-based simulation!. Journal of Simulation, 4(3), p. 204–210.

Piguet, E., Pécoud, A. & Guchteneire, P. d., 2011. Migration and Climate Change: An Overview. Refugee Survey Quarterly, 30(3), pp. 1-23.

Pouchard, L., 2015. Revisiting the Data Lifecycle with Big Data Curation. International Journal of Digital Curation, 10(2), pp. 176-192.

Read, R., Taithe, B. & Ginty, R. M., 2016. Data hubris? Humanitarian information systems and the mirage of technology. Third World Quarterly, 37(8), pp. 1314-1331.

Robinson, S., 1997. Simulation model verification and validation: increasing the users confidence. Birmingham, Proceedings of the 1997 Winter Simulation Conference.

Rossi, B., 2015. Data revolution: the gold rush of the 21st century. [Online]
Available at: http://www.information-age.com/data-revolution-gold-rush-21st-century-2-123460039/
[Accessed 30 05 2018].

Ross, K. J., Hopkinson, K. M. & Pachter, M., 2013. Using a Distributed Agent-Based Communication Enabled Special Protection System to Enhance Smart Grid Security. IEEE Transactions on Smart Grid, 4(2), pp. 1216 - 1224.

Rotterdam School of managment, 2018. Dr Samer Abdelnour. [Online]
Available at: https://www.rsm.nl/people/samer-abdelnour/
[Accessed 29 08 2018].

Ryan, A. J., 2008. What is a Systems Approach?. s.l., arXiv:0809.1698v1 [nlin.AO].
Safa, N. S., Solms, R. V. & Furnell, S., 2016. Information security policy compliance model in organizations. computers & security, 56(1), pp. 70-82.

Sandvik, K. B., 2016. The humanitarian cyberspace: shrinking space or an expanding

frontier?. Third World Quarterly, 37(1), pp. 17-32.

Sandvik, K. B. & Raymond, N. A., 2017. Beyond the Protective Effect: Towards a Theory of Harm for Information Communication Technologies in Mass Atrocity Response. Genocide Studies and Prevention: An International Journal, 11(1), pp. 9-24.

Schenkenberg van Mierop, E., 2016. Coming clean on neutrality and independence: The need to assess the application of humanitarian principles. International Review of the Red Cross, 97((897/898), p. 295–318.

Scott, W. R., 2008. Approaching adulthood: the maturing of institutional theory. Theory and Society, October, Volume 37, p. 427–442.

Siponen, M. T., 2000. A conceptual foundation for organizational information security awareness. Information Management & Computer Security, 8(1), pp. 31-41.

Skopik, F., Settanni, G. & & Fiedler, R., 2016. A problem shared is a problem halved: A survey on the dimensions of collective cyber defense through security information sharing.. Computers & Security, Volume 60, pp. 154-176.

Slawson, N., 2018. Oxfam government funding cut off after Haiti scandal. The Guardian, 16 Feb.

Solms, R. v. & Niekerk, J. v., 2013. From information security to cyber security. Elsevier Computer & Security, October, Volume 38, pp. 97-102.

Stephenson, M. & Schnitzer, M. H., 2006. Interorganizational trust, boundary spanning, and humanitarian relief coordination. Nonprofit Management and Leadership, 17(2), pp. 211-232.

Stoddard, A., Poole, L., Taylor, G. & Willitts-King, B., 2017. Efficiency and Inefficiency in Humanitarian Financing, s.l.: Humanitarian outcomes.

Strand, H. & Dahl, M., 2010. Paper commissioned for the EFA Global Monitoring Report 2011, The hidden crisis: Armed conflict, s.l.: UNESCO.

Suarez, D. & Marshall, J. H., 2014. Capacity in the NGO Sector: Results from a National Survey in Cambodia. Voluntas, 25(1), pp. 176-200.

The Guardian, 2017. Secret aid worker: we don't take data protection of vulnerable people seriously. The Guardian, 13 Jun.

Thomas, A. & Fritz, L., 2006. isasterrelief Inc.. HarvardBusinessReview, Volume November, pp. 114-122.

Uddin, M., 2017. GDPR – The Data Subject , Citizen or Resident?. Cyber Council, 29 01.

Ülkü, M. A., Bell, K. M. & Wilson, S. G., 2015. Modeling the impact of donor behavior on humanitarian aid operations. Download PDF, 230(1), pp. 153-168.

UN, 2018a. Funds, Programmes, Specialized Agencies and Others. [Online]
Available at: http://www.un.org/en/sections/about-un/funds-programmes-specialized-agencies-and-others/
[Accessed 11 04 2018].

UN, 2018b. United Nations. [Online]
Available at: http://www.un.org/en/index.html
[Accessed 12 04 2018].

UNDR, 2017. Data Privacy, Ethics And Protection: Guidance Note On Big Data For Achievement Of the 2030 Agenda, New York: UNGlobalPulse.

UNHCR, 2011. Bokolmanyo Detail Refugee Camp Map - 24 August. [Online]
Available at: https://data2.unhcr.org/en/documents/details/30948
[Accessed 11 09 2018].

UNHCR, 2018. Dadaab Refugee Complex. [Online]
Available at: http://www.unhcr.org/ke/dadaab-refugee-complex
[Accessed 10 09 2018].

UNICEF, 2016. How These Game-Changers Are Responding to the Current Refugees Crisis. [Online]
Available at: http://unicefstories.org/2016/02/05/how-these-game-changers-are-responding-to-the-current-refugees-crisis/
[Accessed 11 09 2018].

Wakolbinger, T., Fabian, F. & Kettinger, W. J., 2013. IT-enabled Interorganizational Information Sharing Under Co-opetition in Disasters: A Game Theoretic Framework. Communications of the Association for Information Systems, 33(1), pp. 67-80.

Weaver, N. & Russell, C., 2017. Our Failure of Imagination Over Refugee Livelihoods. [Online]

Available at: https://www.newsdeeply.com/refugees/community/2017/08/17/our-failure-of-imagination-over-refugee-livelihoods
[Accessed 11 09 2018].

Wennmann, A., 2011. Economic dimensions of armed groups: profiling the financing, costs, and agendas and their implications for mediated engagements. International Review of the Red Cross, 93(882).

Werman, M. & Desmukh, F., 2012. Ban on Cell Phone Use in Pakistan. [Online]
Available at: https://www.pri.org/stories/2012-12-31/ban-cell-phone-use-pakistan
[Accessed 23 04 2018].

Werth, C., 2013. Where should old cargo ships go to die? Some Europeans say bring them home. [Online]
Available at: https://www.pri.org/stories/2013-10-21/where-should-old-cargo-ships-go-die-some-europeans-say-bring-them-home
[Accessed 23 04 2018].

WFP, 2017a. Conducting Mobile Surveys Responsibly- A Field Book for WFP Staff, Rome: United Nations World Food Programme.

WFP, 2017b. Internal Audit of Beneficiary Management, Geneve: Office of the Inspector General | Office of Internal Audit.

Whitman, M. & Mattord, H., 2009. Principles of information security. 3rd ed. s.l.:Thompson Course Technology.

Appendix

Appendix A. MAIA: A detailed description

MAIA includes five steps that are considered necessary to decompose and capture systems that are dependent social processes. The five steps are:
·   The collective structure – actors and their attributes
·   Constitutional structure – the social context
·   Physical structure – the physical aspects of the system
·   Operational structure – dynamics and interactions
·   Evaluative structure – the performance indicators that are used to validate and measure the systems outcome

Figure 11 1provides a visualization of the five steps and how these steps follow the IAD framework. The next sections will explain each step and in a detailed level and discuss all the components of each step.
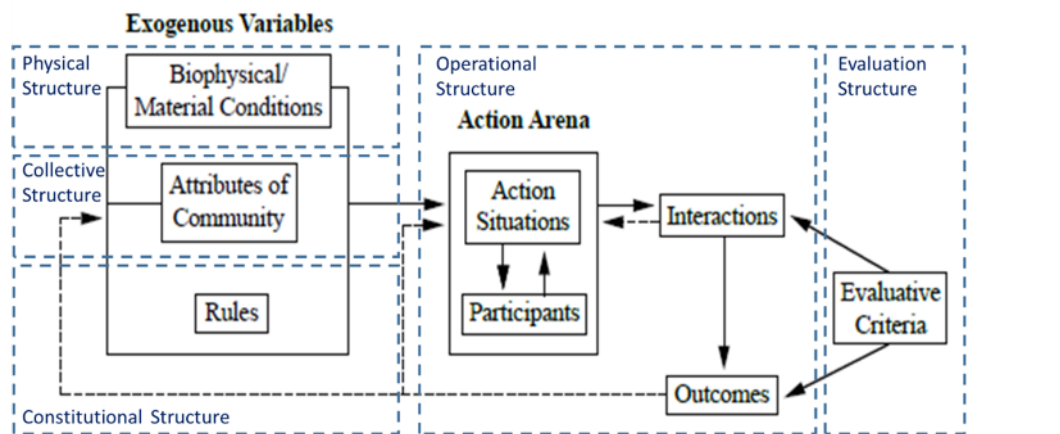
Figure 11 1: A visualization of how the MAIA components follow the IAD framework

Due to the fact that not all MAIA's functions are used, the structure described in this chapter can deviate from the MAIA toolkit as described by Ghorbani, et al. (2013) or the MAIA conceptualization as designed by Ghorbani (2013). These deviations are small and function as a simplification because some extra steps are deemed too in-depth or not applicable to the current case study. For example, the constitutional structure knows four components: roles, institutions, groups, and dependencies. However, groups are not part of the conceptualization of the model and will therefore not be explained in the paragraph that explains the constitutional structure.

Appendix A1: The collective structure

The first step of using MAIA to decompose and understand a system is starting

at its core: the collective structure or the systems agents. Agents can represent any entity that can make decisions about how to behave. Dependent on the level of aggregation, agents can be individuals, groups of people, or companies. For example, when looking at families, agents can be mothers, fathers, children, grandparents and so forth. However, when modelling a neighbourhood or a village, agents can represent families without the need to specify which roles are actually present in these families or how many people are considered part of it. This visualizes the importance of the very first step when using MAIA, deciding on the agents and the level of analysis.

However, naming the agents s not enough to complete this. Agents need to be decomposed to define them and distinguish them from other agents. Agents have the following list of things that helps the researchers to define and shape them:

· Properties: Properties are characteristics, concepts, and variables that are attributed to an agent. For example, Chapter 3 describes how the culture of (I)NGOs partly determine how well they cooperate. Thereby, culture can be considered a property of an (I)NGO. Properties can have a given value or can be variable considering outcomes of the Action Arena.

· Personal values: Personal values symbolises the goals and intentions of agents. Agents can – for example- aim for money or status and will make decisions based on how it believes to reach this goal.

· Belongings: belongings symbolize the ownership of the systems physical components. This can be money, but in the case of a family they might own a house or a car.

· Information: information represents the information that is available for agents. This can be the price of products or property values of other agents.

· Type: Agents can be considered to be two types. They are either institutional or external agents. Institutional agents are agents who influence and are influenced by the system. External agents are considered the environment of the system, meaning that they influence behaviour in the system but are not influenced by it.

· Intrinsic behaviour: This is behaviour that the agents will show regardless of the role it obtained.

· Decision making behaviour: This represents the foundation on which the agent's decisions are based. When decomposing a system, the decision-making behaviour will be a whole set of possible "If this, then that" situations.

Appendix A2: The Constitutional structure

Agents are part of a society, where they can act differently in different interactions and situations. Looking back at Figure 4 2, one sees that the Constitutional Structure of MAIA lies over the Rules of the IAD framework, meaning that the Constitutional Structure dictates the (formal) institutions in the framework. This part of MAIA consists of three steps to enable the researcher to formalize the institutions, the roles, and the dependencies of the interactions between actors.

·   Roles: Agents can take up different roles when confronted with different action situations and behave differently according to the rules that fit the current role. Taking the example of family, a woman can be -among other roles - a mother, sister, and daughter. Neither one of these roles excludes the other, but every role requires different behaviour. Roles in their turn have an objective (a reason why this role is adopted), information, an institution, and an entry condition. Looking at the mother example, a mother wants to care for her child (objective), therefore she needs to know what care entails and who her child is (information), there are some rules that determine behaviour she can follow according to her insight (institutions), and she needs a child as entry condition to take up the role of mother.

·   Institutions: institutions are the rules that determine behaviour of agents and are one of the core ingredients of MAIA and/or the IAD framework. Institutions therefore have different characteristics to enable the researcher to define them as accurate as possible:

o   Attributes: Attributes are the roles that follow this institution.

o   Deontic Type: There are three deontic types: Rules, Norms, and Shared strategies. Rules have an "Or Else" condition, meaning that there are consequences if they are not followed. Norms can have a consequence, but it is not always clear or defined what it is. It might be societies reaction or a loss of face. Finally, Shared strategies don't entail an obligation to be followed, but are followed anyway.

o   Aim: The aim describes the action that is – on the one hand- performed when following this institution and - on the other hand- describes the goal of the institution. It provides the reason why a specific action is undertaken.

o   Condition: The conditions provides the condition for every institution. Some actions can only be performed if other actions are already done of some threshold values are reached.

o   Or Else: The Or Else statement refers to the consequences that are attached if the rules are not followed. The Or Else statement does not need to be present if it regards a Norm or Shared strategy.

·   Dependency: Agents are often dependent on others if they want to reach their objectives or want to take up a certain role. By formalizing these dependencies, the researcher shows the embeddedness of the agents and shows

how they fit in the (social) structure of the system.

Appendix A3: The Physical structure

The physical structure represents the physical world in which the community is embedded and plays an important role in the system. It represents the flow of goods, money, resources, and products through the system. As with agents, naming the physical components is not enough since they have properties, a type, and behaviour as well:

· Properties: Properties are characteristics, concepts, and variables that are attributed to a physical component.

· Type: physical components are open or fenced. Fenced components are restricted and only available for those with permission. Open components do not hold these restrictions and are available to any agent in the system.

· Behaviour: as wit agents, physical components can show behaviour, although this is in general less complex and more a fluctuation of property values.

Appendix A4: The Operational structure

The Operational structure describes the dynamics of the Action Arena. It is a way to describe all the actions that can take place in the arena every time step of a simulation. It is important to note that in the operational structure, there is -apart from the action name - nothing new added to the system. It uses the earlier defined components to formulate which actors undertake which (inter)actions, why, and how. The operational structure exists of a range of Action situations that can be described by five components:

· Roles: The roles show the agents that are involved specified by the roles they obtained for that particular action situation.

· Action: The actions describe the chain of events that happens during this Action situation and by whom they are performed.

· Costs and Benefits: Actions have consequences that can be both positive and negative. These are part of the Actions situation and must be described.

· Physical components: Physical components are often flows of goods, materials, or money that are transferred through the system. This transfer is an action and therefore, the physical components that are part of an Action situation and cannot be forgotten.

· Institutions: Some roles or physical transfers require institutions to be followed and therefor they must be described.

Appendix B. MAIA: conceptualization

This appendix describes the tables that are part of conceptualization using MAIA. The paragraphs follow the structure of MAIA as used in Chapter 5.
Appendix B1: Collective structure
In this section, the collective structures for the Donors, INGOs, NGOs, and market forces are displayed. Table 11 1 shows the components selected for Donors, Table 11 2 for INGOs, Table 11 3 for NGOs and Table 11 4 shows how new INGOs and NGOs are founded via market forces.

Table 11 1: The collective structure for the Donors

Donor definitions	Components
Properties	Culture Legislation Earmarked (or not) If earmarked, preferences Looking for partners Number of partnerships that can be maintained.
Values	Provide resources to humanitarian organizations Facilitate aid to people in need
Information	Reputation of others Information security awareness of others Efficiency of others Culture of others Legislation of others
Physical structure	Resources
Type	Institutional
Roles	Provider Inspirer
Intrinsic capabilities	Able to calculate which INGOs are sufficient partners and who are not
Decision-making behaviour	14% of donors provide unearmarked donations 80% of the 86% remainder donors values efficiency partnerships if earmarked → reputation < current-partner-factor * average reputation End partnership if priority is efficiency → efficiency < current-partner-factor * average efficiency End partnership if priority is information security → information security awareness < current-partner-factor * average information security awareness Only select INGOs with same legislation and culture if earmarked → select INGO with reputation > new-partner-factor * average reputation if priority is efficiency → select INGO with reputation > new-partner-factor * average efficiency if priority is information security → select INGO with reputation > new-partner-factor * average information security awareness If #current partners < #possible partners → set looking for partners 'yes'.

Table 11 2: Collective structure for the INGOs

INGO definitions	Components
Properties	Culture Legislation Reputation Information security awareness Efficiency Competition Possible-NGO-partners First priority Second priority Looking for partners Time without partners
Values	Wants to receive as much resources as possible Wants to find suitable local partners Wants to provide aid to people in need
Information	Reputation of others Information security awareness of others Efficiency of others Culture of others Legislation of others Priorities/desires of donors Number of similar INGOs
Physical structure	Resources
Type	Institutional
Roles	Provider Inspirer Receiver
Intrinsic capabilities	Able to calculate which NGOs are sufficient partners and who are not Able to decide to invest (or not) if, in what.
Decision-making behaviour	If most donors prefer efficiency → set first priority efficiency. If most donors prefer information security → set first priority information security If most donors donate unearmarked → set first priority reputation. Set second priority the second largest priority of donors. If priority is efficiency → reduce the number of wanted partner NGOs If competition > 0.7 → increase number of wanted NGOs Possible NGO partners → round (resources * efficiency) / (the amount of resources the INGO gives to NGOs + 3) * increase/decrease in partners. if priority is reputation → end partnerships with NGOs with reputation > current-partner-factor * average reputation if priority is efficiency → end partnerships with NGOs with reputation > current-partner-factor * average efficiency if priority is information security → end partnerships with NGOs with reputation > current-partner-factor * average information security awareness Only select NGOs with same legislation and culture if priority is reputation → select NGOs with reputation > new-partner-factor * average reputation if priority is efficiency → select NGOs with reputation > new-partner-factor * average efficiency

	if priority is information security → select NGOs with reputation > new-partner-factor * average information security awareness
	If NGO is partner → give resources to NGO equal to variable "Resources-to-NGO"
	If first priority is efficiency → invest 10 resources in efficiency If second priority is efficiency and efficiency < average efficiency → invest 10 resources in efficiency
	If first priority is information security → invest 10 resources in information security awareness If second priority is information security and information security < average information security → invest 10 resources in information security awareness
	If number of NGO partners < number of wanted NGO partners → set looking for partners "yes"
	If no partners for a year (12 ticks) → Default and remove yourself

Table 11 3: Collective structure for the NGOs

NGO definitions	Components
Properties	Culture Legislation Reputation Information security awareness Efficiency Competition Possible-NGO-partners First priority Second priority Time without partners
Values	Wants to receive as much resources as possible Wants to find suitable local partners Wants to provide aid to people in need
Information	Reputation of others Information security awareness of others Efficiency of others Culture of others Legislation of others Priorities/desires of donors Number of similar NGOs
Physical structure	Resources
Type	Institutional
Roles	Receiver
Intrinsic capabilities	Able to calculate which NGOs are sufficient partners and who are not Able to decide to invest (or not) if, in what.
Decision-making behaviour	If most INGO partners prefer efficiency → set first priority efficiency. If most INGO partners prefer information security → set first priority information security If most INGO partners donate unearmarked → set first priority reputation. Set second priority the second largest priority of INGO partners. If priority is efficiency → reduce the number of wanted partner NGOs If competition > 0.7 → increase number of wanted NGOs Possible NGO partners → 0.1 * round (resources * efficiency) * increase/decrease in partners. if priority is reputation → end partnerships with NGOs with reputation > current-partner-factor * average reputation if priority is efficiency → end partnerships with NGOs with reputation > current-partner-factor * average efficiency if priority is information security → end partnerships with NGOs with reputation > current-partner-factor * average information security awareness Only select NGOs with same legislation and culture if priority is reputation → select NGOs with reputation > new-partner-factor * average reputation if priority is efficiency → select NGOs with reputation > new-partner-factor * average efficiency if priority is information security → select NGOs with reputation > 0.7 * average information security awareness If NGO is partner → give resources to NGO 0.5 * variable "Resources-to-NGO"
	If first priority is efficiency → invest 10 resources in efficiency If second priority is efficiency and efficiency < average efficiency → invest 10 resources in efficiency If first priority is information security → invest 10 resources in information security awareness If second priority is information security and information security < average information security → invest 10 resources in information security awareness If no partners for a year (12 ticks) → Default and remove yourself

Table 11 4: Collective structure for the market forces in the system

Market forces definitions	Components
Properties	
Values	Create enough INGOs and NGOs to keep the system balanced
Information	#Donors that require extra INGOs in the system #INGOs that require extra NGOs in the system
Physical structure	
Type	External
Roles	Market
Intrinsic capabilities	Able to calculate if extra INGOs need to be created Able to calculate if extra NGOs need to be created
Decision-making behaviour	If there are Donors looking for new partners → create a new INGO every tick If there are INGOs looking for new partners → create a new NGO every tick

Appendix B2. Operational structure

This section shows the operational structure of the conceptualization. The operational structure consists of an elaboration of every action situation. It describes the actors, the roles, the actions, costs and benefits, the physical components involved, and the institutions determining the decisions made. There are nine action situations displayed in Table 11 5 until Table 11 14.

Table 11 5: Operational structure Donors grant resources

Operational structure Donors grant resources	
Roles	Donors: Providers INGOs: receivers
Actions	• Assessment by Donors if current partners are still suitable and end partnership if not • Find new partners based on priorities • Donate resources to INGOs equal to the received-money-per-donor variable

Costs and benefits	Donors:
	• Costs: resources
	• Benefits:
	  o (if preferred) influence in the system
	  o Implementing value: Facilitate aid to people in need
	INGOs:
	• Costs: (Partly) give up autonomy to determine priorities
	• Benefits:
	  o Resources to continue operations
	  o Closer to implementing value: provide aid to people in need

Physical components	Resources: Donor → INGO Information: INGO → Donor
institutions	Legislation Culture

Table 11 6: Operational structure Set priorities INGOs

Operational structure Set priorities INGOs	
Roles	Donors: inspirer INGOs: receiver
Actions	• Assessment by INGOs what priorities of Donors are • Set own priorities according to those
Costs and benefits	•
Physical components	Information: Donors → INGOs
Institutions	•

Table 11 7: Operational structure INGOs build partnerships

Operational structure INGOs build partnerships	
Roles	INGO: Provider NGO: receiver
Actions	• Asses if current partners are still suitable and end partnership if not • Determine number of possible connections based on available resources • Determine possible partners and connect with them • Pay partners

Costs and benefits	INGOs:
	• Costs: resources
	• Benefits:
	  o Influence in the system
	  o Closer to implementing value: provide aid to people in need
	NGOs:
	• Costs: (Partly) give up autonomy to determine priorities
	• Benefits:
	  o Resources to continue operations
	  o Closer to implementing value: provide aid to people in need

Physical components	Resources: INGOs → NGOs Information: NGOs → INGOs
institutions	Legislation Culture

Table 11 8: Operational structure investment of INGOs

Operational structure INGOs invest	
Roles	INGOs: Receiver
Actions	Invest in information security awareness/efficiency if it is the first priority.
	If information security awareness/efficiency is second priority:
	• Determine the average level of information security awareness/efficiency of similar organizations
	• If own values are below it, invest.
Costs and benefits	Costs: Resources
	Benefits: rise in information security awareness/efficiency
Physical components	Information: INGOs → INGOs
	Resources: INGOs → outside system boundaries
Institutions	•

Table 11 9: Operational structure INGOs seize to exist

Operational structure INGOs stop to exist	
Roles	INGOs: receiver
Actions	Determine if payment has been received the last year
Costs and benefits	Costs: the existence of organization
Physical components	
institutions	Need for funding

Table 11 10: Operational structure NGOs set priories

Operational structure NGOs set priorities	
Roles	INGOs: inspirer
	NGOs: receiver
Actions	• Assessment by NGOs what priorities of partner INGOs are
	• Set own priorities according to those
Costs and benefits	•
Physical components	Information: Donors → INGOs
institutions	•

Table 11 11: Operational structure NGOs build partnerships

Operational structure NGOs build partnerships	
Roles	NGO: Provider NGO: receiver
Actions	• Asses if current partners are still suitable and end partnership if not • Determine number of possible connections based on available resources • Determine possible partners and connect with them • Pay partners

Costs and benefits	NGOs:
	• Costs: resources
	• Benefits:
	  o Influence in the system
	  o Closer to implementing value: provide aid to people in need
	NGOs:
	• Costs: (Partly) give up autonomy to determine priorities
	• Benefits:
	  o Resources to continue operations
	  o Closer to implementing value: provide aid to people in need

Physical components	Resources: NGOs → NGOs Information: NGOs → NGOs
institutions	Legislation Culture

Table 11 12: Operational structure NGO investment

Operational structure NGOs invest	
Roles	NGOs: Receiver
Actions	Invest in information security awareness/efficiency if it is the first priority. If information security awareness/efficiency is second priority: • Determine the average level of information security awareness/efficiency of similar organizations • If own values are below it, invest.
Costs and benefits	Costs: Resources Benefits: rise in information security awareness/efficiency
Physical components	Information: NGOs → NGOs Resources: NGOs → outside system boundaries
institutions	•

Table 11 13: Operational structure NGOs seize to exist

Operational structure NGOs stop to exist	
Roles	NGOs: receiver
Actions	Determine if payment has been received the last year
Costs and benefits	Costs: the existence of organization
Physical components	•
institutions	Need for funding

Table 11 14: Operational structure market forces

Operational structure Market forces	
Roles	Donors: Providers INGOs: Providers

Actions	• Determine if there are Donors seeking for more partnerships
	    ○ If yes, create new INGO
	• Determine if there are INGOs seeking for more partnerships
	    ○ If yes, create new NGO

Costs and benefits	
Physical components	
Institutions	

Appendix B3: Change in decision-making criteria of policy options collective structure

The different policy options bring changes in which decisions are made and how. This section shows the MAIA tables with the change in decision making criteria of the collective structure for the different policy options and the actors involved. Table 11 15 shows the changes for the policy options quality mark, Table 11 16 shows the changes for the policy option earmarked donations, Table 11 17 for the UN umbrella organization, and Table 11 18 shows the changes for the ombudsman.

Table 11 15: Change in decision criteria for the policy option Quality Mark

Actors	(Change in) decision criteria
Global	Quality mark = "On"
Donors	If first priority information security: find INGOs with legislation = legislation of myself and Quality mark = obtained. → If nobody with Quality mark, find INGOs with legislation = legislation of myself and culture is culture of myself.
INGOs	If first priority information security: find NGOs with legislation = legislation of myself and Quality mark = obtained. → If nobody with Quality mark, find NGOs with legislation = legislation of myself and culture is culture of myself. If most possible donors value Quality mark → set first priority information security If most donors prefer efficiency → set first priority efficiency. If most donors prefer information security → set first priority information security If most donors donate unearmarked → set first priority reputation. Set second priority the second largest priority of INGO partners. If Quality mark obtained = False and information security awareness > 0.4 → set resources resources – 10 and Quality mark obtained "yes" If Quality mark obtained = On → set resources resources - 10
NGOs	If first priority information security: find NGOs with legislation = legislation of myself and Quality mark = obtained. → If nobody with Quality mark, find NGOs with legislation = legislation of myself and culture is culture of myself. If most possible INGO partners value Quality mark → set first priority information security If most INGO partners prefer efficiency → set first priority efficiency. If most INGO partners prefer information security → set first priority information security If most INGO partners prefer reputation → set first priority reputation. Set second priority the second largest priority of INGO partners. If Quality mark obtained = False and information security awareness > 0.4 → set resources resources – 10 and Quality mark obtained "yes" If Quality mark obtained = On → set resources resources - 10

Table 11 16: Change in decision criteria for the policy option Earmarked donations

Actors	(Change in) decision criteria
Donors	80% of donors prefers information security of efficiency

Table 11 17: Change in decision criteria for the policy option Umbrella organisation

Actors	(Change in) decision criteria
Global	Set UN-umbrella organisation "On"
UN	If too much (I)NGOs joined the coordination effort, remove (I)NGOs until number of joined organisations = 40. Boundaries of cooperation facilitation: If <40% of organisations are NGOs → all NGOs will leave If <40% of organisations are INGOs → all INGOs will leave If one of the three cultures is less represented than 25% → all organizations with that culture will leave. If organisations experience more than 60% competition (everyone with a degree of competition > 0.6) → they will leave The percentage of organisation that stay represent the chance that the coordination effort will be successful: Abs (final-links - starting-links / starting-links * 100) If coordination efforts are not successful → all partners decrease reputation by 5% If coordination efforts are successful → all partners increase reputation and information security awareness by 5% and decrease resources by 10.
INGOs	Every year (12 ticks) → If priority is reputation → 40% chance of joining the coordination efforts If first priority is information security → 30% chance of joining the coordination efforts If second priority is information security → 10% chance of joining the coordination efforts For every month that INGOs are part of coordination efforts → reputation and information security awareness rise with 0.5%.
NGOs	Every year (12 ticks) → If priority is reputation → 40% chance of joining the coordination efforts If first priority is information security → 30% chance of joining the coordination efforts If second priority is information security → 10% chance of joining the coordination efforts For every month that INGOs are part of coordination efforts → reputation and information security awareness rise with 0.5%.

Table 11 18:Change in decision criteria for the policy option Ombudsman

Actors	(Change in) decision criteria
Global	Set ombudsman organization "On" Every 6 ticks the ombudsman checks an (I)NGO with information security awareness < 0.3 → the chance that something is wrong is 0.5 + current information security awareness level of organisation If something is wrong → reputation of organisation is decreased by 0.1 percent
INGOs	If something is wrong with organisation and that organisation has the same culture and legislation, invest in information security: increase with 1% of information security and decrease of 10 in resources.
NGOs	If something is wrong with organisation and that organisation has the same culture and legislation, invest in information security: increase with 1% of information security and decrease of 10 in resources.

Appendix B4: Additional action situations for policy options in Operational Structure

The policy options bring extra action situations that can be dissected via the operational structure provided by MAIA. The extra action situations are discussed per policy option and shown in Table 11 19 until Table 11 26.

B4.1 Quality Mark
The following tables represent the additional action situations for the policy option quality mark.

Table 11 19: Additional action situation Donors grant resources with Quality mark

Operational structure Donors grant resources with Quality Mark	
Roles	Donors: Providers INGOs: receivers
Actions	• Asses is priority is information security awareness • Find partners based on legislation and if they have obtained the quality mark • Donate resources to INGOs equal to the received-money-per-donor variable

Costs and benefits	Donors:
	• Costs: resources
	• Benefits:
	    o (if preferred) influence in the system
	    o Implementing value: Facilitate aid to people in need
	INGOs:
	• Costs: (Partly) give up autonomy to determine priorities
	• Benefits:
	    o Resources to continue operations
	    o Closer to implementing value: provide aid to people in need

Physical components	Resources: Donor → INGO Information: INGO → Donor
institutions	Legislation

Table 11 20: Additional action situation INGOs build partnerships quality mark

Operational structure INGOs build partnerships Quality mark	
Roles	INGO: Provider NGO: receiver
Actions	• Asses is priority is information security awareness • Find partners based on legislation and if they have obtained the quality mark • possible partners and connect with them • Pay partners

Costs and benefits	INGOs:
	  • Costs: resources
	  • Benefits:
	     o Influence in the system
	     o Closer to implementing value: provide aid to people in need
	NGOs:
	  • Costs: (Partly) give up autonomy to determine priorities
	  • Benefits:
	     o Resources to continue operations
	     o Closer to implementing value: provide aid to people in need

Physical components	Resources: INGOs → NGOs Information: NGOs → INGOs
institutions	Legislation

Table 11 21: Additional action situation INGOs invest in quality mark

Operational structure INGOs invest in Quality Mark	
Roles	INGOs: Receiver

Actions	• Asses if first priority is information security awareness
	• Asses if quality mark is obtained
	    o If not: asses if information security awareness is high enough
	       • If yes, get quality mark
	       • Invest extra in information security awareness
	    o If yes: invest extra in information security awareness

Costs and benefits	Costs: Resources
	Benefits:
	  • rise in information security awareness
	  • The quality mark that functions as substitute for culture-based trust.

Physical components	Resources: INGOs → outside system boundaries
Institutions	• Quality mark threshold

Table 11 22: Additional action situation NGOs invest in Quality mark

Operational structure NGOs invest in Quality Mark	
Roles	NGOs: Receiver

Actions	• Asses if first priority is information security awareness
	• Asses if quality mark is obtained
	   o If not: asses if information security awareness is high enough
	      ▪ If yes, get quality mark
	      ▪ Invest extra in information security awareness
	   o If yes: invest extra in information security awareness

Costs and benefits	Costs: Resources Benefits: • rise in information security awareness • The quality mark that functions as substitute for culture-based trust.
Physical components	Resources: NGOs → outside system boundaries
Institutions	• Quality mark threshold

B4.2 Earmarked donations
This policy option does not have any additional action situations.

B4.3 UN as umbrella organization
The following tables describe the additional action situations for the policy options UN umbrella organization.

Table 11 23: Additional action situation connect to UN

Operational structure connect to UN	
Roles	UN: facilitator INGOs: participant NGOs: participants
Actions	• If reputation is prioritized there is a high chance that INGOs and NGOs join the UN effort • If information security awareness is first priority, there is a middle chance that the INGOs and NGOs join the UN effort • If information security awareness is second priority, there is a low chance that the INGOs and NGOs join the UN effort • If the number of participants is larger than 40, random organizations will leave until the number is 40.
Costs and benefits	Costs: - Benefits: reputation gain when joining the UN effort.
Physical components	
Institutions	• Shared strategy of joining UN

Table 11 24: Additional action situation find agreement

Operational structure find agreement	
Roles	UN: facilitator INGOs: participant NGOs: participants
Actions	• If too much INGOs → NGOs leave • If too much NGOs → INGOs leave • If too little of one culture → organizations with that culture leave • The remaining organizations seek agreement which will have a higher chance to succeed if more stay.

Costs and benefits	If agreement:
	• Costs: resources
	• Benefits:
	   o reputational gain
	   o increase information security awareness
	if not:
	• Costs: decrease in reputation
	• Benefits: -

Physical components	Resources
Institutions	• UN agreement

B4.4 Ombudsman

The following tables describe the additional actions situations for the Ombudsman.

Table 11 25: Additional action situation ombudsman

Operational structure ombudsman	
Roles	Ombudsman: inspector INGOs: inspected NGOs: inspected

Actions	• Ombudsman selects one (I)NGO
	• If (I)NGO fails check:
	   o Reputational loss
	   o Similar organizations invest more in information security

Costs and benefits	
Physical components	
Institutions	• Ombudsman information security standards

Table 11 26: Additional action situation reaction of ombudsman

Operational structure ombudsman reaction	
Roles	Ombudsman: inspector INGOs: inspected NGOs: inspected
Actions	• (I)NGOs invest extra in information security
Costs and benefits	Costs: Resources Benefits : Rise in information security awareness
Physical components	resources
Institutions	• Ombudsman information security standards

Appendix C. Model formalization

This Appendix describes the model formalization. Meaning that the translation of the model conceptualization to the Netlogo code is documented. This appendix starts with the model variables that explain what the different variables mean and what values they can become. Then the model storyline is presented per actor via different flow charts. This is presented in Appendix B1. Appendix B2 shows the model assumptions and the data that is used. Appendix B3 shows the changes in the Netlogo interface due the implementation of the policy option. Finally, appendix B4 shows the verification steps and graphs that were used to verify the model.

Appendix C1: Model parameters and story line
This section shows the model parameters and the story line. First the model variables are shown in Table 11 27 and second the storyline is presented using flowcharts. The table and flowcharts include the different policy options. Furhtermore, the flowcharts are presented per actor and in the same sequence that is used in the model.

C1.1 Variables

Table 11 27: The variables used in the model

variables	Owned by	Explanation	
Number of NGOs	Global	The number of NGOs that will be created during the Setup phase of the model	Integer
Number of INGOs	Global	The number of INGOs that will be created during the Setup phase of the model	Integer
Number of Donors	Global	The number of donors that will be created during the Setup phase of the model	Integer
Received money per donor	Donors INGOs	The number of resources that an Donor gives to partner INGOs per timestep	Integer
Resources to NGO	INGOs NGOs	The number of resources that an INGO gives to partner NGOs per timestep	Integer
Culture	INGOs NGOs Donors	Explains cultural difference between organizations. Culture is displayed in 3 different numbers and some number work better together than others.	Integer 1, 2, 3
Reputation	INGOs NGOs Donors	Organizations with a high reputation are more likely to get partnerships. Reputation can be gained by long term cooperation and via the number of links a organizations has.	Real 0-1
Efficiency	INGOs NGOs Donors UN	Explains how much of the resources an (I)NGO uses to provide aid. The more connections and the more investment in information security awareness, the less efficient the organisation. Assumption: INGOs are less efficient than NGOs	Real 0-1
Degree of competition	INGOs NGOs	How many similar organizations exists.	Real 0-1
Information security awareness	INGOs NGOs	How aware the organization is in terms of information security. Determined by investment and the time it has been since the last investment.	Real 0-1
Legislation	INGOs NGOs Donors	Legislation that determines if organisations can cooperate. some countries prohibit certain cooperation's.	Integer 1, 2, 3
Possible connections	INGOs NGOs Donors UN	The number of connections an organisation can/wants to make	Integer
Resources	INGOs NGOs Donors	Resources represent the financial situation of the organization when it regards INGOs and NGOs. The resources of Donors determine how many INGO they can donate to.	Integer
Identification	INGOs NGO UN Donors	All actors hold an identification that shows what kind of organizations they are.	String: "INGO" "NGO" "Donor" "UN"
Partnership-time	INGOs NGOs	Gives an indication of the duration of partnerships of the organization.	Real
Partner-reputation	INGOs NGOS	Provides an indication of the reputation of the partners	Real 0 – 1
Partners-yesterday	INGOs NGOs	Serves as the memory of the organization. It stores the number of partners of the previous time-step so that an increase or decrease of partners can be determined.	Integer
Efficiency-yesterday	INGOs NGOs	Serves as the memory of the organization. It stores the efficiency of the previous time-step so that in	Real 0 – 1

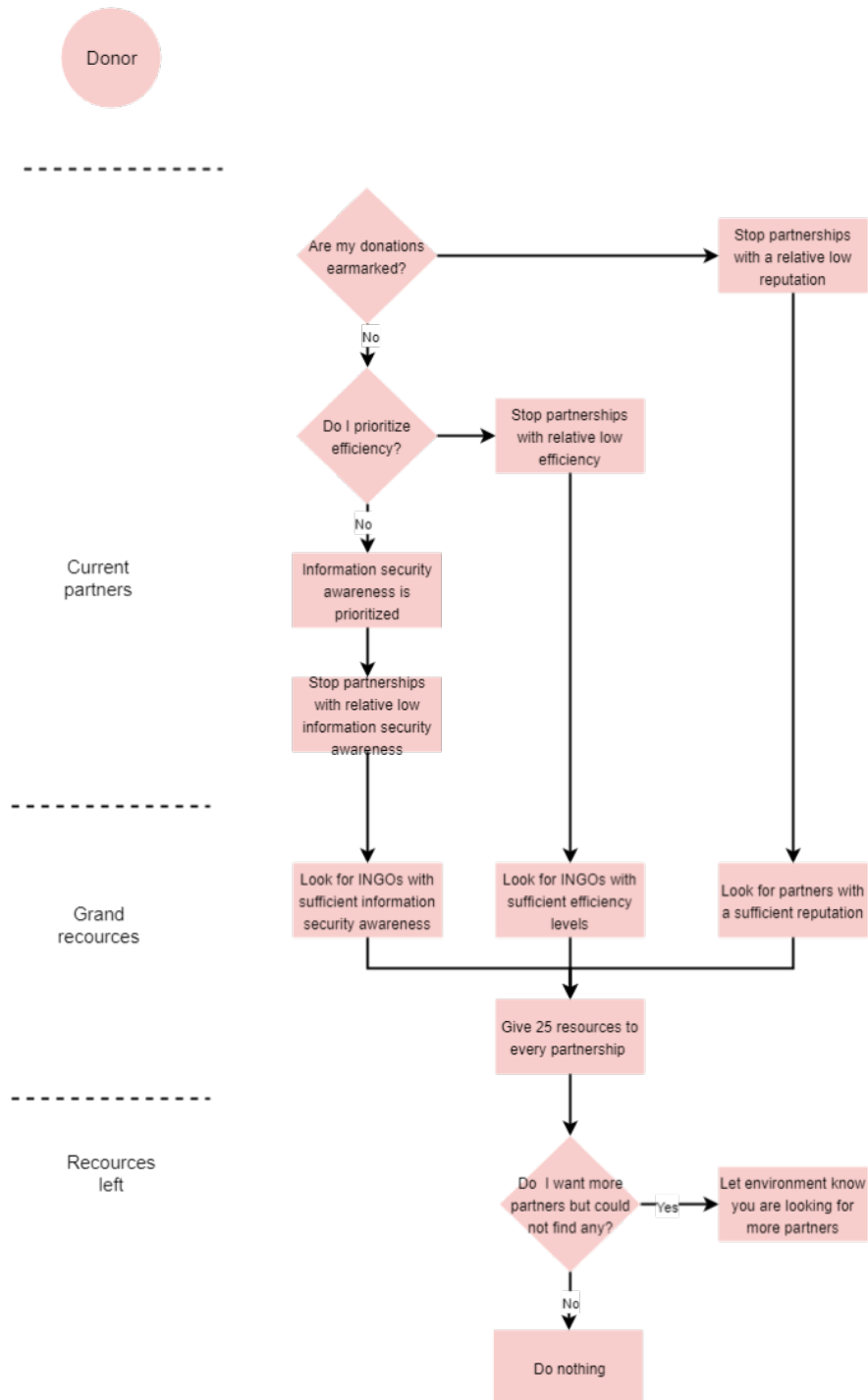|		increase or decrease of efficiency can be determined.	
Information security awareness yesterday	INGOs NGOs	Serves as the memory of the organization. It stores the information security awareness level of the previous time-step so that in increase or decrease in information security awareness can be determined.	Real 0 – 1
Priority1	INGOs NGOs	Shows the first priority of the organization. It can be either be reputation, efficiency, or information security awareness.	Integer 1, 2, 3
Priority2	INGOs NGOs	Shows the second priority of the organization that will receive investment if money is left after first investment and partnership creating. It can be either reputation, or information security awareness, or efficiency.	Integer 1, 2, 3
Empty-time	INGOs NGOs	Counts how many timesteps the organizations did not have any partnerships. If an organization is alone for a year, it will default.	Integer 1 - 12
Quality-mark-obtained	INGOs NGOs	Only if quality-mark = "On", shows if the organizations has the information security awareness quality mark.	Integer 0, 1
Donor-pref-eff	Donors	The percentage of donors that values efficiency over information security awareness	Integer 0 - 100
Looking	INGOs Donors	Shows if the organization is looking for more partners because if can donate to more but could not find any suitable partner.	Integer 0 , 1
Preference	Donors	Show the priority of the donor. The donor preference show if the donor values efficiency, reputation, or information security.	Integer 1, 2, 3
Earmarked	Donors	Shows if the donor provides earmarked donations	Integer 0 , 1

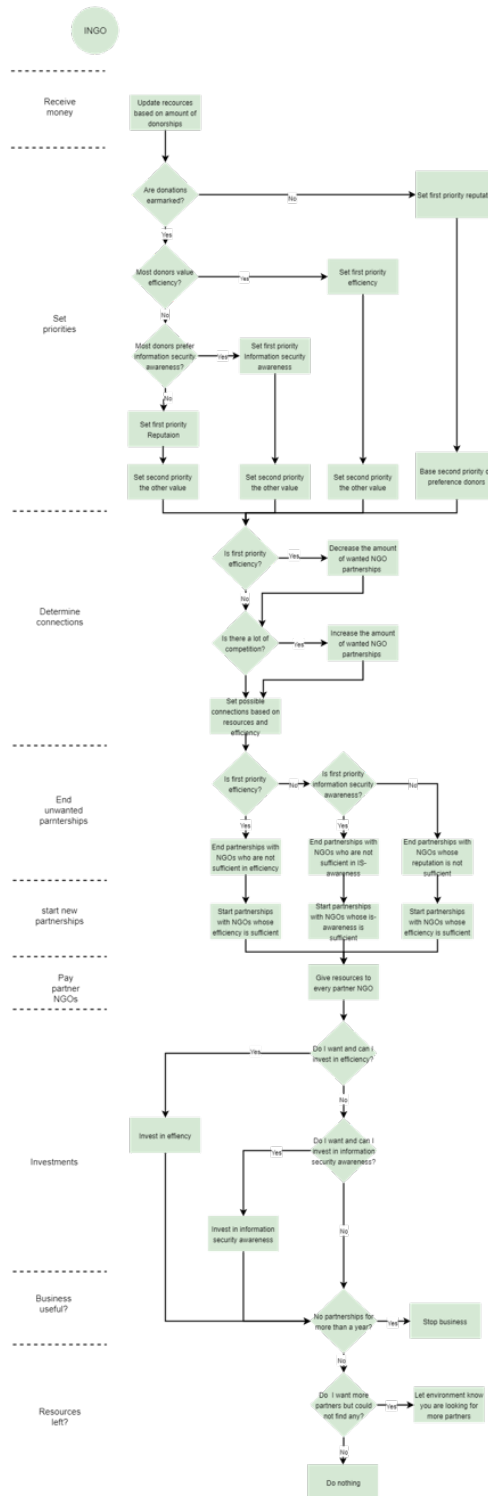Figure 11 2: flowchart that shows the storyline of the Donors

INGO

Receive money

Update resources based on amount of donorships

Are donations earmarked? — No → Set first priority reputation

Yes

Most donors value efficiency? — Yes → Set first priority efficiency

No

Set priorities

Most donors prefer information security awareness? — Yes → Set first priority information security awareness

No

Set first priority Reputation

Set second priority the other value

Set second priority the other value

Set second priority the other value

Base second priority on preference donors

Is first priority efficiency? — Yes → Decrease the amount of wanted NGO partnerships

No

Determine connections

Is there a lot of competition? — Yes → Increase the amount of wanted NGO partnerships

Set possible connections based on resources and efficiency

Is first priority efficiency? — No → Is first priority information security awareness? — No → End partnerships with NGOs whose reputation is not sufficient

End unwanted parnterships

Yes

End partnerships with NGOs who are not sufficient in efficiency

Yes

End partnerships with NGOs who are not sufficient in IS-awareness

start new partnerships

Start partnerships with NGOs whose efficiency is sufficient

Start partnerships with NGOs whose is-awareness is sufficient

Start partnerships with NGOs whose efficiency is sufficient

Pay partner NGOs

Give resources to every partner NGO

Do I want and can I invest in efficiency? — Yes

No

Investments

Invest in effiency

Do I want and can I invest in information security awareness? — Yes

No

Invest in information security awareness

Business useful?

No partnerships for more than a year? — Yes → Stop business

No

Resources left?

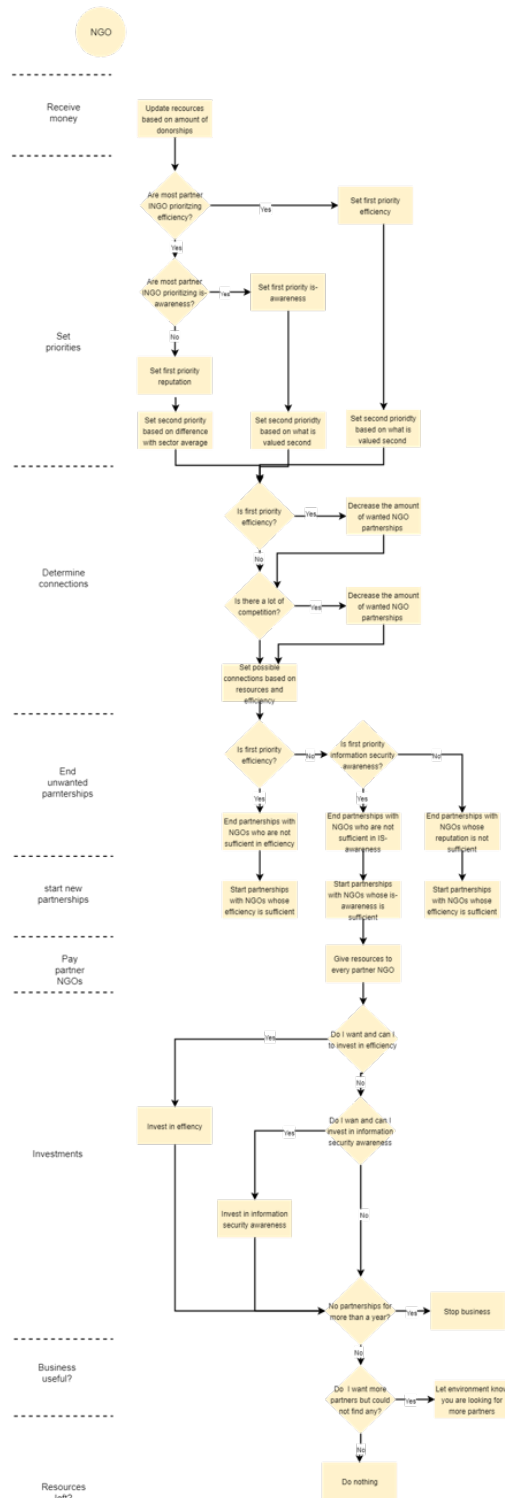Do I want more partners but could not find any? — Yes → Let environment know you are looking for more partners

No

Do nothing

Figure 11 3: The flowchart that shows the storyline of INGOs

Figure 11 4: : The flowchart that shows the storyline of NGOs

UN

Initiate
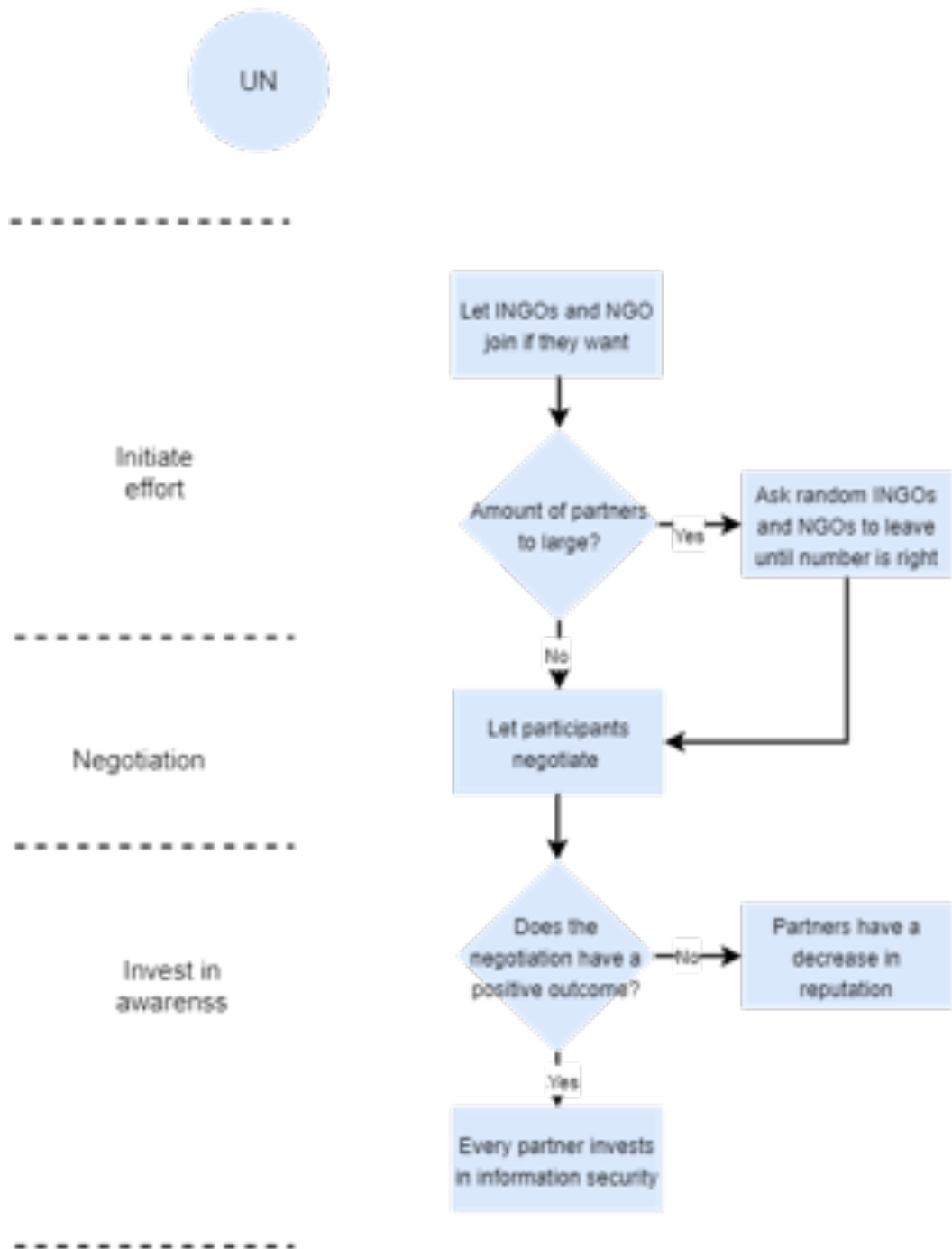effort

Let INGOs and NGO
join if they want

Amount of partners
to large?   —Yes→ Ask random INGOs
                    and NGOs to leave
                    until number is right

No

Negotiation

Let participants
negotiate

Invest in
awarenss

Does the
negotiation have a   —No→ Partners have a
positive outcome?   decrease in
                            reputation

Yes

Every partner invests
in information security

Figure 11 5: The flowchart that shows the storyline of UN umbrella organizations policy option

Figure 11 6: The flowchart that shows the storyline of the Ombudsman policy option

Appendix C2: Model assumptions

This appendix has two parts. The data used for the model and the list with assumptions to build the model. The assumptions are presented per parameter value in Table 11 29 and per modelling decision via a list. The assumptions regarding the modelling decisions are presented per policy option.

C2.1 Data

Table 11 28: The data used for the model

Variable/parameter	Value	Source
Percentage of donors who provide unearmarked donations	14%	(WFP, 2017b).
Percentage of donors how provide earmarked donation	86%	(WFP, 2017b).
Percentage donor money to local NGOs	0 (globally 0.3% so assumed 0)	(Engine Room, 2016)
UN coordination effort	Every year	Based on other coordination efforts/summits who are often annual (OCHA, 2018)

Table 11 29: The assumptions used for the model

Model version	Variable	Owned by	Value	Source/info
Basic	Efficiency (start value)	NGO	0.55 – 0.95	Unknown
	Information security awareness (start value)	NGO	0.05 – 0.2	Unknown
	Reputation (start value)	NGO	0.1	Unknown
	Efficiency (start value)	INGO	0.35 - 0.75	Unknown
	Information security awareness (start value)	INGO	0.05 – 0.15	Unknown
	Reputation (start value)	INGO	0.1 – 0.25	Unknown
	Current-partner-factor	Donors INGOs NGOs	0.8	Unknown
	New-partner-factor	Donors INGOs NGOs	0.7	Unknown
	Increase in information security awareness after investment	INGOs NGOs	0.05	Unknown
	Decrease in information security awareness if nothing is invested	INGOs NGOs	0.002	Unknown
	Increase in efficiency after investment	INGOs NGOs	0.05	Unknown
	Decrease in efficiency if nothing is invested	INGOs	0.002	Unknown
	Time before default	INGOs NGOs	12 months	Unknown
	Number of (I)NGOs founded per month	INGOs NGOs	1	Unknown
Quality - mark	Rise in information security awareness due to extra investment	INGOs NGOs	0.05	Unknown
	Level of information security awareness needed for quality mark	INGOs NGOs	0.4	Unknown
Umbrella organization	Possible connections	UN	40	Unknown
	Chance that an organization will join if reputation is prioritized	INGOs NGOs	40%	Unknown
	Chance that an organization will join if is-awareness is prioritized	INGOs NGOs	30%	Unknown
	Change that an organization will join if efficiency is prioritized	INGOs NGOs	10%	Unknown
	Rise in reputation if organizations joins coordination effort	INGOs NGOs	0.005 per time-step	Unknown

	Rise in information security awareness if organizations join coordination efforts	INGOs NGOs	0.005 per time-step	Unknown
	Percentage that a culture should minimally be presented	INGOs NGOs	25%	Unknown
	Percentage that (I)NGOs should minimally be presented	INGOs NGOs	40%	Unknown
	Degree of competition that is maximally accepted between present (I)NGOs	INGOs NGOs	0.6	Unknown
	Loss of reputation if the coordination effort fails	INGOS NGOs	0.05	Unknown
Ombudsman	The information security boundary that determines if organizations can be inspected	INGOs NGOs	0.3 information security awareness level	Unknown
	Initial chance that the ombudsman finds no wrongdoings	INGOs NGOs	50%	Unknown
	Additional chance that the ombudsman finds no wrongdoings	INGOs NGOs	Information security awareness level	Unknown
	Loss of reputation if wrongdoings are found	INGOs NGOs	0.1	Unknown
Earmarked donations	Percentage of Donors prioritizing information security awareness	Donors	88%	Unknown

C2.2 List of assumptions

List of basic assumptions:

· There are three different cultures.

· There are three different legislation types who are not compatible.

· INGOs have a lower efficiency than NGOs

· The reputation of NGOs is -at least at the beginning – low due to their national/local character

· INGOs have higher start reputation due to their international character

· NGO have a lower information security awareness at the beginning

· Current partners are held to (slightly) easier standards than new partners.

· Current partners must hold at least 80% of the average value of the first priority of the Donor/INGO/NGO

· New partners must hold at least 70% of the average value of the first priority of the Donor/INGO/NGO

· Only 0.3% of global resources go to NGOs, so assumed that Donors don't

make connections with NGOs but only with INGOs.

· It is assumed that INGOs and NGOs prioritize the priorities of their biggest share of donors. So if 1 donor prefers reputation and 2 prefer efficiency, the (I)NGO will priority the latter.

· It is assumed that more partners will decrease efficiency

· It is assumed that more partners will increase reputation

· It is assumed that a high level of competition will increase the number of wanted partnerships due to the need to build reputation

· it is assumed that partnerships are judged based on the average values of the competition

· it is assumed that if there are enough resources and a priority is set, an (I)NGO will always invest in that priority.

· It is assumed that every time-step that there has been no investment in information security awareness, the awareness decreases.

· It is assumed that every investment has a positive effect, wrong or negative investments do not occur.

· It is assumed that after a certain amount of time without partners or incoming resources, an (I)NGO will disappear.

· It is assumed that donors and INGOs will always look for more partners if their resources allow them.

· It is assumed that as long as there are Donors or INGOs looking for more partners, every month an INGO or NGO will be founded

· It is assumed that Donors only give to organizations that meet their criteria and that they will not lower their criteria if no organizations are found.

· It is assumed that the available budget – and thereby the number of possible partnerships - of Donors does not change

List of Quality-mark assumptions

· It is assumed that an Quality mark increases trust that can replace culture as trust-factor. Therefore, partnerships with other cultures can be made if the other has the quality mark.

· It is assumed that organizations who have the quality mark invest more in information security to keep their quality mark but also because they believe the topic to be important.

List of Umbrella-organization assumptions

· An UN effort to build cooperation between organizations can maximum entail 40 organizations.

· Every year there is an coordination effort to increase information security awareness

· It is assumed that if there is too little of one culture present, the organizations holding that culture will stop their cooperation.

· It is assumed that if to little INGOs/NGOs are present, the group with the smallest number will stop their cooperation.

· It is assumed that if there is too much competition between the participants, these participants will stop their cooperation.

· It is assumed that joining an coordination effort will increase the reputation of the organization

· Is its assumed that by joining an coordination effort, information security will rise within the organization

· The coordination effort can fail or succeed, participating therefor is not a guarantee for success

· It is assumed that the more organizations withdraw, the higher the change that the coordination effort will fail

· If the coordination effort will fail, the participants will face a loss in reputation

· If the coordination effort succeeds, the participants will invest in information security awareness and will gain reputation.

· After a coordination effort, all links are broken and all organizations face the same odds to join.

List of Ombudsman assumptions

· It is assumed that every half year the ombudsman will take up another case.

· It is assumed that the ombudsman will only look at (I)NGOs with a low information security awareness since they have the highest chance of data breaches and wrong information handling.

· It is assumed that the higher the information security awareness of the inspected organization the smaller the chance that something is wrong.

· It is assumed that if the ombudsman find wrongs in the organization, it will immediately lead to a loss of reputation

· It is assumed that the ombudsman has a dissuasive effect on others, therefor if wrongdoings are found in an organization, other similar organizations will invest in information security to prevent this from happening.

List of Earmarked donations assumptions

· It is assumed that it is not realistic to let 100% of the donors prioritize information security

Appendix C3: Change in models interface by policy options.

Figure 11 7, Figure 11 8 and Figure 11 9: The policy option Earmarked donations show the interfaces of the model when the policy options quality mark, Earmarked donations and UN umbrella organization are enabled. The blue outlines show where the change has occurred. In Figure 11 7 the graph has values different from zero, Figure 11 8 there is a blue agent added that represent the UN agency and in Figure 11 9 shows the change in the variable donor-pref-eff that represent the number of donors that prefers efficiency over information security awareness.
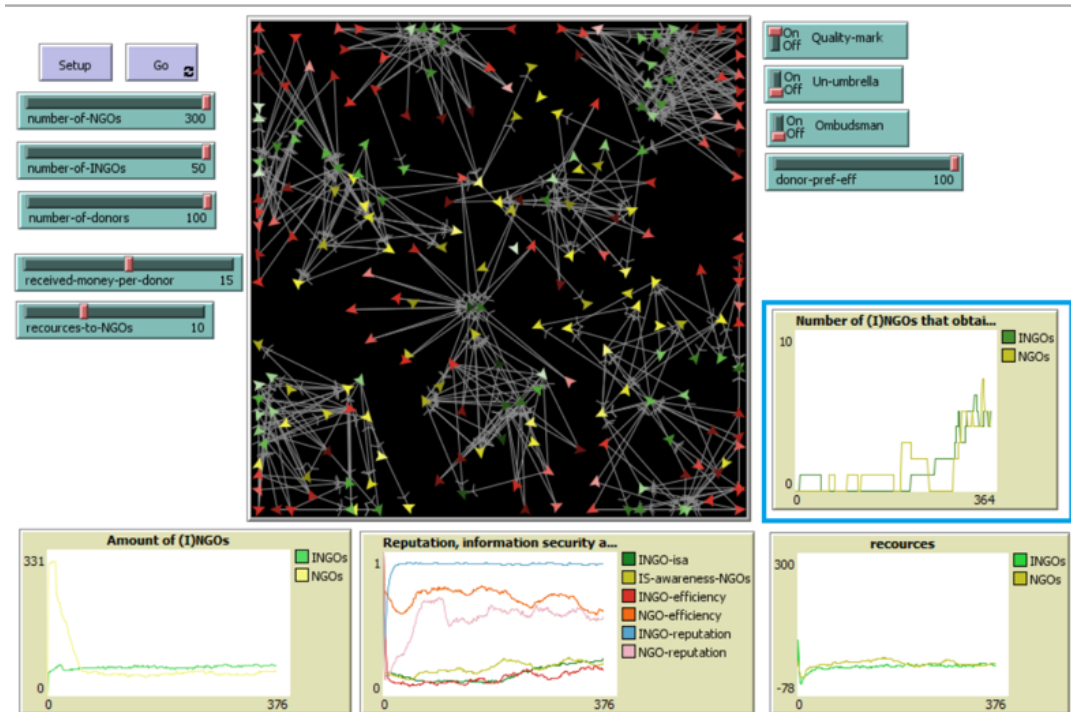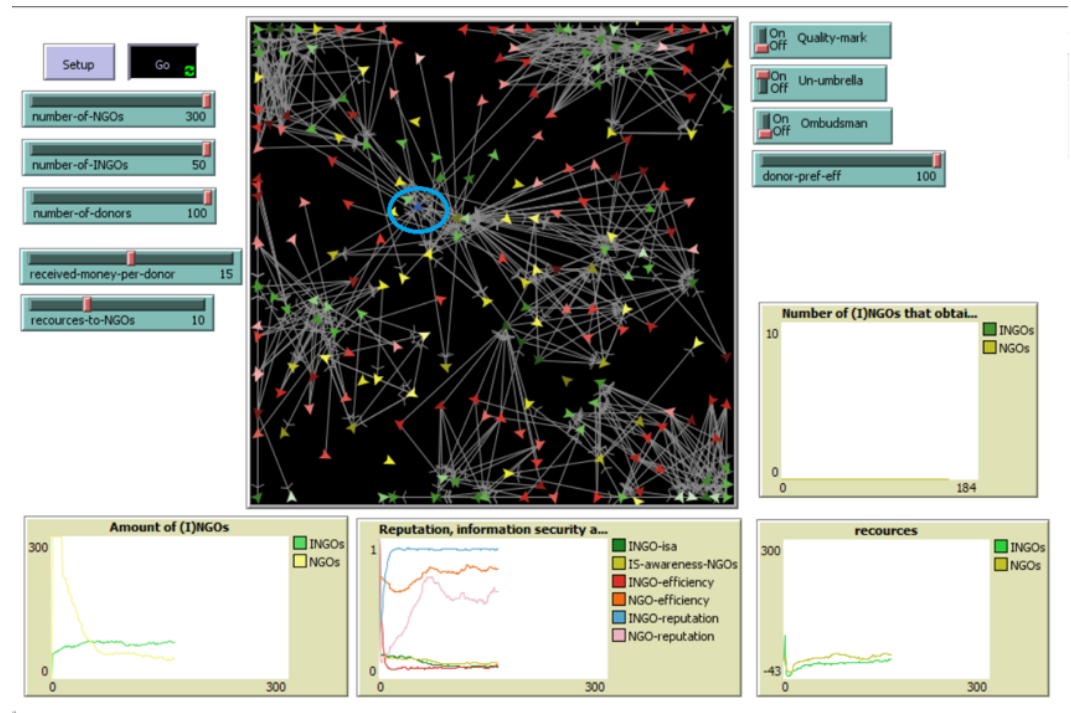
Figure 11 7: The policy options quality mark

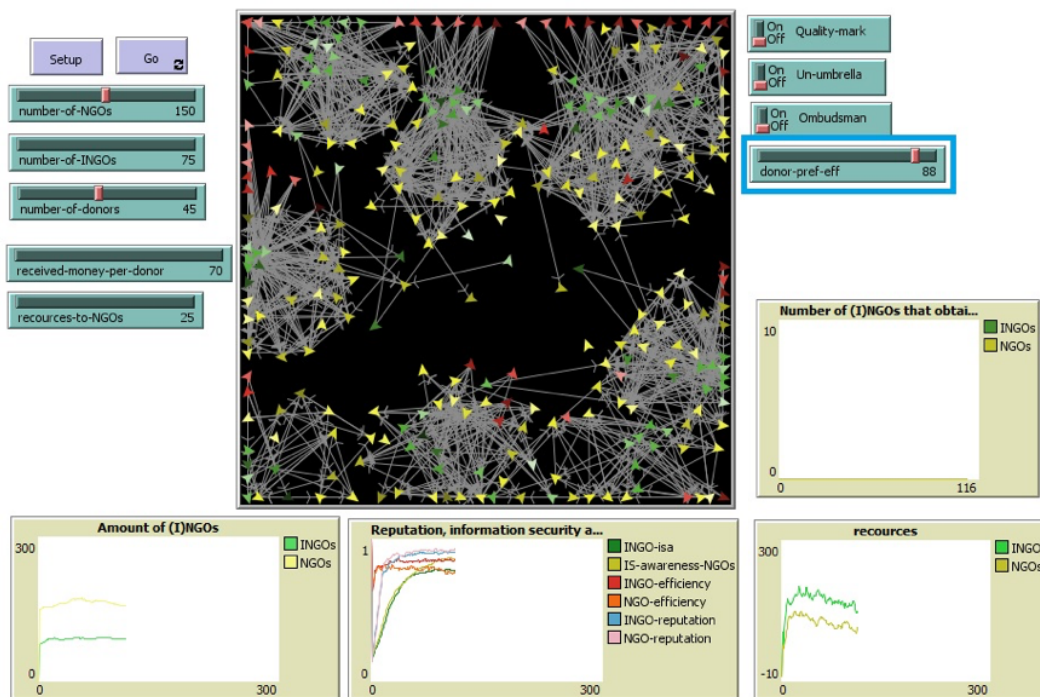Figure 11 8: The policy option UN umbrella organization

Figure 11 9: The policy option Earmarked donations

Appendix D. Verification

This Appendix contains the complete verification process. First, the different verification steps are described and second the verification implementation is shown to see the results of the selected verification methods.

Appendix D1: The verification steps

Verification evaluates if the conceptual model is correctly translated into the agent-based model and that all the relevant actors, relationships, and behaviours are modelled well. The verification method that is used to verify the model follows the verification steps as described by Nikolic, et al. (2013) in their book Agent-Based Modelling of Socio-Technical Systems. This verification method consists of eight steps accommodated under four main verification steps. These steps are:

- Recording and tracking agent behaviour
- Single agent testing
o Theoretical Prediction and Sanity Checks
o Breaking the Agent
- Interaction testing limited to minimal model
- Multi-agent testing
o Theoretical Prediction and Sanity Checks
o Breaking the Agent
o Variability testing
o Timeline example

Recording and tracking agent behaviour is the first and most basic step of the verification process. It is something that is often done during the building process the model as well. During the recording and tracking agent behaviour step, the modeller monitors relevant output, input, and state variables to check if the model is operating as expected and intended. This process is often build up by starting with monitoring behaviour of single agents to monitoring group behaviour (ibid).

Single agent testing focusses on the model with only one agent to reduce the complexity that often accompanies agent-based models. There are two types of tests that can be done when performing a Single agent test step. The first – Theoretical Prediction and Sanity Checks – focuses on the behaviour of the agent under normal parameter conditions. It looks if the behaviour matches the indented behaviour. The second test – breaking the agent- monitors under which parameter conditions the agent stops behaving normally (ibid).

Interaction testing limited to minimal model tests the models behaviour under de minimal number of required agents (ibid). In this case one Donor should be enough, since modelled market forces will ensure that INGOs and NGOs will be created if the Donor can have more partnerships than the current amount.

Multi-agent testing consist of the same tests as Single-agent testing and two

additional tests. The first additional test is Variable testing. This is done by running the model a large amount of times to see what kind of behaviour occurs via statistical analyses. Second, a Timeline Sanity check is performed to see if there is unexpected behaviour that occurs during a complete run (ibid).

Variability testing shows if the - often - chaotic behaviour of agents differs significantly and if they do (or do not), whether that is due to problems in the code or is intended. For this test, it is important to run the model a large number of runs. Therefore, the number of replications is set to 100, the number of timesteps is set to 360, and the input variables are considered representable.

The timeline sanity check is the final verification test and tests whether the model behaves unexpectedly or inexplicably over a large amount of timesteps. This test has two purposes: first to see if behaviour occurs that cannot be explained and second if certain behavioural patterns are not overlooked. Some models or model settings have attractors – the values that will eventually always be the output - that can be very influential on the model outcomes. If these fall just outside the determined timespan, conclusions might be drawn based on incomplete data.

Appendix D2: The verification implementation

This section shows all the verification steps and decisions that are undertaken to verify the model. First the steps during the test recording and tracking agent behaviour are shows. Second, the single agent test is shown. Third the minimal agent test is discussed. Fourth, breaking the agent test is performed. Fifith, the variability testing is discussed, and finally the Timeline sanity check is shown.

D2.1 recording and tracking agent behaviour

Baseline:

·   The number of NGOs must be equal to the slider number-of-NGOs Confirmed

·   The number of INGOs must be equal to the slider number-of-INGOs Confirmed

·   The number of Donors must be equal to the slider number-of-Donors Confirmed

·   If the received-money-per-donor slider goes up, INGOs can make more connections Confirmed

·   If the received-money-per-donor slider goes down, INGOs can make less connections Confirmed

·   If the resources-to-NGOs slider goes up, NGOs can make more connections Confirmed

·   If the resources-to-NGOs slider goes down, NGOs can make less connections Confirmed

·   No partnerships are built with organizations with different legislation Confirmed for Donors, INGOs, and NGOs

·   No partnerships are built with organizations with different culture

Confirmed for Donors, INGOs, and NGOs

·	If number of partners is lower or equal to possible-ngo-partners/number-of-links, the variable looking is equal to 0. Confirmed for Donors, INGOs and NGOs

·	If number of partners is higher than possible-ngo-partners/number-of-links, the variable looking is equal to 1. Confirmed for Donors, INGOs and NGOs

·	The number of connections that Donors want/can make stays equal Confirmed

·	If resources smaller or equal to 10, possible-ngo-partners = 0 Confirmed

·	If possible-ngo-partners = 0, no new partnerships are built, current partnerships stay if partners are deemed suitable Confirmed for INGOs and NGOs

·	If invested, information security awareness or efficiency goes up. Confirmed

·	If information security awareness goes up, efficiency goes down Confirmed

·	If information security awareness goes down, efficiency goes up Confirmed

·	Reputation goes up if number of partners goes up Confirmed

·	Reputation goes down if number of partners goes down Confirmed

Quality mark

·	The number of INGOs with quality-mark-obtained = 1 becomes greater than 0 at some points in time Confirmed

·	The number of NGOs with quality-mark-obtained = 1 becomes greater than 0 at some points in time Confirmed

·	Donors can connect with INGOs with different cultures if they have a quality mark Confirmed

·	INGO can connect with NGOs with different cultures if they have a quality mark Confirmed

·	NGOs can connect with NGOS with different cultures if they have a quality mark Confirmed

·	Quality mark button can be activated at any point Confirmed

Earmarked:

·	The percentage of donors with preference is information security awareness equals 1 – slider-pref-eff Confirmed

·	Slider can be changed any time, however, this will not influence the system since the preference of donors is determined during Setup procedure Confirmed

UN umbrella organization

·	One extra UN agent is created during setup Confirmed

·	The number of UN links is not larger than 40 Confirmed

·	Sometimes the effort succeeds Confirmed

·	Sometimes the effort does not succeed Confirmed

·	Every 6 ticks organizations can join Confirmed

·	Organizations who join have either priority1 = 2 or 3 and/or priority2 = 2 or

3 Confirmed

·   While the organizations join, their reputation goes up Confirmed

·   Every 12 ticks there is an outcome and all the links are broken. Confirmed

·   If the outcome is success, reputation and information security awareness of those who joined go up Confirmed

·   If the outcomes is failure, the reputation of those who joined go down Confirmed

·   The UN-umbrella button can be activated any time rejected

Ombudsman:

·   Every 6 ticks one organization is checked Confirmed

·   If fails, the reputation of that organization goes down Confirmed

·   the ombudsman checks both INGOs and NGOs Confirmed

·   the ombudsman does not check Donors Confirmed

·   The ombudsman button can be activate at any time Confirmed

D2.2 Single agent testing

·   One NGO

o   NGO disappears after 12 ticks Confirmed

D2.3 minimal agent testing

·   one INGO and one NGO

o   NGOs appear every tick until the INGO can build a connection Confirmed

o   If the INGO has a connection, the looking variable will be equal to 0 Confirmed

o   After 12 ticks, the INGO will disappear due to lack of income Confirmed

o   Within 12 ticks after the INGO disappears, all the NGOs will be gone Confirmed

·   One Donor, one INGO, and one NGO

o   Every tick a INGO will appear until the Donor is satisfied and has enough INGOs to choose from if current connections are not sufficient Confirmed

o   Every tick and NGO will appear, this process will never stop due to the fact that there will always be unsatisfied INGOs Confirmed

·   One Donor and one INGO

o   INGOs are built every tick Confirmed

o   INGOs are built after the first tick Confirmed

D2.4 Breaking the agent

During this test, the researcher deliberately seeks ways to break the system using extreme values.

·   The number of donors is set on 3000, other values are kept regular Broken

o   During the Setup, the different agents are separated from each other and are randomly place within their own boundaries. The space selected for Donors is too small to contain 3000. The limitation that agents cannot be on the same patch is removed for all agents during setup phase. After the removal of this limitation the tests for an extreme amount of Donors, INGOs or NGOs can be Not-broken.

- The variables "received-money-per-donor" and "resources-to-NGOs" is set 0. The number of INGOs and NGOs stays small but does not disappear completely due to the initial number of resources INGOs have when they are founded. Not broken
- The variables "received-money-per-donor" and "resources-to-NGOs" and the initial number of INGO resources is set 0. This breaks the system because the number of NGOs will become 0 after a short amount of ticks, meaning that INGOs cannot determine average values of NGOs anymore. Broken
- The amount of ticks that is needed to default and disappear is set 1. The system is more stable than if the variable is set on 13 ticks. This is due to the fact that agents without partners disappear quickly and do not have time to request new agents. Not broken
- The amount of ticks that is needed to default and disappear is set 0. The system breaks after 1 tick because all the INGOs and the NGOs disappear and the Donors are not able to determine average of INGOs. Broken
- Possible partnerships of agents are set 0. The system breaks after 13 ticks because the INGOs are not able to receive money and they disappear. Broken

The conclusion drawn from the breaking the agent tests is that the system only breaks if settings are found to remove the INGOs and/or NGOs from the simulation. Every other combination of settings will not result in a broken system.

D2.5 Variability testing

Variability testing shows if the -often- chaotic behaviour of agents differs significantly and if they do (or do not) if that is due to problems in the code or that it is intended. For this test, it is important to run the model a large amount of runs. Therefore, the number of replications is set on 100 and the amount of timesteps is set on 360. The policy options where disabled and the parameter settings that were used for these runs are:

- number-of-donors = 40
- number-of-INGOs = 50
- number-of-NGOs = 100
- received-money-per-donor = 15
- resources-to-NGOs = 10
- donor-pref-eff = 88

Figure 11 10 shows the histograms of the number INGOs and NGOs. The number of INGOs shows not abnormal behaviour. However, graph with the number of NGOs shows behaviour that can be considered a bit off. The code involving het number of NGOs and the creating of new NGOs has been checked but no irregularities have been found. Nothing is done so far, however, if more irregularities are found, the model will be run with more repetitions to see if the behaviour becomes more normal shaped if all/more values are tested.
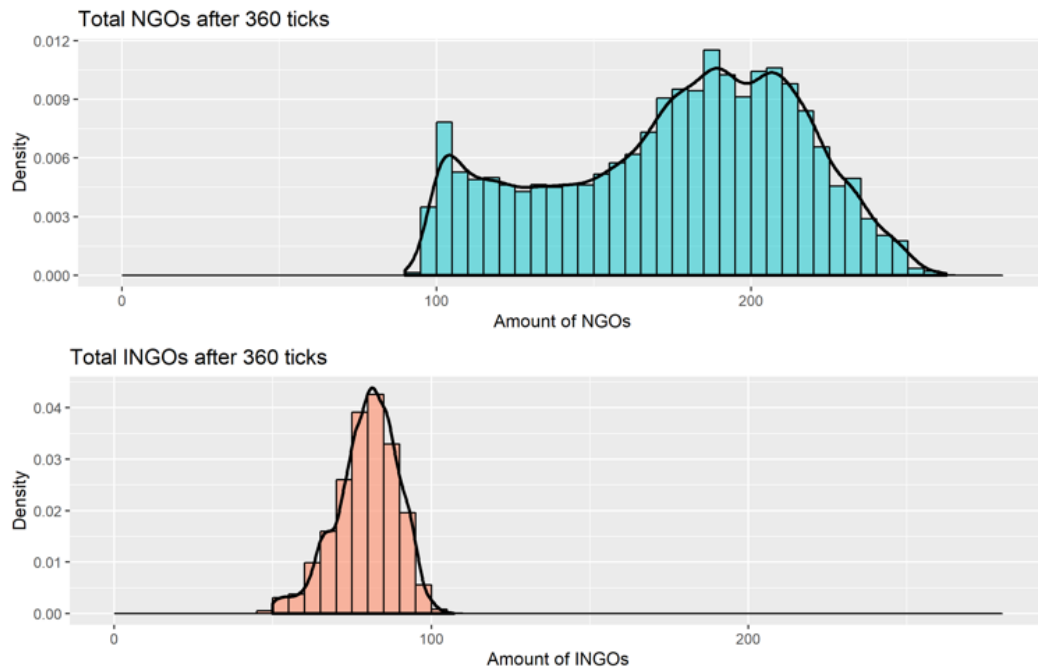
Figure 11 10:The distribution of INGOs and NGOs after 360 steps with 100 repetitions

Figure 11 11 shows the distributions of the information security awareness, efficiency and reputation for both the INGOs and the NGOs. These distribution show no evidence of anomalies that cause reason for concern.
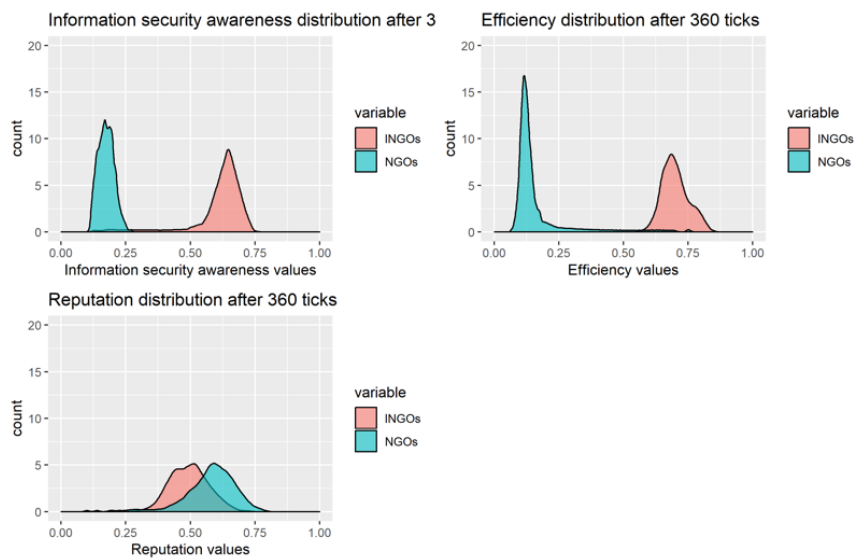

Figure 11 10:The distribution of INGOs and NGOs after 360 steps with 100 repetitions

Finally the number of resources are researched. Figure 11 12 shows the distribution of resources of INGO and NGOs. The distribution of INGO looks perfect, however, the behaviour or the resources of NGOs is wrong. There are large outliers and most of the results are either 0 or 1. The code is inspected to see what causes this behaviour. Two minor faults in the code have been found and corrected. However, the main problem that causes this behaviour lies not in the code but in the values that are chosen as representable. The value of the slider received-money-per-donor was too low to for the INGO to be able to pay for their own activities and pay local partners. The resources flowing to the NGOs where to little. This will be taken into account during the experimental design.

Resources INGOs after 360 ticks

Resources NGOs after 360 ticks
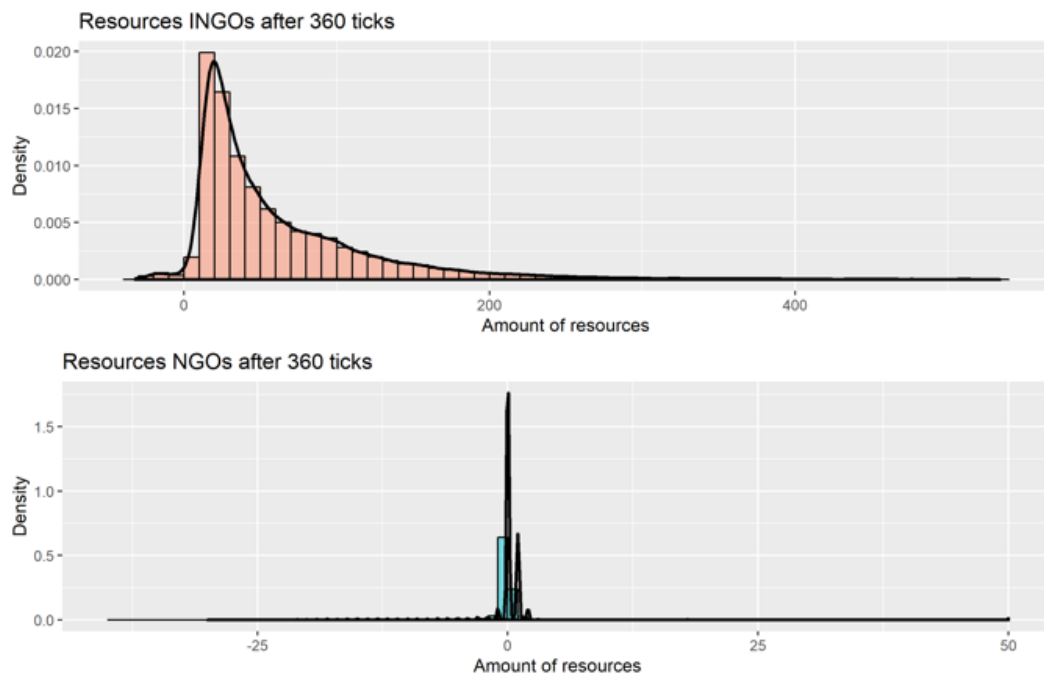
Figure 11 12: The distribution of resources of INGOs and NGOs after 360 steps with 100 repetitions

D2.6 Timeline sanity

The timeline sanity check is the final verification tests an looks if the model behaves unexpected or inexplicable over a large number of timesteps. This test has two purposes: first to see if behaviour occurs that cannot be explained and second if certain behavioural patterns are not overlooked. Some models or model settings have attractors – the values that will eventually always be the output - that can be very influential on the model outcomes. If these fall just outside the determined timespan, conclusions might be drawn based on incomplete data. For this timeline sanity check, the model is run 10 times 10.000 timesteps. Which

each timestep representing a month, is runtime is beyond any reasonable timespan. However, it provides much insight in the model behaviour. The policy options where disabled and the parameter settings that were used for these runs are: turquoise

- number-of-donors = 40
- number-of-INGOs = 50
- number-of-NGOs = 100
- received-money-per-donor = 15
- resources-to-NGOs = 10
- donor-pref-eff = 88

Figure 11 13 shows the number of INGOs and NGOs during these runs. One can see that there is no unexpected behaviour in this graph and that there are not attractors that steer the model outcomes towards a certain point. Furthermore, one can see in this graph that the model becomes in a balanced state where the model values fluctuate around certain values. This happens within the first 1500 model steps and after that, the behaviour does not change much.

Figure 11 13: The Number of INGOs and NGOs over 10.000 steps with the default parameter settings

Furthermore, Figure 11 14 shows the three output variables of the INGOs and NGOs during these runs. The behaviour of the information security awareness, efficiency, and reputation show the same kind of behaviour as the number of INGOs and NGOs. There are no unexpected values, no attractors and no behaviour that drastically changes over a longer period of time.
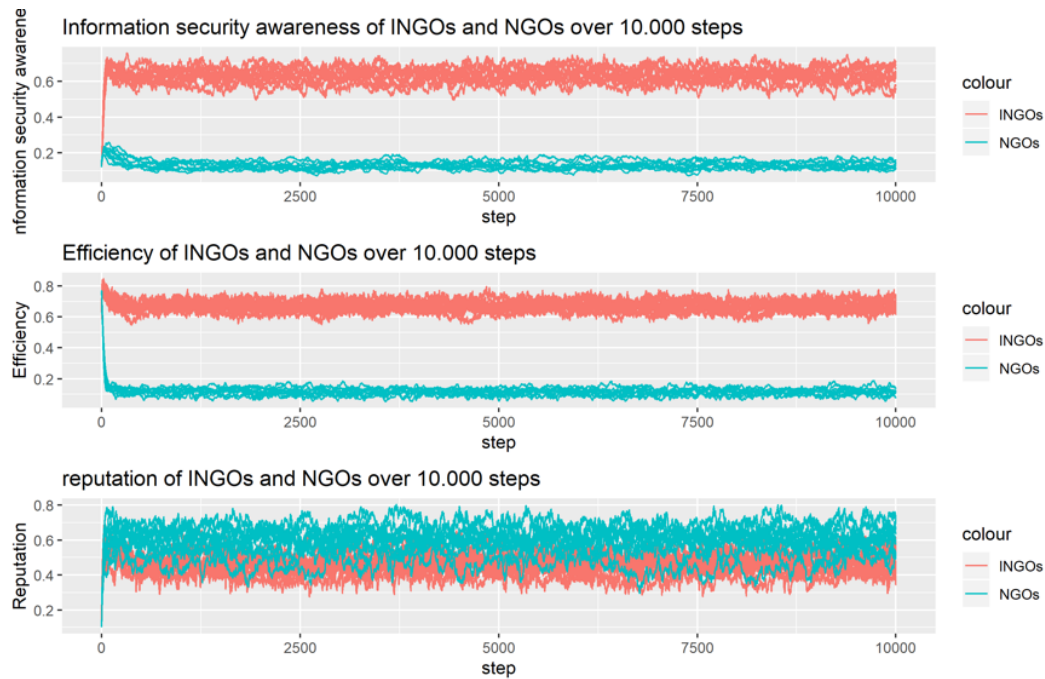
Figure 11 14: Output variables of INGOs and NGOs over 10.000 steps with default parameter settings

Appendix E. Model exploration

Appendix E1: Method selection
Setting up an experimental design requires a couple of steps to be taken. The first step is the definition of hypotheses of which there can be two types. The first focussing on the generation of specific outcomes and the second more explorative of nature, focussing on what might occur considering certain circumstances. Due to the explorative nature of this research, the hypotheses that will be formulated will be in line of the latter form.
The second step is determining the runtime and the possible warm-up time. Due to the fact that the model does not rely on data, a random parameter sweep will be taken across 10.000 ticks runtime to determine when emergent patterns appear and when – and if- the system becomes stable. This will help to make sure

that emergent behaviour is not missed or conclusions about attractors or stable behaviour are not made misinformed.

The third – and final step is setting up the experiments itself. The most straightforward manner to do so is a full factorial design. However, this requires an almost unlimited amount of computation power and time, which both are unavailable in this research. There are four ways of working around a full factorial design. First, a Latin Hypercube sampling – as done with the determination of the runtime – can be used to determine the needed parameter settings for the experiments. Second, Monte Carlo method can be used to determine the parameter settings. However, Monte Carlo is less accurate with viewer repetitions than Latin Hypercube sampling and therefore Latin Hypercube sampling is preferred in this type of research. The third option is random parameter settings in a range set by the researcher. This is not preferred due to the lack of statistical prove of the selecting the right parameters, but sometimes necessary due to the limited resources and time. The final option is the use of scenarios. In this type of parameter setting, the parameter settings are designed in a way that they represent certain scenarios that occur in real life.

For this experimental design the third method will be applied. Due to the many assumptions, lack of data, and quantitative validation methods, the numbers used in this model are not representative for an on reality applicable solution. A statistical substantiated behaviour space on statistical unsubstantiated parameter values does not hold added value for the research.

Appendix E2: Model exploration results

Due to the fact that market forces are accounted for in the model, it is expected that the initial values of the INGOs and the NGOs have little influence in the models behaviour. After 12 timesteps, the INGOs and NGOs start to disappear if they do not receive enough resources. Furthermore, new INGOs and NGOs are being founded every timestep as long as there are donors and INGOs who seek more partnerships. Therefore, the first three input variables that are being investigated are: number-of-donors, received-money-per-donor, and resources-to-NGO.

The output variables that are investigated in this section are

- Amount of INGOs
- Amount of NGOs
- Information security awareness of INGOs
- Information security awareness of NGOs.
- Efficiency of INGOs
- Efficiency of NGOs
- Reputation of INGOs
- Reputation of NGOs

E2.1 Value exploration

Staring with the initial number of donors. Figure 11 15 shows the boxplots for

the INGOs and the NGOs for the initial donor values of 10, 30, and 60 donors. As expected, the number of INGOs and NGO increases with an increase in the number of donors. However, both the INGOs and the NGOs know a large range of outliers that need to be discussed.

First, the outliers in the number of INGOs, who are largely in the areas under the ranges captured by the boxplot. These outliers can be explained by the initial settings of the model. The initial amount of INGOs was set on 10 and 50, while the medians lie respectively around 50, 70, and 85. These value differ, especially with the initial amount of 10. It takes some time for the INGOs to increase in number to the level that is required by the system. Furthermore, the lowest value for all three scenarios are at 10, which confirms this observation. Therefore, these values are probably the early runs where the model is still stabilizing itself. The outliers who are in the range above the boxplots cannot be explained and therefore need further investigation.

Second, the outliers of the NGOS, who are all above the boxplot areas. These are not easily explained and therefore are investigated further.
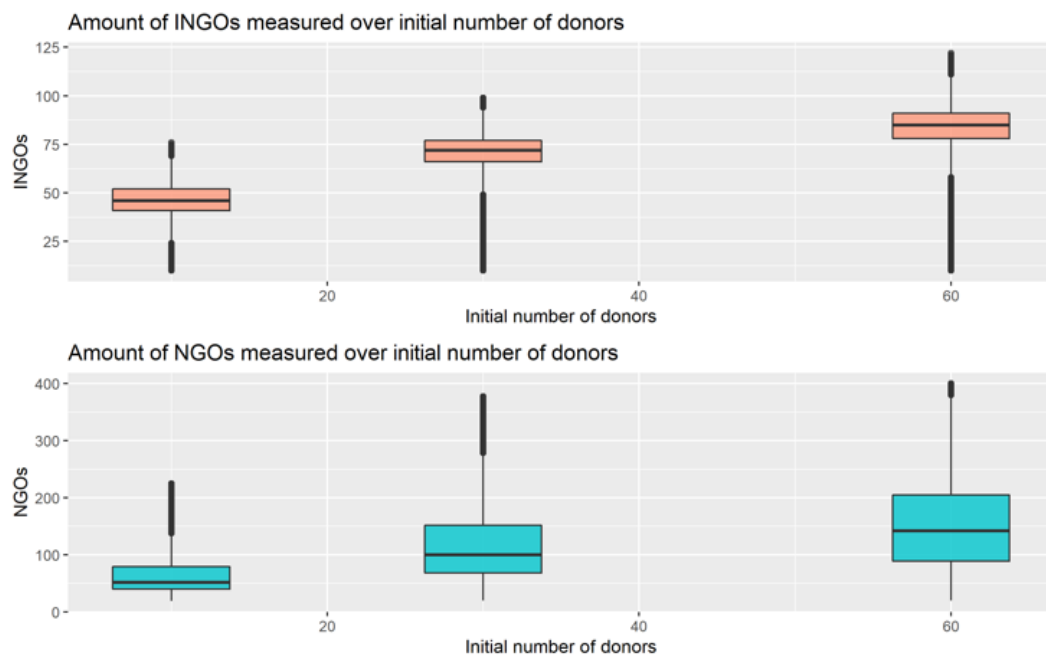
Figure 11 15: The number of INGOs and NGOs measured over the initial number of donors

Figure 11 16 shows the number of INGOs explained by the input variables "received-money-per-donor" on the y-axis and "resources-to-NGOs" on the x-axis. The graphs show that there are differences, but these are not extremely large. How much resources INGOs receive or spent therefore has little influence on

the number of INGOs. However, the differences are large enough to explain the outliers visible in Figure 11 15.
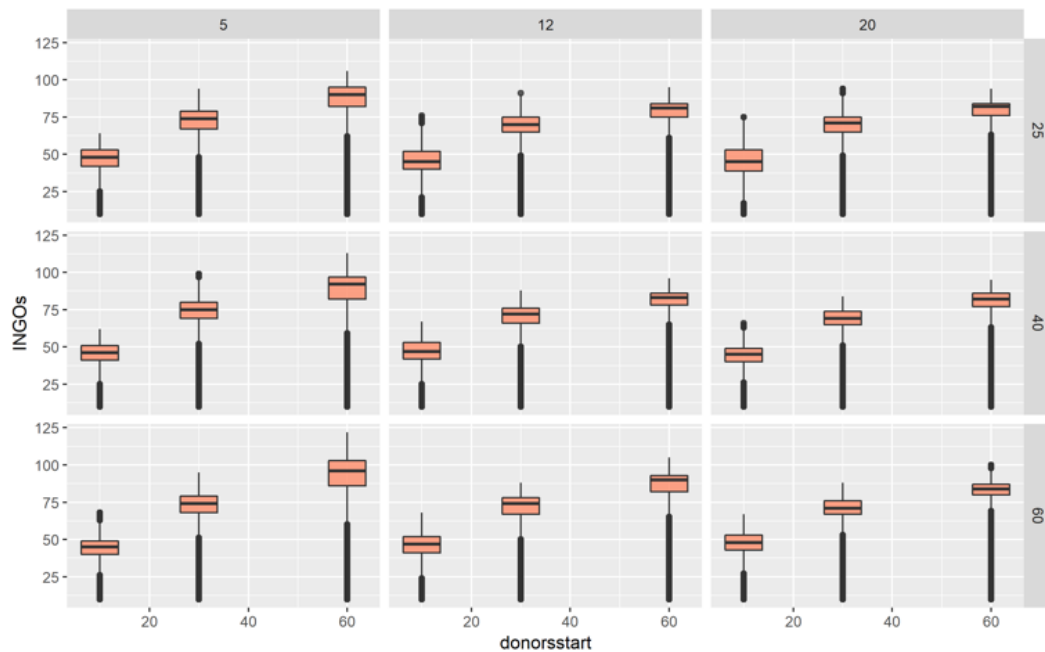

Figure 11 15: The number of INGOs and NGOs measured over the initial number of donors Figure 11 16: Number of INGOs over donor value, number of resources to INGOs(x), and resources from Donors(y)

Figure 11 17 shows the same graph as Figure 11 16 but for the NGOs. Here, the difference between the flows of resources is much larger. Furthermore, the outliers that are shown in Figure 11 15 can be explained by the differences in resource flows. Especially the variable "resources-to-NGOs" has much influence on the number of NGOs, which shows large differences.
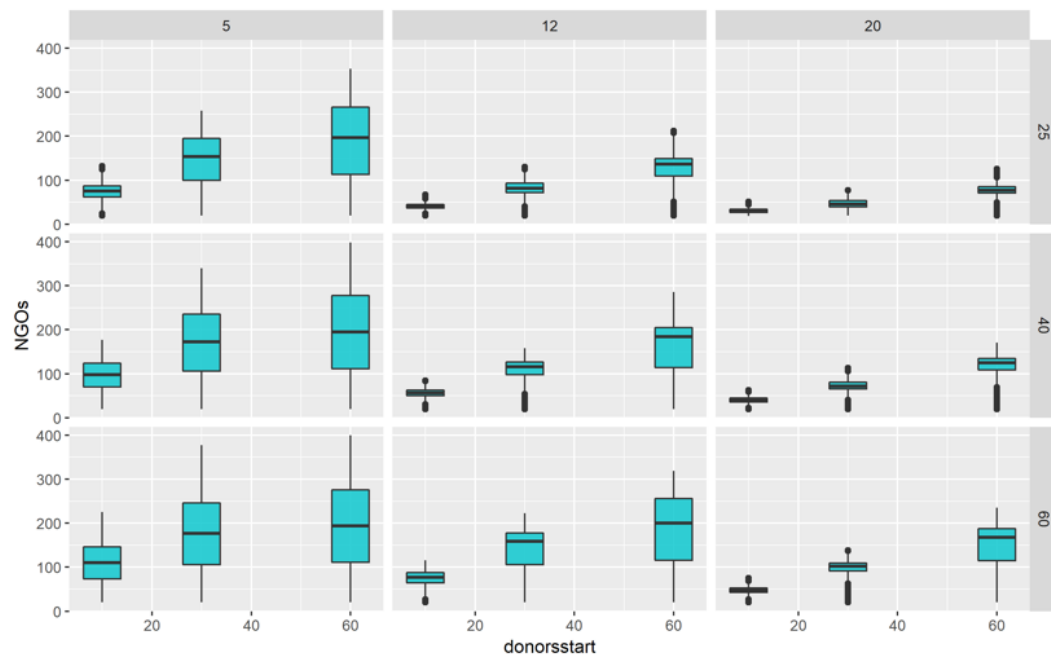
Figure 11 17: Number of NGOs over donor value, number of resources to INGOs(x), and resources from Donors(y)

The impact of the variables "number-of-donors", "received-money-per-donor", and "resources-to-NGO" on the number of INGOs and NGOs has been investigated. It shows that all three variables have -to some extent – influence on the number of INGOs and NGOs. However, the "received-money-per-donor" variable the least of all.

The next step is to see how these variables influence information security awareness, reputation, and efficiency. Figure 11 18 shows the influence of the number of donors on the information security levels. The six boxplots show that if there are more donors, the information security awareness levels are higher. Furthermore, with more donors, the number of outliers below the boxplot is higher as well. It is assumed that these are caused by the initial information security awareness level of the model, which is set between 0.05 and 0.15 and the time that is needed to increase these levels.
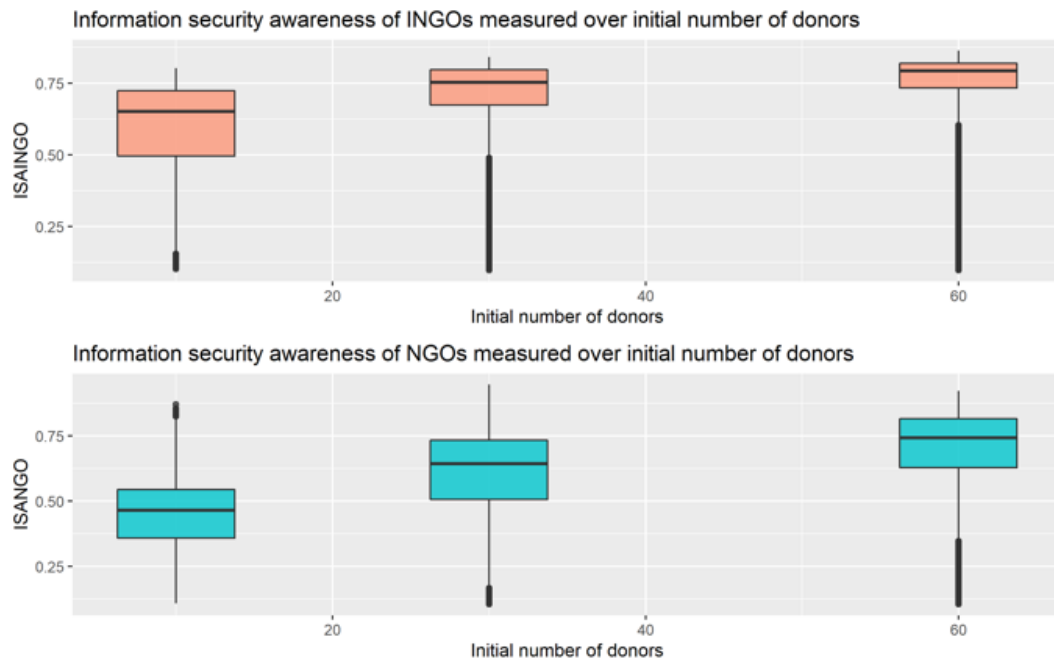
Figure 11 18: The influence of the initial number of donors on information security awareness

Figure 11 19 shows the six boxplots for het efficiency levels of INGOs and NGOs set out against the initial number of donors. The boxplots of the INGOs show behaviour that is in line with the behaviour as seen in Figure 11 18: More donors mean higher levels of information security awareness – or in this case efficiency. However, the behaviour of the NGOs differs due to the fact that there is no significant difference between the three initial donor values.
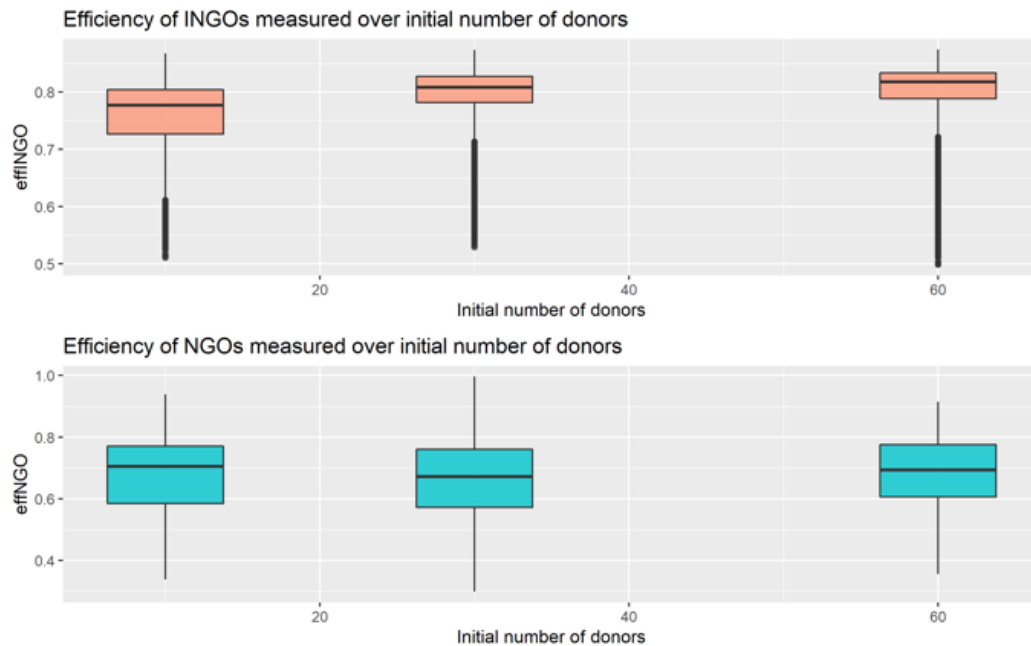
Figure 11 19: The influence of the initial number of donors on efficiency

Figure 11 19 shows the six boxplots for the reputation levels of INGOs and NGOs set out against the initial number of donors. These levels rise faster than Information security and efficiency. This is probably because reputation is something that is assumed as something that does not require investment, while the other are dependent on the amount of resources that is spent to increase it.
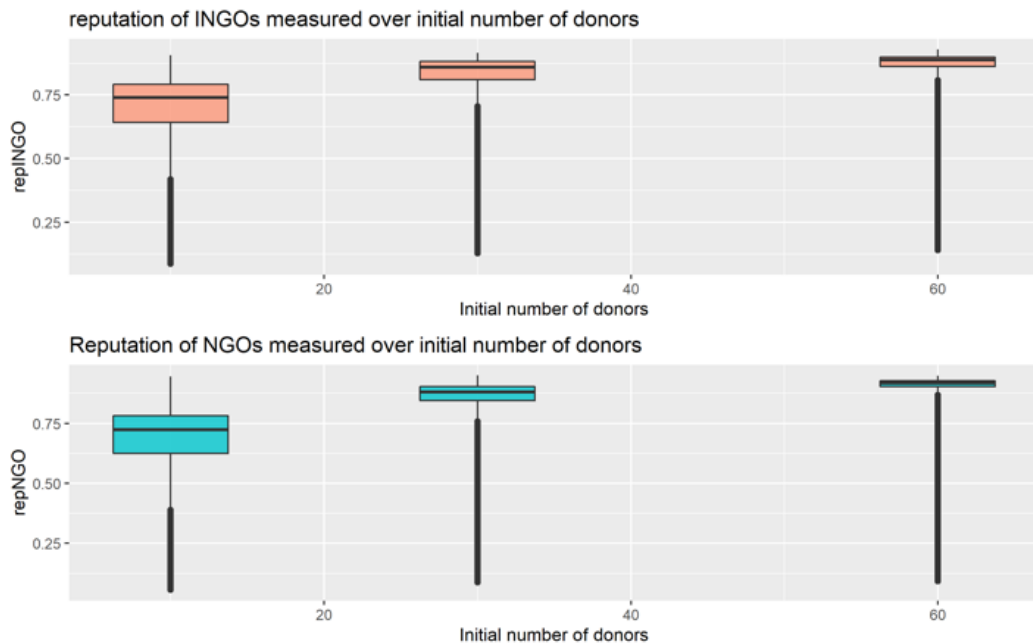
Figure 11 20: The influence of the initial number of donors on reputation

Looking at Figure 11 18, Figure 11 19, and Figure 11 20, all three variables show largely the same behaviour with an increase of donors and therefor an increase in resources in the system. Therefore, only information security awareness is taken into account in the next steps. In the next step, the information security awareness levels are set out against the input variables "received-money-per-donor" on the y-axis and "resources-to-NGOs" on the x-axis. The distinction between the initial donor values is kept as well.

Figure 11 21 shows this for INGOs. The figure shows that "received-money-per-donor" and "resources-to-NGOs" have an influence on the information security awareness levels of INGOs, but the correlation is hard to find. Therefore, it is recommended do explore a wider range of these variables in the main experimental design to create clearer outputs.

information security awarness of INGOs per inital donor value
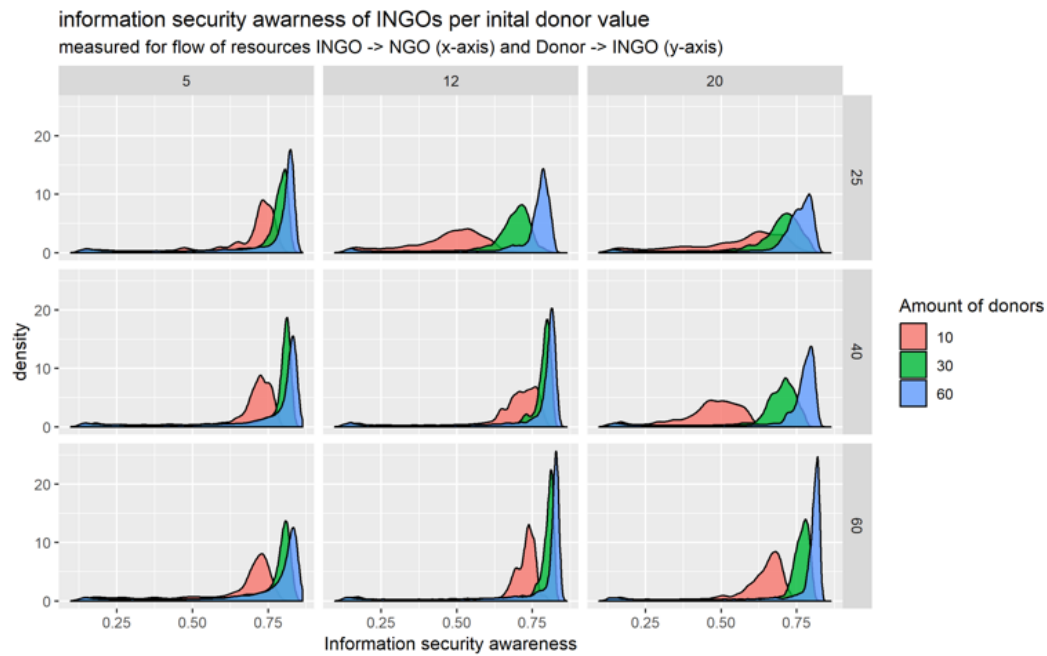measured for flow of resources INGO -> NGO (x-axis) and Donor -> INGO (y-axis)

Figure 11 21: Information security awareness over donor value, amount of resources to INGOs(x), and resources from Donors(y)

Figure 11 22 shows the information security awareness levels are set out against the input variables "received-money-per-donor" and "resources-to-NGOs" for NGOs. Similar results show as in Figure 11 21 in terms of the correlation between these variables. Therefore, it is recommended do explore a wider range of these variables in the main experimental design to create a clearer distinction between the outputs.
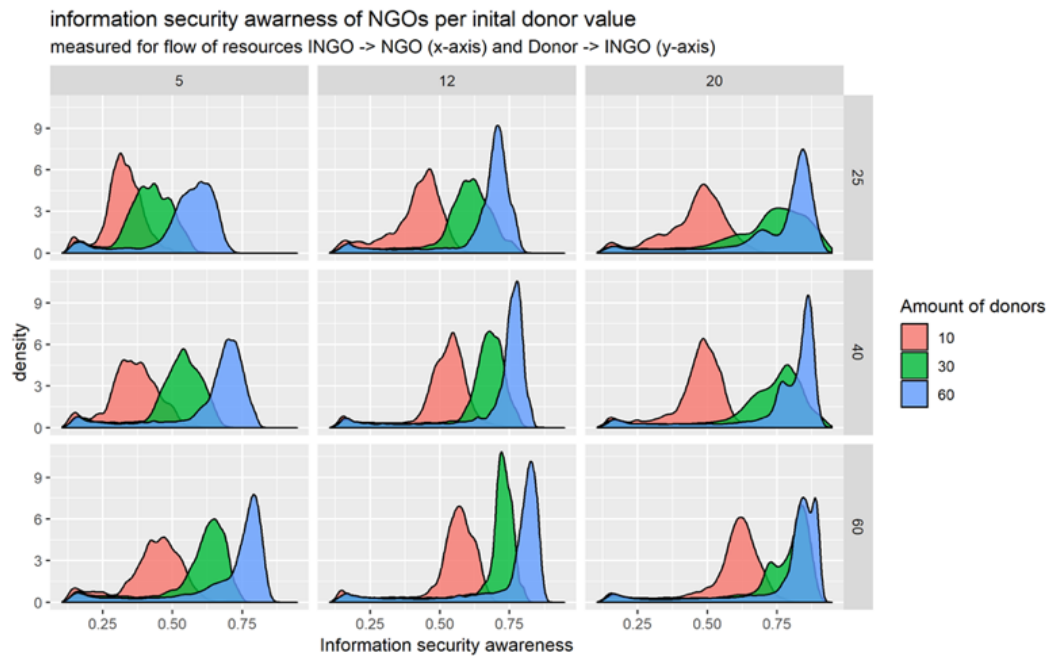
information security awarness of NGOs per inital donor value
measured for flow of resources INGO -> NGO (x-axis) and Donor -> INGO (y-axis)

Figure 11 22: Information security awareness over donor value, amount of resources to INGOs(x), and resources from Donors(y)

E2.2 Timeline exploration

The Timeline sanity check shown in appendix B4.5 shows that a runtime of 10.000 steps was not necessary when it comes to runtime determination. Therefore, the model is run for 6000 steps. Figure 11 23 shows the number of INGOs and NGOs plus their corresponding resources over these 6000 time steps. The first thing that comes to mind is the fact that INGOs stabilize relatively fast, while the behaviour of the NGOs stays more capricious. However, it can be perceived stable since there are not attractors visible and the behaviour fluctuates around stable levels.
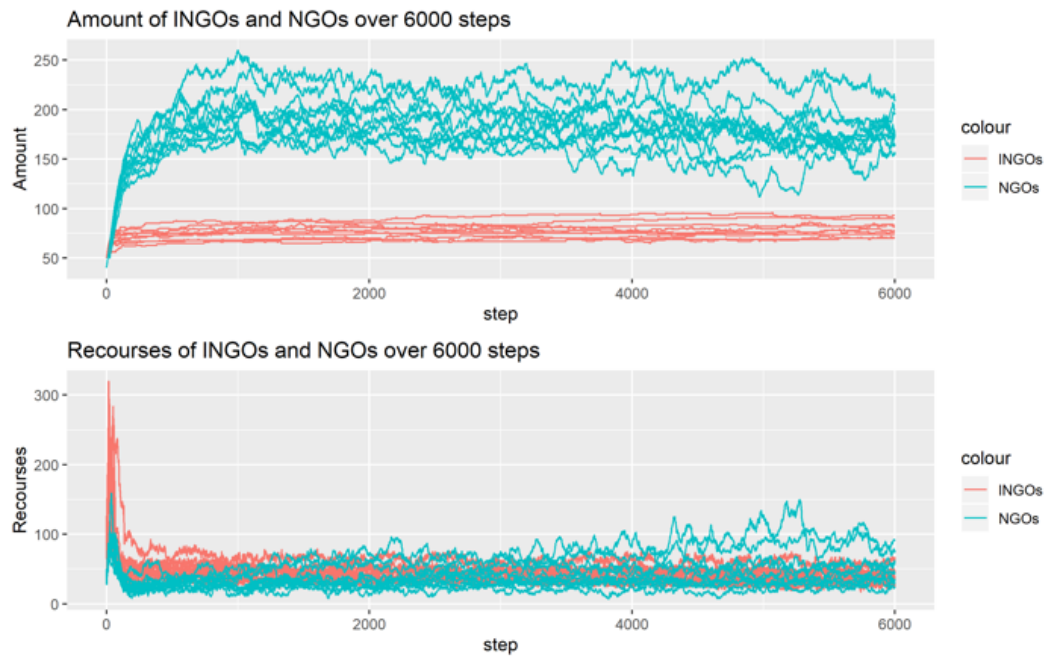
Figure 11 23: The number of INGOs and NGOs over 6000 timesteps and their corresponding resources

Figure 11 24 shows the information security awareness, efficiency, and reputation levels of INGOs and NGOS over 6000 steps. The first thing that comes to mind is that the reputation levels almost immediately stabilize. Information security awareness and efficiency need longer, but around 1000 time steps they stabilize as well.

Looking at figure Figure 11 23 and Figure 11 24 a 1000 time step runtime is possible, but data could be lost when the number of NGOs is increased. Therefore, it is decided to set de runtime on 1500 time steps. Figure 11 25 and Figure 11 26 show the graph with the 1500 boundary to where the simulation time is set.
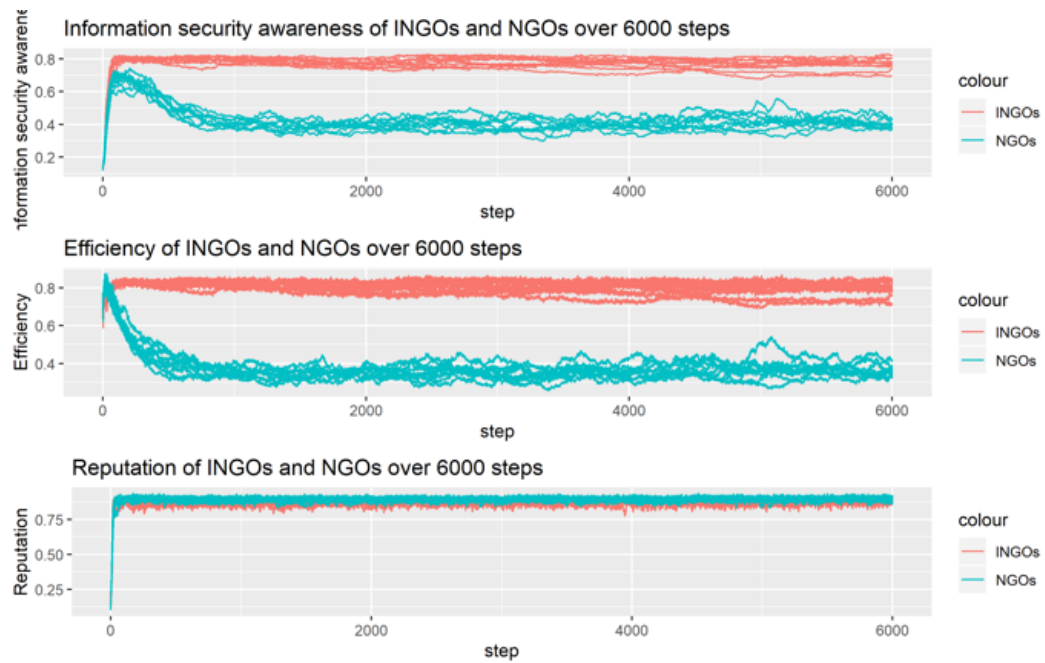
Information security awareness of INGOs and NGOs over 6000 steps

Efficiency of INGOs and NGOs over 6000 steps

Reputation of INGOs and NGOs over 6000 steps

Figure 11 24: The information security awareness, efficiency, and reputation levels

Amount of INGOs and NGOs over 6000 steps

Recourses of INGOs and NGOs over 6000 steps

Figure 11 25: The boundary of the 1500 time step runtime
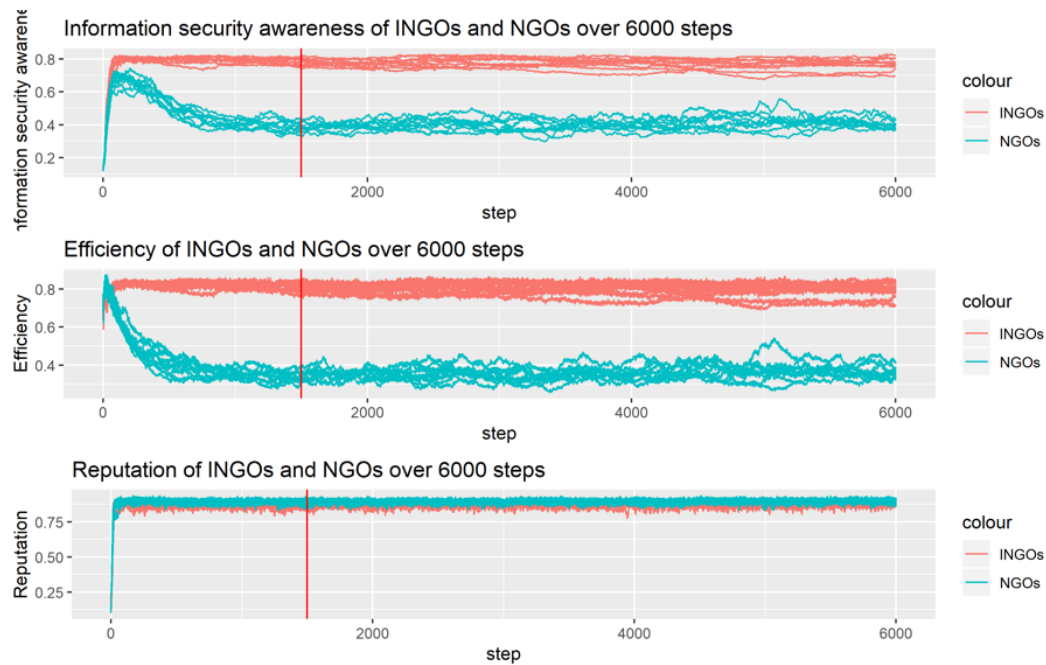
Figure 11 26:The boundary of the 1500 timestep

Appendix F. Validation

During the validation, the researcher tries to answer the question "Did I model the right system?". This step is vital because if the validation turns out negative, the model result will not be able to answer the model and/or research question. Validation is seen as a difficult step, especially during explorative research where the researcher is more concerned about the future state of the system than representing the current state adequately. Validating future-oriented and explorative models focusses therefore more on the usefulness than the actual representation of the real world system. Hereby, the goal of the model is generate insight about how the system could work or what knowledge is missing to accurately model the system instead of the quantitative outcome of the model. Since this holds for this research, there validation methods that will be discussed are the ones that are applicable for these kind of models (Nikolic, et al., 2013). The possible validation methods are:

· Historic replay
· Expert validation
· Literature validation
· Model replication

Historic replay models the system accurately so that it matches historic data. If the

model can represent historical events, behaviours, an actions, the experiments can explore future events. However, there is no historical data discovered during the research that provides insight in humanitarian cooperation regarding or un-regarding information security awareness. Therefore, this validation method will not be used during the validation step of this research (ibid).

Expert Validation is a commonly used validation method when it comes to agent-based models. Due to a lack of data, problem owners and experts are asked to assess the model, the model assumptions, behaviours, and usefulness for the designed purpose. However, one has to take into account that experts can be wrong or biased. Therefore, this must be addressed in the discussion of the research (ibid). Due to a lack of data, the validation method that will be used in this research will be Expert Validation.

Literature validation means that the model is compared to other, similar models used in earlier research to see if it is compatible in terms of behaviour, course of action, and system assumptions (ibid). In Chapter 2 and Chapter 3 different research regarding the use of modelling in the humanitarian sector is discussed and the conclusion drawn from that research was that this was not available. Therefore this form of validation will not be used.

Model replication is seen as the last resort when the other validation methods fail to be applicable. Model replication means that the same system is modelled preferably with another modelling method and by another researcher (ibid). If behaviour is similar and results comparable than the model can be deemed trustworthy. Due to time constraints and the fact that the research team consist of one person, this option for validation will not be taken into account. However, this will be discussed during the discussion of the research because it is – especially due to the lack of data about this topic – something to consider for further research.

Looking at these four validation techniques, expert validation is the only technique that is considered possible and feasible for this research. The expert validation is discussed in Chapter 8.

Appendix F2: Expert validation questionnaire

Dear participant, thank you for your help in validating my research. Before we start, please fill in your name and a small description of how you are involved in the humanitarian sector and/or what you expertise is in this field.

The goal of my research is to identify the interaction between humanitarian organizations and the core mechanisms that shape this behaviour. This study focusses on the influence of these interactions on the sector's dedication of resources to information security. From this study an agent-based model was built to simulate the different interactions between large donors, international NGOs, and local NGOs.

The choice of Modelling and simulation as the research method serves two goals:

·	To systematically identify the norms and rules of the humanitarian sector which can form a starting point to improve information security in the sector.

·	To identify the missing information and data that is needed to build a model. This will be used for the recommendations on future research on how to gain insight in the humanitarian sector.

Because little amount of literature and data on interaction in the humanitarian sector was found, the model of this study is based on assumptions. Through this survey, I ask you to validate some of the core assumptions based on your own expertise and experience. This validation covers three topics:

·	Model assumptions
·	Model flow
·	The validation of the method

Topic 1: Model assumptions

The model assumptions that follow, form together the foundation of this study's model. Please answer with "agree" or "disagree" and elaborate on your response.

Assumption 1: When scouting the field for new partnerships with other humanitarian organisations, the Culture of each organisation is highly/very important. An organisation looks for similarity in their potential partner because they deem them to be more trustworthy than others.

Assumption 2: Humanitarian organisations will not cooperate with organizations or regimes that are deemed illegal or are not supported by their home government.

Assumption 3: Organisations prefer to re-instate a former partnership with another organisation over new ones. Better image and higher level of transparency of these "new" ones do not influence this preference.

Assumption 4: Humanitarian organisations base their priorities on the preferences of their donors. When donors explicitly prefer well-ordered information security in their organisation of choice, humanitarian organisations will spent more of their resources to get this done.

Assumption 5: Humanitarian organizations base their choice of new partnership on the reputation of their potential partners and how transparent they spend their resources.

Question 1: Are there aspects of the interaction between humanitarian organisation not mentioned in these assumptions that should have been mentioned?

Topic 2: Model flow

Modelling and simulation were used to build a model with three types of agents: First, the donors, who choose international organizations to donate resources to. They assess their potential partners based on the previous assumptions. Second, the international NGOs seek partnerships with local NGOs, using the same assumptions to find suitable partners. Last, local NGOs can decide to partner with other local NGOs if needed. Partnerships are costly and the organisation that initiates the partnership is responsible to provide for the needed resources. Both the international and the local NGOs can spent their resources in four

different ways:
- ·   Provision of care
- ·   Organizational costs (salaries etc.)
- ·   Build partnerships and provide partners with resources
- ·   Investment to increase performance of the organizations.

Question 2: is this top-down flow of resource allocation consistent with (the) reality?

Question 3: is this top-down way of finding and forming partnerships consistent with (the) reality?

Question 4: Are there mechanisms of establishing partnerships, players, variations of partnerships, or ways of using/spending resources in the humanitarian sector not named in this questionnaire?

Topic 2: Method validation

Modelling and simulation are used in this study to systematically gain insight on the humanitarian sector and locating possibly missing data and information. A downside of this technique is that the constructed model becomes very abstract and might miss a connection with reality.

Question 5: What are your thoughts on using modelling and simulation in research?

Question 6: Do you have suggestions on alternative research methods that might also be suitable for this study?

Final remarks

Thank you for your time and effort. I appreciate your input and have as a final question:

Question 7: Are there any final remarks, tips, or comments that would help me with this research?

Appendix F3: Expert panel

This section shows an overview of the members of the expert panel. The information provided is quoted from the websites of the institutes they are connected with.

Dr Helen Hintjens

"Assistant Professor in Development and Social Justice at the International Institute of Social Studies in The Hague. For more than 30 years she has studied the comparative asylum policies of EU member states in the context of broader post-colonial relationships and ideas. Her regional focus on the countries of the African Great Lakes region, especially Rwanda and Eastern DRC, and the relations of francophone Africa with EU member states. She has conducted research into urban health needs and strategies in The Hague and Rotterdam with colleagues from ISS and EUR" (Erasmus University, 2018)

Andrej Verity

"An information management officer at the United Nations (UN) Office for the Coordination of Humanitarian Affairs (OCHA) in New York and a co-founder of the Digital Humanitarian Network. Between responding to emergencies, he

leads OCHA's multi-skilled Digital Services team providing strategic end-to-end service development, integrating and promoting standards and taxonomies, and managing platform-as-a-service support to a variety of sites ranging from ReliefWeb to the Humanitarian Data Exchange to the Financial Tracking Service to unocha.org. Verity has been working in the information management field for over 15 years, with the last 12 in the humanitarian realm. He has responded to many of the recent, major sudden onset emergencies - the 2010 Haiti earthquake, the 2010 Pakistan floods, the 2013-14 Philippines typhoon and the 2015 Nepal earthquake" (DHnetwork, 2018).

Nontas Papadimitriou

"Experienced Quality assurance manager and auditor. Information Management Specialist with a demonstrated history of working in the non-profit organization management industry. Skilled in Operations Management, Emergency Management. Additional practical & academic skills supported by a Certification in Humanitarian Supply Chain Management (CHSCM) focused in Logistics, Materials, and Supply Chain Management from Fritz Institute" (LinkedIn, 2018).

Samer Abdelnour

"An Assistant Professor at the Rotterdam School of Management. Part of his work uses organization theory to explore how international (humanitarian) organization conceptualize, plan and launch interventions. He also does conceptual work on actors, agency and institutions (in the tradition of taken-for-granted norms, rules, values). Since 2006, He has undertaken extensive fieldwork in Sudan and Southern Sudan with displaced communities, former combatants, and the organizations seeking to serve them. A key focus for his current work is 'Humanitarian Technology', funded through a Marie Curie Fellowship (2015-2017)" (Rotterdam School of managment, 2018).

Shyamika Smits Jayasundara

"Dr.Shyamika Jayasundara-Smits is a post-doctoral researcher at the Department of Sociology of the International Institute of Social Studies (ISS), Erasmus University Rotterdam.

She holds a PhD in Development Studies from International Institute of Social Studies (ISS), Erasmus University Rotterdam, The Netherlands, MA in Conflict Transformation and Peacebuilding from Eastern Mennonite University, Virginia, USA and BA (Hons.)in International Relations from University of Colombo, Sri Lanka. She is a former Fulbright Fellow. She is interested in exploring issues on global governance with an emphasis on peace and violent conflicts. She is a specialist on South Asia and have mainly conducted field work in Sri Lanka. Dr. Jayasundara-Smits also has an extensive background as a consultant with various International Organizations, Civil Society Organizations and Community Based Organizations on Conflict, Post-Conflict and Peacebuilding related issues" (Eramus University, 2018).

Appendix F4: Summary of survey responses

F3.1: Validation of the model assumptions

In this section, the expert validation of the core assumptions is discussed. The core assumptions are the foundation of the model and decisions about how to conceptualize the model are based on these assumption. This validation step is to make sure that the assumptions are rightly subtracted from literature and in line with practise. All five assumptions will be discussed separately, together with the first question of the validation survey which focusses on the assumptions as well.

Assumption 1: When scouting the field for new partnerships with other humanitarian organisations, the Culture of each organisation is highly/very important. An organisation looks for similarity in their potential partner because they deem them to be more trustworthy than others ▢ Positively validated.

All experts agreed with this assumption, especially in the donor – INGO relationship building. However, there are some aspects that are not taken into account. First, there is the notion that culture represents trust. Multiple experts have stated that culture alone is not sufficient enough to describe how trust between organization work. Trust is often something that is shared between people instead of organizations. A trusted personal relationship between people is often leading when organizations decide to build partnerships.

Second, the ability to communicate is more important than sharing a culture, although sharing a culture often means speaking the same language and understand each other.

Finally, building partnerships is often not about trust and culture, but about finding complementary organizations or beat the competition. Complementary organizations means that organizations seek partners who are able to do something or have access to something that the own organizations lacks. Partnerships in this case are therefore build out of need instead of trust. Furthermore, if there is much competitions between similar humanitarian organizations, partnerships will be build out of the need/desire to gain more access and influence than the competition.

Assumption 2: Humanitarian organisations will not cooperate with organizations or regimes that are deemed illegal or are not supported by their home government ▢ Negatively validated

This assumptions is unanimously rejected by the expert panel. There are experts who have stated that this is officially the rule, however, it does not apply to practise. Looking at the responses of the expert panel, there are two reasons why this assumptions does not hold in practise: the need for access and the need to go where humanitarian assistance is required. Most areas where humanitarian assistance is required are controlled by organizations or regimes that are not supported by their home government. Seeking partnerships with these groups/regimes is the only way to require relatively safe access to these areas. Furthermore, this does not only hold on a local level. On a strategic level, humanitarian organizations – as well as governments – are willing to cooperate

with (political) parties that are declared illegal by their own government to gain access to areas or extend influence. One of the examples that is provided here is the example of the western support for various Ukrainian political and social movements during the Russian annexation of Crimea.

Looking at the general reactions of the expert panel, the legal restrictions and obligations are not as black and white as assumed. Humanitarian organizations decide case-by-case which organizations or regimes they want/need to partner with and the legal preference of their home government is just one of the factors that is taken into account when making these decisions.

Assumption 3: Organisations prefer to re-instate a former partnership with another organisation over new ones. Better image and higher level of transparency of these "new" ones do not influence this preference ◻ Positively validated.

The expert panel agreed on this assumption, however, some things where mentioned. First, there is a difference between organizations and people who populate the organizations. Their personal relationships are leading when partnerships are build. This is identified as the mechanisms behind re-instating of the partnerships although they might "score" worse than others. Second, humanitarian organizations go where access leads them. If earlier partnerships have provided them with more/better access, they are likely to return. Finally, transparency and image are concepts that are not by definition valued by humanitarian organizations. Organizations who do not value these concepts, will not seek them in their partners.

Assumption 4: Humanitarian organisations base their priorities on the preferences of their donors. When donors explicitly prefer well-ordered information security in their organisation of choice, humanitarian organisations will spent more of their resources to get this done ◻ Positively validated.

This assumptions is unanimously confirmed by the expert panel. There is one thing that is mentioned by multiple expert in the panel that can be added to this assumption. This is the relation between donors and humanitarian organizations. Donors demand different things and cannot be assumed homogenous. Humanitarian organizations on the other hand, will try to pursue their own agenda while keeping their donors satisfied. This means that they will "play the game, but bend the rules". Hereby, the expert stated that what humanitarian organizations say and how they act might be different to keep their access to resources on multiple fronts.

Assumption 5: Humanitarian organizations base their choice of new partnership on the reputation of their potential partners and how transparent they spend their resources. Partially positively validated.

This assumption is regarded positively, but partially. All experts from the panel agree with the statement but added that the reputation and transparency are just one of the factors that are taken into account, and definitely not the most important. They underline that among reputation and transparency, access,

risk, acceptance by host community, ability to monitor, credibility, and ethics as potential (but not all) factors that determine choice of partnership.

Question 1: Are there aspects of the interaction between humanitarian organisation not mentioned in these assumptions that should have been mentioned?

There are three main suggestions that – in addition to what has been answered based on the assumptions – are mentioned in the answers to this question. First, the difference between humanitarian settings is underlined. In crisis situations different criteria play a role than in long-term refugee camps, although in both situations refugees affected by conflict are the people humanitarian organizations offer assistance. A model that is to general and does not take the different settings into account misses a big part of how decision-making criteria are selected.

Second, risk is an important factor in building relationships. Especially in conflict affected situations, humanitarian workers -both foreign and local – are at risk. Partnerships that increase safety or reduce risk for the humanitarian workers are seen as preferred in these situations.

Finally, not all partnerships are successful. Many aren't. There should be a mechanism in the model that represent a the personal factor of relationships building. Some partnerships do not succeed and this decreases the likelihood that cooperation between these organizations will happened again.

F3.2 Validation of the model backbone structure

This part of the validation process focusses on the model backbone. The model is built using a top-down perspective on resources and a bottom-up perspective on information. These flows determine the models structure and are validated to see to what extent these flows are consistent with reality. This part of the validation process consists of three questions.

Question 2: is this top-down flow of resource allocation consistent with (the) reality? Partially right

The responses from the expert panel are mixed. Most agree, however, they agree while stating that generally speaking it is true, but in practise it is more complicated. There is a lot of funding that goes directly to local NGOs, faith-based groups and even individuals. It is less than a percent of tot total amount of funding, but in a billion dollar industry, this amount is still billions and therefore too large to neglect.

Question 3: is this top-down way of finding and forming partnerships consistent with (the) reality? Partially right

The expert panel makes a clear distinguish between high-level global interactions and on the ground local-level partnerships. In the case of large - often governmental – donors who seek international NGOs to fulfil a political agenda the assumed relationships are deemed right. However, when looking at the local partnerships between INGOs and NGOs or between NGOs, this is completely different. Personal relationships, faith-based initiatives, shared history, and embeddedness in the local communities are all factors that are part of this system. These interactions

all play at local levels and are more networked than top-down.

Question 4: Are there mechanisms of establishing partnerships, players, variations of partnerships, or ways of using/spending resources in the humanitarian sector not named in this questionnaire?

Religion, ethnicity, and (political) allegiances are the three factors that are mentioned by multiple experts. These are all top-down forms of trust that exceed the nation of culture and cannot be determined or explained taking a global perspective. These factors can be between INGOs and NGOs, but also between INGOs or NGOs and beneficiaries.

F3.3 Validation of the method

Finally, the validation of the method as a way to conduct research is validated. Modelling and simulation is used in this study to systematically gain insight on the humanitarian sector and locating possibly missing data and information. To make sure that this method is the right one or is able to bring enough insight to reach the research objectives, the method is validated as well.

Question 5: What are your thoughts on using modelling and simulation in research?

In general, the expert panel agreed on using modelling and simulation to gain insight in how humanitarian interactions is designed. However, most of the experts underline this to be a first step in research. Modelling can identify the missing knowledge, but for this method to contribute it should be extended with interviews, case studies, and - in an ideal situation- field research.

Question 6: Do you have suggestions on alternative research methods that might also be suitable for this study?

This question is answered during question 5, were the expert panel underlined the additional research that needs to be done in order for the modelling research to be of added value.

Appendix G. Results

Appendix G1: Model results

In this section, the different experimental results are discussed. Hereby, the focus lies on information security awareness, the influence of resources, the influence of the recourse flow, and the influence of the number of donors in the system. Due to the difference in results, the INGOs and NGOs are discussed in different graphs.

G1.1 The influence of resources

The model exploration showed a possible large role of resources in the model results, but this could not be proven with the dataset used for the model exploration. Therefore, this section discusses the role of resources in the model results. This is done in two steps: First the difference in resources per policy options is discussed and second the influence of resources on information security

awareness is shown.

Figure 11 29 and Figure 11 29Figure 11 30 show the boxplots for the resources per policy options for the INGOs and the NGOs. For the INGOs, the boxplots are very similar with medians around the same levels and the standard deviations all very similar, except for the policy option "Earmarked donation". This policy options is the only one that is different from the other policy options with a – slightly – different mean and a larger distribution and variable range. However, looking back at Figure 11 27, this policy option does not show more information security awareness. Therefor the hypotheses that more resources directly correlate with more information security awareness cannot be confirmed at this stage.
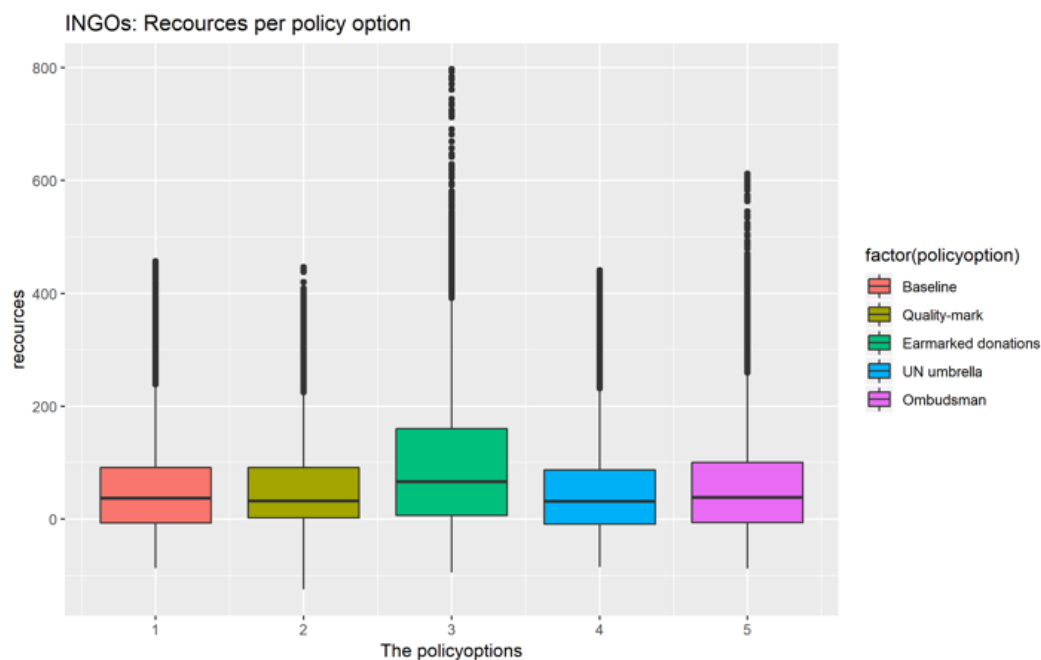
Figure 11 29: The difference in resources per policy options for the INGOs

Figure 11 30 shows the boxplots for resources per policy option for the NGOs. This figure shows that the only policy options that gives different – lower – results is the policy option quality mark. The other four policy options show similar medians, standard deviations and value ranges. The results of the second policy option is this figure correspond with the Figure 11 28, where this policy options shows lower results than the other policy options as well. Opposite what the results for the INGOs show, the hypotheses that resources influence information security awareness seem to hold for the NGOs.
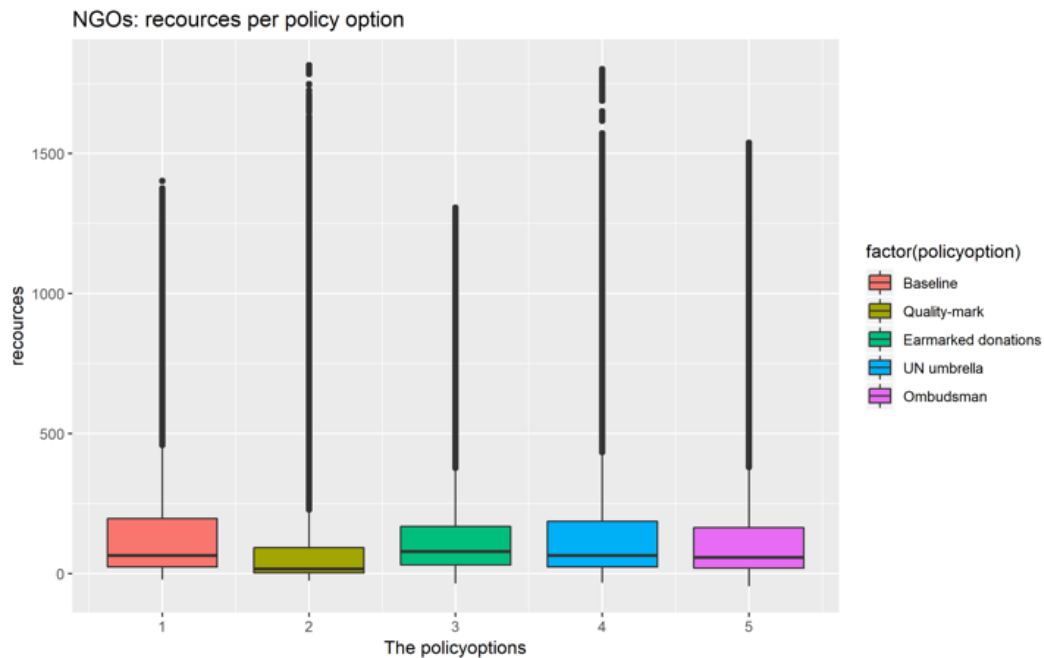
Figure 11 30:The difference in resources per policy options for the NGOs

To research to influence of resources on information security awareness, a second step must be taken. In this step, the amount of resources is set against the information security awareness levels of the INGOs and NGOs. This is show in Figure 11 31 and Figure 11 32.

Figure 11 31 shows that the correlation between information security awareness and resources for INGOs is uniformly distributed. Meaning that a rise in resources does not mean a rise in information security awareness. Looking at the previous graphs regarding the INGOs, this is expected. However, this graphs proves that for the INGOs, the hypotheses derived from the model exploration can be rejected.

information security awarness of INGOs
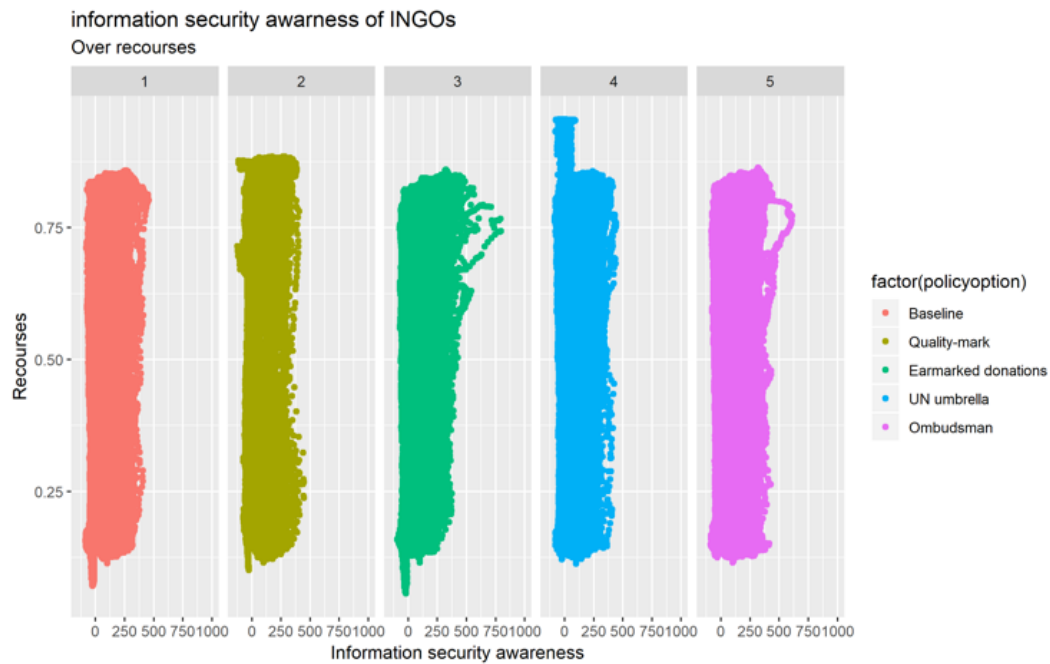Over recourses

Figure 11 31: Information security awareness set out over resources of INGOs

Figure 11 32 shows the same correlation for the NGOs, and these results are different. For all five policy options, there is a positive relationships between resources and information security awareness. Meaning that a rise in resources means a rise in information security awareness. Looking at the previous graphs regarding the NGOs, this is expected. This graphs proves that for the NGOs, the hypotheses derived from the model exploration can be confirmed. However, there is a difference in these relationships, indicating that there might be other variables that influence these results as well.
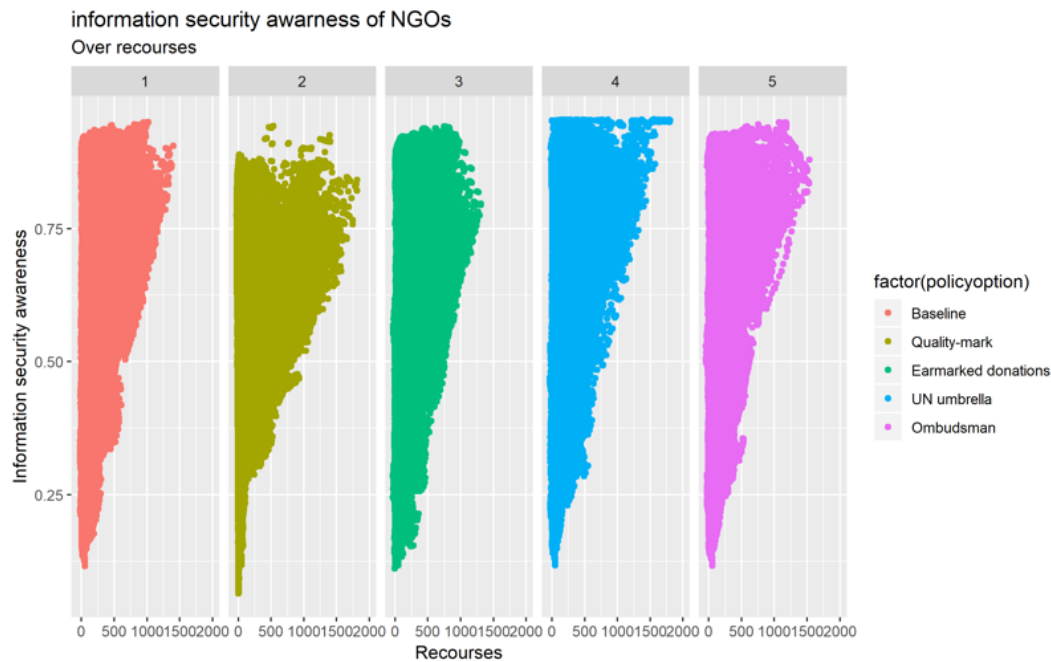
Figure 11 32: Information security awarness set out over resources of NGOs

G1.3 The influence of the resource flow

In this section, the influence of the recourse flow is discussed. The recourse flow is determined by the variable "received-money-per-donor" and "resources-to-NGOs". This is done in four graphs, showing in influence for both the variables per policy options for the INGOs and NGOs. Due to the in the previous section discovered difference between INGOs and NGOs. First the result for the INGOs are discussed and second for the NGOs.

Figure 11 33 and Figure 11 34 show the influence of "received-money-per-donor" and "resources-to-NGOs" on information security awareness of INGOs. The graphs show behaviour that is – after the results of the model exploration – expected. The more resources INGOs receive from donors the higher the information security awareness levels. Furthermore there is a clear difference between the different policy options. Important to note here, is that the resources from the previous paragraph and the recourse flow are two different things. The resources form the previous paragraph show the amount of resources the INGOs and NGOs owned at certain timesteps, while the "received-money-per-donor" variable shows how much resources they obtain per timestep from their donors. Although these two variables are closely related, they are not the same.

Figure 11 34 shows how much of the obtained resources INGOs give to their NGO partners per time step. The relations shown in this graph is expected as well. The bigger the share of resources INGOs give to their partners, the less remains to

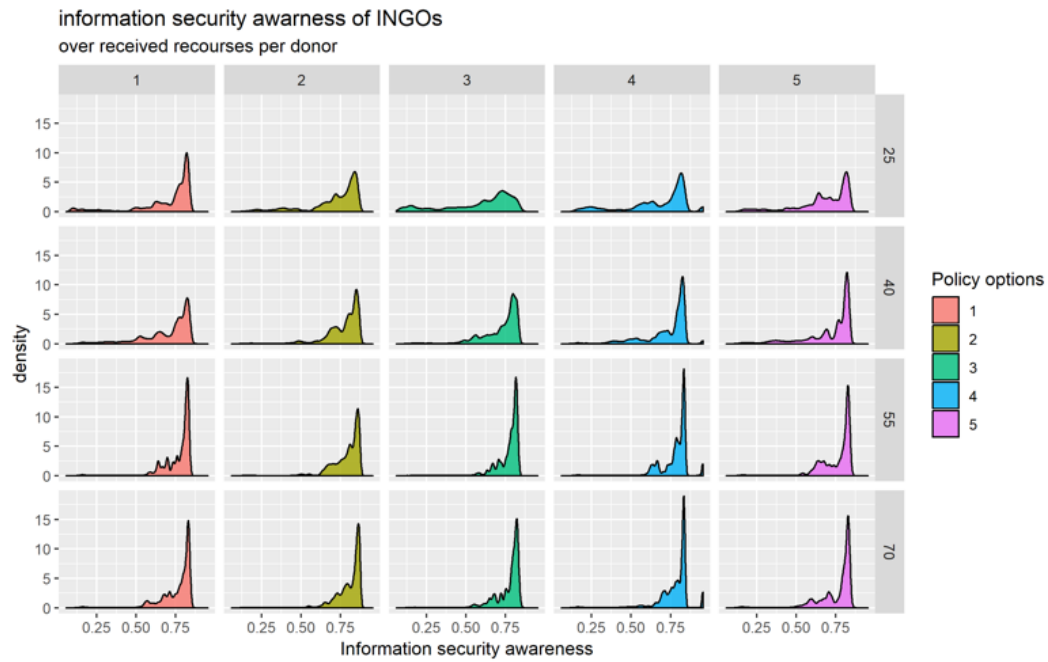invite in information security awareness.

Figure 11 33: The influence of the received resources per donor on information security awareness for INGOs
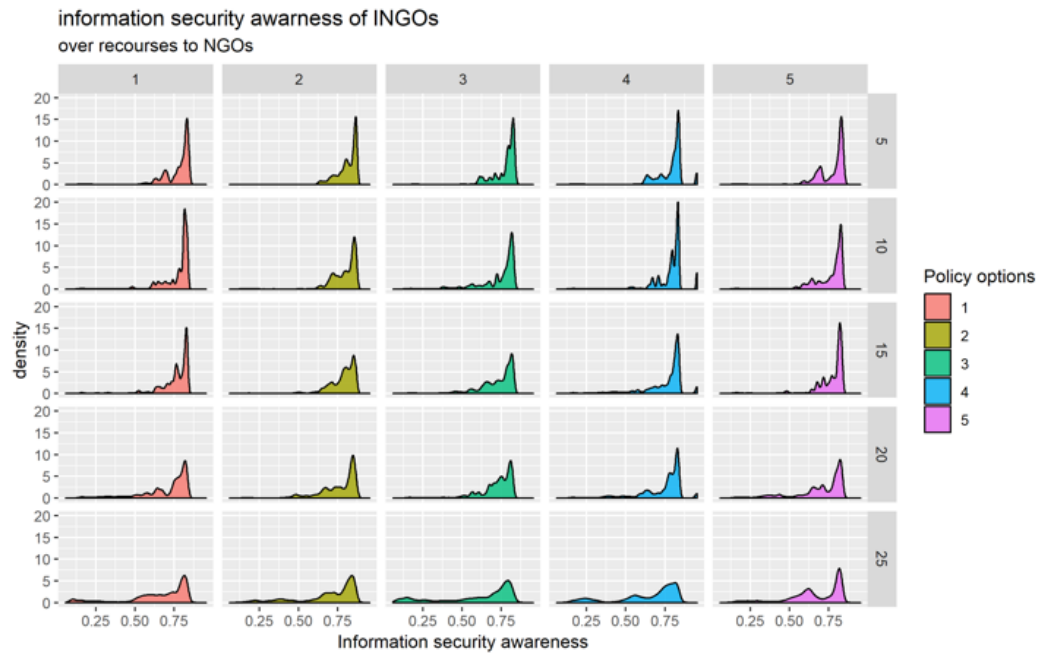

Figure 11 34: The influence of the resources to NGOs on information security awareness for INGOs

The end.