Evaluating Strategies for Intra-Organizational Information Management in Humanitarian Response

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ABSTRACT

Information management is critical in humanitarian response, yet intra-organizational information management practices have not been well-studied. This paper evaluates several strategies for intra-organizational information management. An agent-based model represents the dynamics of information-gathering and -sharing, in order to examine the impact of each strategy on (1) the time required to acquire adequate information for decision-making and (2) the amount of excess information acquired in the process. The results show that holding regular information-sharing meetings significantly reduces the time to acquire adequate information, but does not reduce information overload; however, deploying an information management specialist reduces both time required and information overload. Other strategies enable smaller improvements. The results support recommendations for humanitarian organizations deciding how to improve their internal information management approaches. As the role and importance of humanitarian information management is expanding and changing rapidly, our results are a timely contribution to both inspire further research on intra-organizational information management and to support practice decisions as organizations design their own information management strategies.

Keywords

information management, agent-based model, intra-organizational, humanitarian

INTRODUCTION

In the first days following a disaster or emergency declaration, humanitarian organizations scramble to understand the size, scope, and impact of the event, in order to support critical decisions about how to respond. In these contexts, information is scarce and rapidly changing, due to infrastructure damage and fast-moving events. Organizations spend significant time and resources to understand what the needs are following the event so as to shape their response efforts. (Gralla et al. 2013; Digital Humanitarian Network, Decision Makers Needs Community and UN OCHA 2013. The problem of how organizations decide to manage their information is highly relevant, not just for the strategic resource deployment that hinges on this decision, but also because the operational decisions that are made using situational information- such as the appropriate locations for medical clinics- are critical to the effectiveness of the subsequent response and recovery.

Information management is both critical and challenging in humanitarian response (Schryen et al. 2015; Comfort 2007; Altay and Labonte 2014). Information must be diffused as quickly as possible to enable time-sensitive

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decisions, but practitioners also bemoan the "fire hose" effect when they must handle vast amounts of information, overwhelming their capacities to determine what is useful information and what is superfluous to their specific tasks but important for the overall response (Altay and Labonte 2014; Bui et al. 2000).

In practice and in research, humanitarian information management is receiving increased attention, especially information-sharing across organizations. The Office for the Coordination of Humanitarian Affairs (OCHA) typically coordinates information and response efforts (IASC Working Group 2008), and studies have examined barriers to and strategies for effective inter-organizational information management and coordination (Altay and Pal 2014; Faraj and Xiao 2006; IASC 2010, e.g.,).

However, humanitarian organizations are increasingly standing up their own information management (IM) teams to assist in funneling useful information to their field teams to assist in planning, situational awareness, and decision-making (Surge Information Management Support 2014; NetHope Inc. 2017; Pham 2016). This relatively new organizational function in humanitarian organizations, and the various strategies used to accomplish this work, has not yet been explored in the literature, despite work that looks at inter-organizational information management strategies.

This paper uses an agent-based model to analyze various strategies for intra-organizational information management, in order to identify how each of these strategies contributes to humanitarian team members' faster task accomplishment. We consider six strategies that are either employed in practice or recommended by other studies: (1) increasing willingness to share information with other agencies; (2) holding meetings to share information; (3) deploying an IM specialist; (4) deploying an IM specialist with a remote team of IM support specialists; (5) improving the quality of the IM specialists' work; and (6) varying the frequency of information-sharing meetings. Our agent-based model builds on Altay and Pal's framework and updates the scenario to reflect the recent focus on intra-organizational information management.

BACKGROUND AND RELATED LITERATURE

Information management (IM) is acknowledged as an important part of humanitarian response (Christopher and Tatham 2014; Tomasini and Van Wassenhove 2009).Organizations understand that information can improve the efficacy of humanitarian operations (Schryen et al. 2015; Comfort 2007). However, historically, individual organizations have not had a specific IM function on their teams. The cluster system has provided information management support to the response community for a number of years, serving as an information hub for the overall response as well as for individual sectors such as water and sanitation or nutrition (UN OCHA 2017).

To support the humanitarian community's focus on coordination through information-sharing, studies have investigated the benefits of various strategies for information management. In particular, Altay and Pal evaluate the value of two strategies in speeding up information diffusion in a response: employing an information hub (which represents the information management function of the clusters) and improving inter-organizational trust. Their findings support the assertion that clusters can help diffuse information more quickly, but they found that the willingness to share information between organizations was the greater determinant of rapid information spread.

In addition to inter-organizational IM, information management happens within organizations as well. While OCHA leads on the coordination of information between actors, much of the information they coordinate originates from individual operational organizations (Verity et al. 2014). Some of the most important coordination information consists of which organizations are doing what in which parts of the affected area. These commitments can only be shared for wider distribution among partners *after* individual organizations have made those decisions internally, based on their own process of evaluating information and determining where their organization will work and in what capacity.

Internal IM is therefore critical to the success of each organization's response and to the coordination of the response overall. Theory supports the importance of improving internal information management: Faraj and Xiao argue that an organization working in fast-paced, high-stakes environments must practice knowledge coordination in order to manage and effectively apply distributed expertise. It is not clear whether the internal barriers to information management are similar to the barriers to inter-organizational information management.

Low willingness to share was identified as a key barrier for inter-organizational information sharing (Altay and Pal 2014), but is less likely to inhibit internal IM, except when information originates outside the organization. Other barriers, such as "information overload", when huge amounts of information start becoming available (Bharosa et al. 2009), are likely to be equally challenging for internal and inter-organizational information management. Internal information management requires investment and attention to information-sharing and -management

practices within the organization, which is difficult for reasons ranging from a lack of understanding the benefits of information coordination to a lack of available resources.

IM functions are now being stood up within operational organizations in some contexts (Surge Information Management Support 2014; NetHope Inc. 2017; Pham 2016). For example, the Surge Information Management Support project at the International Federation of Red Cross and Red Crescent Societies (IFRC), and various National Societies, supports response information management with either remote or deployed information managers (Surge Information Management Support 2014). However, since many of these IM roles have been introduced recently, their effectiveness and structure have not been evaluated in depth.

To support the deployment of more effective internal IM functions, it is important to understand what IM strategies work well. Altay and Pal have evaluated practical strategies for inter-organizational information management; this paper builds on their framework to explore a gap in the existing literature- strategies for *internal* information management- and makes recommendations that we hope will enable improvements to organizational IM in practice.

METHODS

To examine the advantages and disadvantages of various strategies for internal information management, we use an agent-based model that represents key dynamics of information-seeking and -sharing in humanitarian response. Our model builds on the framework developed by Altay and Pal. Agent-based models are useful for this purpose because they explore how the interactions among responders collectively contribute to organization- and system-wide outcomes. Specifically, this model examines the influence of individual information-sharing interactions on the diffusion of information within the humanitarian response ecosystem, measured by the time it takes individual responders to find the information they need in order to make decisions and plan operations. It also represents the "cost" of improving information-sharing by computing the information overload – information that is irrelevant for a particular task, acquired by each responder.

While the model represents information diffusion across the entire response, we are particularly interested in how an individual organization, which we label the "focal" organization, chooses to manage its own information. Several internal IM strategies are modeled and evaluated. We first analyze a baseline situation with no active strategy for managing and sharing information, then examine the following strategies to understand their relative effectiveness in improving speed of information diffusion and reducing information overload:

- Increasing willingness to exchange information with other organizations
- Implementing regular team meetings to exchange information
- Deploying an IM specialist (with regular IM tag-ups)
- Deploying an IM specialist with a remote support team
- Varying the frequency of exchange meetings or IM tag-ups

The model uses simple rules to represent the essential elements of seeking and exchanging information in humanitarian response. By focusing only on the key dynamics, the model makes clear how different organizational strategies for managing information compare with each other, and provides some indication of which strategy might be most useful in different response scenarios. The paragraphs below provide a summary of the model environment and performance measures; then, the following sections explain in more detail the types of agents and the types of interactions among agents, and finally the way the model represents the six strategies for information management.

Model Environment The model simulates the basic interactions that may result in an exchange of information during the response – interactions with other responders and with information sources. Borrowing from Altay and Pal's conceptualization of the response environment, agents move around a physical space, and when they randomly encounter other agents, they seek to exchange information with them. They may or may not gain some information from each interaction (the details of each interaction and its success are discussed in Section). When responders have sufficient information, they stop seeking information and exit the environment (move to a "camp"). Figure 1 illustrates the model environment. The physical space of the model represents the geographic area affected by the disaster and, in particular, the space within which agents must move to find their information. The "camp" represents the ability to make a decision – when agents have enough information, they can work on their tasks (move to the camp) and stop seeking information. The random movement models the need for physical movement in the response area and the lack of knowledge of where to find people or who must be found.

The model also represents the various elements of information – both relevant and irrelevant – that may be acquired by actors, and the diverse information needs of actors with different roles. There are a finite number of 'pieces' of information available in the scenario - represented by a complete 10-item array. As agents learn a new piece of information, their personal array of information gets updated. If the agent already has that piece of information, then their body of knowledge remains the same. To represent the different specializations of each responder and the ensuing differences in their information needs, each agent is randomly assigned a 'task'- represented by a portion of the complete array of information in the model, from 1-10 items, depending on the complexity of their task- at the start of the simulation which dictates which specific pieces of information are required for them to complete their information-seeking. For example, if an agent's task requires them to have 4 specific pieces of information, then there are 6 pieces of irrelevant information in the model, and 4 pieces that are relevant. To avoid information overload, responders want to reach their destinations with little to no irrelevant information. Irrelevant information is information that does not help the agent make the decision about their assigned task. Information that is relevant to their task is not considered part of the information overload.

This model environment abstracts away many features of the real response environment in order to focus only on the key dynamics: the need for interactions with other actors in order to acquire information, the time required to identify and meet those actors, the need for particular information, and the factors that enable or constrain information exchange in these actor interactions. One important dynamic that is not represented is the time required to process and format information; this is left to future research. Collectively, this model environment enables investigation of the relative effectiveness of various simple strategies for information management – such as filtering information for relevance before passing it to responders, or increasing inter-organizational willingness to exchange.

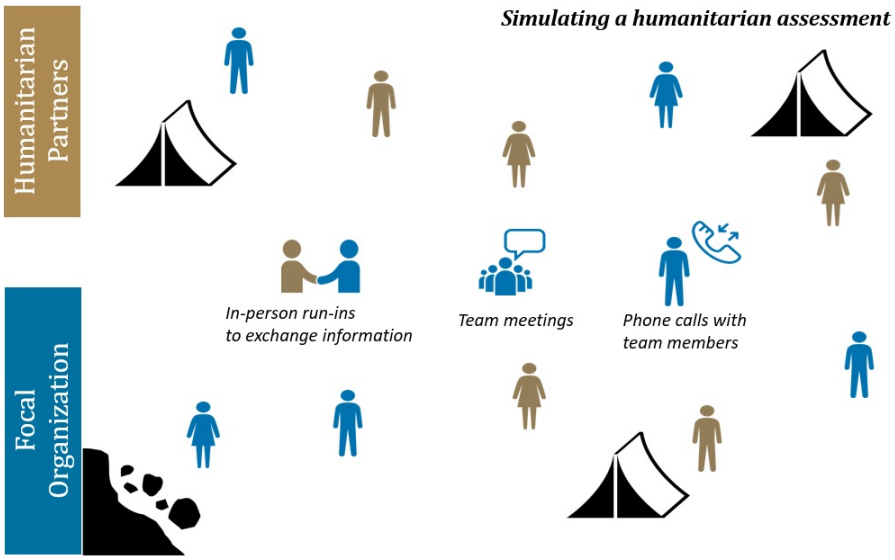

Figure 1. Model Environment: Agents move through the response space, interacting with other agents to find information needed for decision-making and planning

Measures of Performance In this study, the performance of various organizational IM strategies is evaluated based on two performance measures: (1) how quickly the focal organization's responders are able to find the information they need in order to make their response decisions, and (2) the amount of irrelevant information these responders acquire in the process.

Time to task accomplishment is measured by the median number of 'turns' required before all of the focal organization's responders finish their information seeking and arrive at their camps (the number of 'turns' is a rough measure of time, since a turn involves one movement each by all agents in the model).

Information overload is captured by the number of excess, unneeded pieces of information that a responder holds when they finish their information-seeking. In this model, as in reality, responders hope to focus on just the information that is most relevant for them and avoid acquiring and processing excess information.

Types of Agents

Humanitarian response organizations typically deploy an initial team to assess the situation, plan their organizational response, and start the aid delivery process. In addition to specialists in program management or relevant sectors

such as health, nutrition, or logistics, humanitarian organizations have also begun deploying information managers to assist with information seeking, analysis, and distribution.

We model six types of agents, each of which are described in more detail below. They include 'implementers' (responders) from our focal organization, implementers from other organizations, a deployed IM specialist, remote IM specialists, and injectors.

'Focal' Implementers & Other Implementers Implementers agents represent the response team members who, in actual response contexts, perform assessments, coordinate with other agencies, and plan organizational responses. Implementers are split into two categories: those who work for our focal organization, and those who work for other organizations. Implementers move around the model's physical space, looking to exchange information with the other agents that they encounter. When they are done looking for information, they move to one of the four camps.

Deployed IM specialist The focal organization can choose to deploy an IM agent to support the deployed implementers. This agent will also move around, looking for information. The deployed IM role hopes to facilitate the search for information that the implementers are undergoing, by filtering and sharing relevant information with team members quickly. The information management role does not have programmatic decisions to make, so it does not go to a camp, but rather continues to seek information until all its colleagues have reached their camps.

Remote IM support team Remote IM specialists support the focal organization from afar, and can only interact with injectors (representing online information sources) and the deployed IM agent. Like the deployed information management role, the remote roles also do not end up at a camp because they do not make programmatic decisions.

Injectors The injectors represent other actors in the affected area who might have or acquire information about the situation. This includes community-based organizations, government offices, news outlets, and the affected population. Injectors are the agents that hold the most information at the start of the simulation, and (in our model) are always willing to exchange information with other agents.

Agent Interactions

Much of the information exchanged in actual responses occurs through direct interactions between individuals. Responders meet each other at meetings, during meals, and in transit, and exchange information during these encounters.

To represent these dynamics in the model, we assume information must be gathered from other agents. Implementers may interact with any other agents, including implementers from their own or other organizations, injectors, and the information management function within their organization. Agents can exchange information in two different ways. First, they may exchange information through in-person interactions, when they are in the same physical space as another agent. Second, they may exchange information through remote communications; these are restricted to members of the same organization. The random movements required to encounter other agents and try to exchange information with them represent the greater difficulty of tracking down and meeting with actors external to the organization. Both kinds of interaction are described below.

In-person interactions Agents move randomly throughout the model environment seeking information from other agents. When an agent encounters another agent by chance, they go through a series of negotiations that determine whether or not they will get any information from this exchange (see Figure 2, below).

As Figure 2 shows, when an agent starts its turn, it checks to see if there is an agent in its immediate vicinity. If there is, the agent checks to see if the second agent has information. If the second agent does have information, the agents decide whether they are willing to exchange information with each other (determination of willingness to exchange is described in more detail below). If the agents decide that they are willing to exchange information with each other, they then decide for themselves whether the information they are receiving is of high quality (determination of information quality is also described in more detail below). If the information is not of high quality, the agent does not take the information; otherwise, the agent receives the information, whether it is relevant to their task or not. If the information is deemed to be of high quality, the information is exchanged. If, at any point during this interaction, the answer to any of these questions is "no", then the information is not exchanged, and each agent continues to seek information elsewhere. At the end of the turn, each agent checks to see if the information they

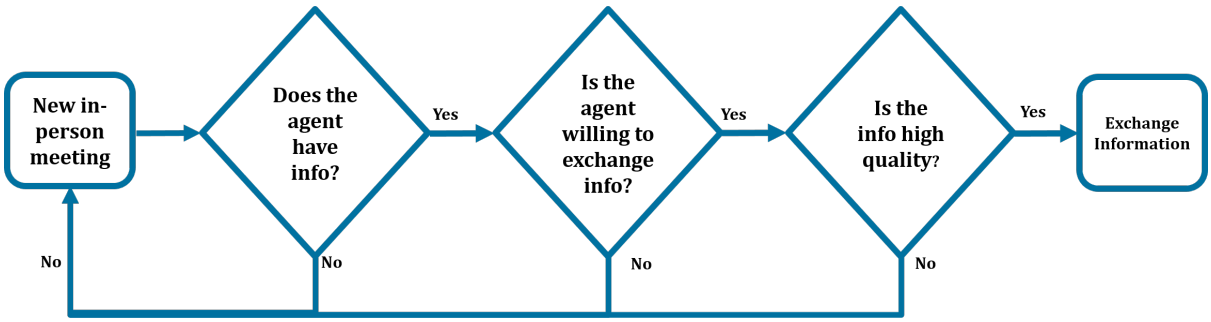

Figure 2. Model Rules

have received gives them sufficient information to proceed to the camp. If so, they move to the camp location and remain there for all remaining turns (because they have finished their information seeking).

Willingness to exchange information In reality, organizations make decisions about what information is share-able with their operational partners and which needs to be communicated only to its own staff (Chan et al. 2016; Karunakara 2013). As in Altay and Pal, the concept of willingness to exchange information is represented as the probability that a particular interaction will involve two agents who are both willing to exchange information with each other. As mentioned earlier, agents are always willing to share with their own organizations, and we also assume injectors are always willing to share their information, to represent the behavior of information sources in a response.

Quality of information The quality of information represents the real-life operational scenario of whether implementers can readily use the information they receive. Information may be in various formats, such as PDF reports, excel spreadsheets, maps, and other forms of processed data, and not all such formats may be usable to implementers (Day et al. 2009; Altay and Labonte 2014). Each implementer is assumed to judge for themselves the usability of any information. Information quality is represented in the model as a probability that the information obtained can be used by the implementer (as in Altay and Pal); if the information is deemed to be of low quality, the information is useless to the agent and thus is not exchanged or "gained" by the agent who are offered it. We do not assume that information received from one's own organization, including from the IM support, is always high-quality.

Remote Interactions When no IM specialist is present, implementers from the focal organization may hold regular coordination and information exchange meetings in which all the information held by any implementer is shared with all other implementers. Information filtering does not happen in meetings, because each team member is exposed to each piece of information. When an IM specialist is present, on the other hand, the IM specialist holds individual meetings with each implementer in order to share the specific information that the implementer needs. In this manner, the IM specialist acts as a filter, so that these regular "tag-up" meetings provide only the relevant information to each implementer (see Figure 3, below). As a result, the IM specialist provides less unneeded information because their job function is to seek and filter information. Importantly, the IM specialist is the only strategy that explicitly works to reduce information overload through information filtering during an information exchange.

Evaluating strategies for managing information

The agent-based model is used to evaluate how different strategies for information management impact the time to acquire information and information overload. The paragraphs below describe each of the evaluated strategies and how it is represented in the model, and Table 1 shows the parameters for each scenario.

Baseline In the baseline scenario, there is no IM specialist, and the willingness to share with other organizations is assumed to be a 50% chance that any given agent interaction will result in willingness to share. Similarly, the chance of receiving information that is of high quality is also 50%. No regular meetings or calls are held. This represents the lack of an active strategy for information management.

Increase willingness to exchange information with other agencies In Scenario 2, we vary all agents' willingness to share information with other agencies, in order to see how much this strategy influences performance. We

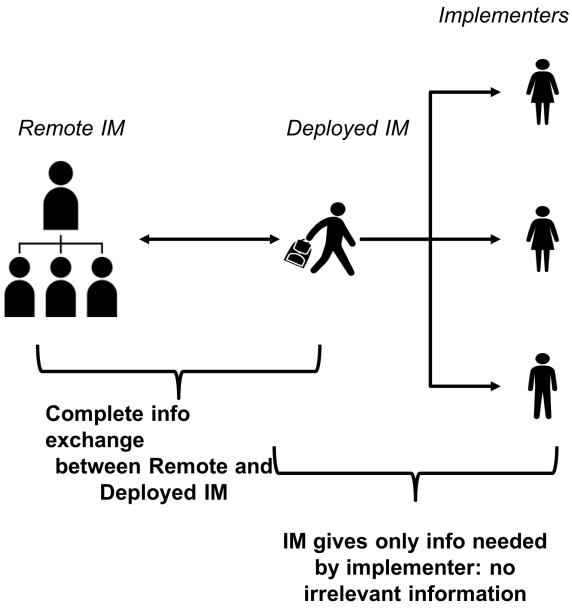

Figure 3. Exchanging Information during Communications with IM Support

Scenario	Team composition	IM team quality	Willingness to share with other orgs.	Meeting/call frequency
1. Baseline	No IM support	N/A	0.5	None
2. Increase willingness to exchange information with other agencies	No IM support	N/A	Varied among: 0.25, 0.5, 0.75	None
3. Hold meetings to share information	No IM support	N/A	0.5	Every 10 turns
4. Change frequency of meetings/calls	No IM Support / Deployed IM	0.5	0.5	Varied among: 10, 40, 100, 300, 450, 600, 1000 turns
5. Deployed IM	Deployed IM	0.5	0.5	Every 40 turns
6. Deployed + Remote IM	Deployed + Remote IM	0.5	0.5	Every 40 turns
7. Improve quality of IM support	Deployed IM	Varied among: 0.25, 0.5, 0.75, 1.0	0.5	Every 40 turns

Table 1. Scenarios for investigating strategies for information management

modeled various levels of openness to sharing: no organization will be 100% willing to share all information with others, so organizations were assigned levels that represented mostly willing to share (75%), neutral to sharing (50%, the baseline), and hesitant to share (25%).

Hold regular internal team meetings to share information A simple strategy for improving information management is to hold a regular information-sharing meeting within the organization. We represent meetings in Scenario 3 by enabling team-wide remote exchanges of information at regular intervals. When no deployed IM specialist is present, the response team exchanges all information with one another.

Deploy an information management specialist An alternative strategy that an organization might employ to manage information in a response is to deploy an information manager as part of the response team to seek out and filter information. This strategy is represented in Scenario 4 by adding an additional agent to the organization, which does not seek a camp, dedicated to information-seeking. In addition, the IM specialist holds regular "tag-up" calls with each of the implementers to exchange only information that is relevant for each implementer at regular intervals.

Activate remote information management support Scenario 5 includes both remote and deployed IM specialists. The addition of remote IM agents adds five more information-seeking agents to the team. While they move around the same physical space in the model, these agents represent remote agents, and they can only gather information from injectors, and can only share information with the deployed IM agent. The remote IM agents share all their information with the deployed IM agent just before the IM tag-up calls, so the implementers benefit from their information-gathering activities.

Improve quality of information management support If the focal organization has decided to use dedicated IM support, a further strategy for facilitating the management of information is to improve the skill level of the IM support, which increases the probability that the information they offer to others is of high quality. To evaluate this strategy, Scenario 6 includes variations with various levels of skill for both the deployed IM support agent, and is operationalized as probabilities that the agent offers information that is usable by the recipient, as described above. Varying the quality of the IM support demonstrates the extent to which the quality of the support influences performance.

Note that the quality of IM support does not refer to the specialist's ability to *seek out* information, but rather to their ability to process it into a useful product.

Change the frequency of meetings or tag-up calls Scenario 7 runs the model with several different meeting frequencies in order to examine whether there is an optimum cadence to these information-sharing meetings. The meeting frequency is set to occur every 10 turns, every 40 turns, and every 100 turns. A 'turn' is roughly a measure of time, but is better thought of as a response's clockspeed (Fine 1998), tied to the speed at which decisions are being made. Therefore, Scenario 7 investigates how often meetings should occur relative to the response clockspeed.

Implementation

The model was developed using NetLogo 6.0 (Northwestern University, Evanston, IL). The independent variables were varied as shown in Table 1, and the impact on the dependent variables – time to task accomplishment and information overload – was examined. Each variation of each strategy was run 1,000 times, and the average values are reported. (Convergence was tested by running some strategies 10,000 times and ensuring that the average values were the same). The baseline scenario includes 10 implementers from the focal organization, 10 other implementers, 10 injectors, and optionally 1 deployed IM specialist and five remote IM support specialists for the focal organization.

RESULTS

The results are summarized in Figures 4 and 5 and Table 2. Figure 4 shows the impact of each strategy on the time to task accomplishment, and Figure 5 shows its impact on information overload. The speed of information diffusion is the number of turns until all tasks within the organization's response team are completed, averaged across the 1,000 runs for each strategy and normalized against the baseline scenario, as well as the median turns to complete

task, i.e., the number of turns until half of the team completed its tasks (normalized against the baseline scenario). We added the median time to avoid the "long tail" of the last implementer seeking the last piece of information. The information load is reported as the average excess information that any given individual carries, across all runs. These results allow us to identify the organizational strategies for information management that may reduce the time that response teams spend on seeking information and reduce the amount of information overload that they experience. The paragraphs below discuss the results for each of the strategies evaluated.

Figure 4. Impact of Organizational Strategies on Time to Completion Overload

Improving all agents' willingness to exchange information did not make much of an impact on time to task accomplishment, and had a non-linear effect as organizations went from 25% willing to exchange to 50 and then to 75. There was a larger effect on time to task completion when organizations moved from 25% willing to exchange to 50%, as compared to moving from 50% to 75%. Even if there are diminishing returns as organizations become more willing to exchange information, being more willing to share helps reduce the time that organizations spend looking for information. There is no impact on information overload when willingness to share is varied.

This result is surprising in light of the findings of Altay and Pal. They found that willingness to exchange information achieved significant time savings. Their focus, however, was on inter-organizational information diffusion, whereas our analysis focuses on internal information management. Willingness to share makes little difference in our model because many of the actors are working for the same organization and therefore are always willing to exchange information with one another.

Information sharing meetings without IM support result in significant improvements in time to task accomplishment, by 50% over the baseline, but do not result in decreases in information overload, as there is no filtering during meetings. The time to task accomplishment is faster because responders share all their information with one another regularly without waiting to "bump into" each other in physical space.

Deploying an information management specialist of medium skill (with a 50% probability of offering high quality information to others) results in a decrease in time to task completion by 24% compared to the baseline, and a reduction in average information overload by 8% compared to the baseline. The time to task accomplishment is faster for several reasons. First, there is one additional agent seeking information, and that agent never leaves to work on a task, enabling more information-gathering interactions. Second, the presence of the deployed IM agent enables regular, team-wide communication, so information is spread without waiting to encounter responders in

Figure 5. Impact of Organizational Strategies on Information Overload

Strategy	**Speed of Average Team Task Completion: % Change from Baseline**	**Speed of Median Individual Task Completion: % Change from Baseline**	**Information Overload : Percent Change from Baseline**
1. Baseline	Baseline	Baseline	Baseline
2. Increase willingness to exchange info	-4%	-1.3%	0%
3. Regular meetings to share information (40 turns)	+1%	-23%	+3%
7. Change frequency of meetings/calls (100 turns)	-15%	-37%	+5%
4. Deploy IM support	-23.5%	-24%	-7.2%
5. Deploy IM support with Remote IM support	-25%	-24%	-7%
6. Improve quality of IM support	-30%	-34%	-12.6%

Table 2. Comparison of Organizational Strategies

physical space. Third, the deployed IM agent replaces the information-sharing meeting with a targeted interaction to each responder, sharing only relevant information, which results in the decrease in information overload.

Activating a remote information management team to support the deployed IM specialist has almost no impact on reducing time to task accomplishment or on information overload. The remote IM team does not add much value because they can only gather information from the limited sources, and do not provide any additional information-sharing functions.

Improving the quality of the information management support can further improve the time to task accomplishment and information overload. Figures **??** and **??** show results for a deployed IM specialist who can produce high-quality information 25% of the time, 50% of the time, and 75% of the time. Improving the quality can reduce the time to task accomplishment more than a remote IM team. The results are similar for information overload.

Varying the frequency of meetings or tag-up calls can also affect the time to task accomplishment. We compared different meeting frequencies; Figures **??** and **??** show results for meetings every 10 turns (baseline), every 40 turns, and every 100 turns. Comparing different meeting frequencies suggests that there is an organizational decision to make regarding meeting frequency- time to task accomplishment can drop dramatically more when meetings are held at an appropriate frequency, but information overload actually increases when meetings are less frequent, likely because the team members have more information on hand when they meet with their team to exchange information. When meetings are held too frequently, team members have not had enough time to gather new information, and so the meeting passes without significant information exchanged; essentially, the time is wasted in a meeting when the team members should be seeking information. Additional preliminary results that are not shown here suggest that there is an optimal frequency to hold meetings. These results need to be explored further to draw conclusions about what this means for operational teams. This model only takes into consideration how meetings contribute to information sharing, and does not take into consideration other benefits of meetings, such as coordination, setting priorities, etc.

While previous work has identified successful strategies for information sharing across organizations in humanitarian response, these findings start to identify the successful strategies that individual organizations can use for their own internal operations.

DISCUSSION

The results suggest that, among several strategies for information management, holding regular meetings or deploying an IM specialist make the largest difference in the time it takes to collect sufficient information for decision-making. Of these two strategies, only the IM specialist also reduces information overload. Both increasing willingness to share and improving the quality of the IM team can improve time to task accomplishment, but not as significantly. Activating remote support for the deployed IM team has limited value for information seeking, especially when weighed against the significant resources required.

These conclusions are based on a simple model, but they nonetheless provide insights that may be relevant and valuable in practice. Organizations must make decisions about how to approach the task of information management, and the strategies evaluated here are some of the options that they may use. While the model does not reflect all aspects of reality, it models the fundamental information-seeking and -sharing dynamics that govern the acquisition and spreading of information. Future work could test and validate these conclusions empirically.

The strategies explored in this paper require very different resources from organizations. Some strategies involve policy changes, such as an organization's willingness to exchange information with other actors. Other strategies involve staffing decisions that impact the composition and structure of response teams. Organizations are faced with very real political, security, and resource constraints that may make one or more of these strategies unrealistic for a given organization and/or response. The "cost" and resource commitment required to deploy each strategy will differ across organizations and responses. However, by understanding the relative benefits of each option, organizations may be able to make more informed decisions that address their own goals and priorities.

The findings suggest some recommendations for when each strategy would be appropriate. When resources are limited and speed of information acquisition is critical, regular information-sharing meetings are a useful strategy. They are simple to implement and highly effective at improving the speed of information diffusion, although they will not result in a reduction in information overload. Information-sharing meetings are recommended for any response, as long as they are not held overly frequently.

When the speed of information acquisition is important and information overload is also a concern and/or there are available resources, deploying an IM specialist is the best choice. In addition to speeding up the acquisition of information by adding dedicated information-gathering capacity and holding regular information tag-ups to provide

targeted information to responders, in reality an IM specialist adds additional value. The IM support specialist is dedicated to the tasks associated with information management, ensuring that they are completed rather than slipping further down the to-do list of a responder who is also dealing with programmatic, logistical, or financial aspects of the response (represented in our model by leaving the information-gathering arena to do work at a camp).

Surprisingly, willingness to share information does not, in this model, make a significant impact on information acquisition in the focal organization. However, this model focuses primarily on a single organization, rather than the humanitarian system as a whole in a response. Both in practice and in research (**AltayLabonte2014b**; Altay and Pal 2014; Bharosa et al. 2009; Faraj and Xiao 2006; IASC Working Group 2008; UN OCHA 2017), information sharing is emphasized for the impact it can have across organizations, when every actor in the system opts to increase their willingness to share. The results from this model should not be taken as justification for refusing to share information in a response. Instead, the results simply show that increasing willingness to share does not increase a single organization's own information-seeking capabilities in the environment we modeled.

The remote information management support did not, in this model, have much added value beyond the value of the deployed information manager whom they support. This may be due to their remote status, which limits the sources of information they have access to. Their main value may instead lie in assuming the work of processing information, such as making maps or cleaning data sets, so that the deployed team can focus on the tasks that require direct participation in the response. This model does not account directly for information processing, but future iterations could include it. Further research is needed to understand in which contexts remote IM teams are most helpful and why, so organizations can make informed decisions about activating remote staff.

We see some improvements in time to task accomplishment when the quality of the IM team improves, suggesting benefits of investing resources in training and human resource development for personnel to fill this role. Conversely, if skilled IM support personnel are not available, our results suggest that unskilled personnel should not be deployed; instead, team-wide information sharing meetings result in almost the same time savings as deploying someone who is ill-equipped to manage information in these settings, and do not require the resources of a dedicated deployment for a role that does not benefit the team.

These recommendations all come at some amount of cost to an organization, which is not explored here - the contribution of this paper is to explore how each of the information management strategies impact the speed of finding information for decision-making and on the amount of information overload that teams might experience.

CONCLUSIONS

These findings are initial explorations of how various strategies for managing information might assist a humanitarian organization's response – and in particular, how each strategy affects the speed and efficiency of information acquisition. The results should support humanitarian organizations in deciding how to invest resources in information management, both in the short term, for a given response, and in the long term, for human resource development and internal policies. Further research on the specific structure and function of information management teams, as well as how internal information management processes link to inter-organizational coordination, would provide more specific guidance on IM processes and structures, and help to link the existing understanding of inter-organizational coordination to information management at the organizational level. Successful internal information management is a necessary precondition for successful information-sharing and coordination at the inter-organizational level, since much information about a response originates within individual organizations. Therefore, our focus on internal information management is an important complement to existing theory on inter-organizational coordination.

As the role and importance of information management is expanding and changing rapidly, this is a timely contribution to both inspire further research on intra-organizational information management and to support practice decisions as humanitarian organizations design their internal information management strategies.

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