Shortcomings of Netcentric Operations During the COVID-19 Pandemic

Abir Agray and Kenny Meesters(✉)

Tilburg University, 5037AB Tilburg, The Netherlands
k.j.m.g.meesters@tilburguniversity.edu

Abstract. As the COVID-19 pandemic is a multi-agency, long-lasting crisis with a complex information structure, the netcentric approach in the crisis operations would be expected to show its advantages. However, the implementation of netcentric operations seems to be met with challenges during the COVID-19 pandemic. This research investigates the capability of organizations to adapt the netcentric approach, specifically in relation to information sharing in changing contexts. Thereby, the factors that influence inter-organizational information sharing within netcentric operations are examined. It can be concluded that in practice, reapplying the principles of netcentric operations to a different context can be challenging. More specifically, over time, the netcentric operations become ingrained in process, systems, and tools. While this codified and institutionalized netcentric approach supports the daily information exchange in emergencies, it also reduces the ability of organizations to adapt their approaches to new requirements dictated by changing circumstances.

Keywords: Netcentric Operations · Information Sharing · Crisis Response · COVID-19 · Information Systems

1 Introduction

At the end of February 2020, the first COVID-19 case in the Netherlands was detected. Since not much was known about the virus or its effects, it has been hard to coordinate the crisis by the government. The virus also had and still has a great impact on not only the healthcare sector but also on the societal aspects across the nation. This crisis therefore brings uncertainty across several sectors. To reduce this uncertainty and support the development of the response to the emergency, having access to information is vital. As The Prime Minister Mark Rutte of the Netherlands therefore stated: "We are making 100% of the decisions based on 50% of information". The importance of information management to obtain, process and share this information within crisis response also came to light during the response to COVID-19 pandemic. Since the COVID-19 pandemic affects the whole country, several emergency organizations from all levels need to work together. It is important for all these organizations to have accurate information to anticipate effectively. However, information sharing among all these organizations during a crisis with such large scope is not always done effectively which in turns affects the coordination of the crisis.

Published by Springer Nature Switzerland AG 2023
T. Gjøsæter et al. (Eds.): ITDRR 2022, IFIP AICT 672, pp. 170–184, 2023.
https://doi.org/10.1007/978-3-031-34207-3_11

Past disasters have shown that there are a number of challenges associated with coordinating crisis response [1]. Researchers argue that coordination is often suboptimal among governments, humanitarian organizations, and volunteers [2]. According to previous studies these problems that occur in crisis coordination can often be attributed to the fast-changing network, time pressure, uncertainty and unpredictability of information needs and flows [3, 4]. To overcome these problems netcentric operations have evolved as a coordination mechanism [5]. The aim of this coordination mechanism is to improve situational awareness among organizations by sharing real-time data about each other's actions and the crisis [5]. Thus, netcentric operations should cause organizations to have the right information at the right time [6].

As the COVID-19 pandemic is a multi-agency, long-lasting crisis with a complex information structure, netcentric operations would be expected to show its advantages. Theoretically it should provide agility and self-synchronization of crisis response teams [7]. Netcentric operations should increase efficiency, security, agility and shared situational awareness [6]. However, the implementation of netcentric operations seems to be met with challenges during the COVID-19 pandemic. Since the scope of this crisis involves the whole country, a large collaboration network needed to be set up with organizations that never worked together before. In order to coordinate such a crisis, other processes and structures are needed to gain capabilities to be more agile and therefore adapt faster to any given situation [8].

This research is set up to understand the capability of organizations to adapt the netcentric approach to information sharing in changing circumstances and operational contexts. Thereby, the factors that influence inter-organizational information sharing within netcentric operations will be examined. The general factors that influence inter-organizational information sharing have been researched by several scholars and can be attributed to organizational, technological, and political determinants [9]. However, how these factors influence inter-organizational information sharing during a crisis within a network centric context is not researched yet [10]. This research aims to bridge the gap between information management within crisis response by examining how organizational, technological, and political factors influence inter-organizational information sharing within a network centric context.

2 Research Method

This research consists of three main phases (Fig. 1). The first one is the preliminary research phase. This phase consists of the literature review and explorative interviews. The literature was analyzed by following the steps of Wolfswinkel, Furtmueller & Wilderom [11]. The second stage includes in-depth interviews and analysis of existing interview scripts as a case study. According to Charmaz [12], a sample size is not relevant during a case study. Therefore, interviews were held until no other new theoretical insights were found [12]. That is when a total of 10 interviews was reached during the interviews and when a total of 4 interview scripts were analyzed. All the interviews were recorded, and an interview script was written afterwards. Also, the second stage of the research method includes the analysis of the data.

The first set of interviews will be analyzed by using template coding techniques [13]. When all the interview scripts are coded, an occurrence table will be set up. This

table shows how many times a code was discussed during all the interviews. Lastly, the conclusion and discussion will be drawn.

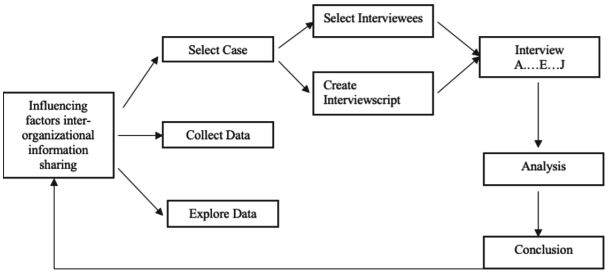

Fig. 1. Research Method

3 Related Work

3.1 Netcentric Operations

The term network centric operations find its origin in the military. In its essence, network centric operations imply the autonomy and empowering of individuals in their ability to adapt to the changing environment/circumstances. This high level of adaptability is achieved by leveraging technical and human capabilities [10]. Alberts et al. [14], define four tenets that describe the benefits of network centric operations. These four tenets include the improvement of information sharing, collaboration, and shared situational awareness. Network centric operations also compresses the strategic, tactical, and operational echelons and emphasizes the need to operate across organizational boundaries [14].

This indicates that the process of sharing data and information is not done on a "command and control" basis anymore but from a network point of view. This does not imply however, that the command-and-control method is not used at all anymore. The method had just been adjusted because there was a need for decentralized information sharing so groups in the field could anticipate faster to the current situation [5]. A pure hierarchical coordination mechanism lacks this ability [14].

Researchers have shown that network centric operations improve (shared) situational awareness by overcoming two main drawbacks: time and information. It helps to improve information sharing in dynamic situations where multiple actors are involved. This coordination mechanism however includes more than just information sharing [15].

There are capabilities necessary to achieve the benefits of network centric operations. These capabilities can be attributed to four domains [7]:

1. Social domain: includes the nature of interaction.
2. Cognitive domain: includes the creation of rules, responsibilities, roles and constraints.

3. Information domain: includes the allocation of resources (information assets and access) and establishing rules for information sharing.
4. Physical domain: includes the allocation of resources (materiel).

In order to control a certain situation in which different organizations are involved, synchronization of plans among these organizations is needed. Synchronization requires shared awareness across domains. In order to achieve shared awareness, organizations need to share a common understanding of the situation by sharing information [16].

Network centric operations have evolved in crisis management to tackle the disadvantages which a hierarchical coordination mechanism brings. When a hierarchical coordination mechanism is used, tactical groups tend to ignore information unless it is provided by a higher level of command. All decisions are made at the top of the hierarchy. The theoretical advantages of using network centric operations in crisis management are therefore the right information is provided at the right time to the right people. Network centric operations also should increase efficiency, security, agility and shared situational awareness. However, the concept of network centric operations requires a change within and among organizations, policies and their technological infrastructure [17]. To be able to work with a network centric coordination mechanism, it is important that each organization within the network has accurate information, that the information is shared among all organizations, that there are shared goals and values and that organizations are willing to achieve those goals together [18]. However, research shows that network centric conditions among organizations are still not met. Evaluation shows that there is no real inter-organizational coordination, the goals are diverse and not shared, organizations do not have access to information and information systems are not used optimally [18]. Finally, within a context where a high level of agility is needed, like the COVID-19 pandemic, the capability to adapt to these circumstances is still questioned by researchers [8].

3.2 Information Sharing Within Netcentric Operations

Information sharing can be described as the extent to which critical information is communicated to others [19]. Information sharing can occur on several levels. Depending on the complexity of a certain situation and the organizations that are involved, information sharing can evolve from intra-organizational to interorganizational to intergovernmental. The more complex a situation is and the larger the scale, the higher the evolvement of information sharing. Since the scope of this research is on a certain crisis situation within the Netherlands and organizations in crisis response operate independently during a crisis in this context [10]. The focus will be on inter-organizational information sharing.

Inter-organizational information sharing can be defined as "the cross-boundary information sharing that takes place among multiple organizations as opposed to among multiple units within the same organization" [9]. This definition will be used in this research to describe the term. During a crisis, multiple organizations need to share information on all levels (operational, tactical and strategic). Several problems occur during a crisis within the process of information sharing and coordination since 1) the network changes rapidly, 2) time pressure, 3) uncertainty, 4) unpredictability of information needs and

flows. Information sharing within network centric operations should lead to coordination, the improvement of information quality and collaboration [3, 4]. However, it also could involve the threats of information overload and responsibility dilution [10, 20].

Thus, the sharing of information could be useful however, there are several drawbacks when information is shared. Besides the threat of information overload and responsibility dilution [10, 21], there is also a possibility of coordination neglect. Coordination neglect is described as a cognitive problem that finds it roots in the theories people use to coordinate and organize with others [22]. Within network centric operations, coordination neglect could be a pitfall because much information and data are being shared without knowing for whom the information is important and for which cause the information will be used. Many information is being shared within the network but little to no attention is given to the integration of this information. Emergency responders can therefore not anticipate shared information [5].

Many studies have discussed the determinants of inter-organizational information sharing among public organizations [23, 24]. These determinants could be mainly addressed to three categories: organizational, technological and political. Research states that organizational and technological determinants play a more important role in interorganizational information sharing [9]. However, since the factors are not yet tested within the scope of a research like this one, all the three determinants will be considered.

3.3 Organizational Determinants

Effective inter-organizational information sharing is affected by several determinants. The benefits for the organization that comes with inter-organizational information sharing, are problem solving and the expansion of the professional network. However, there are also some disadvantages that organizational determinants have on the sharing of information. These disadvantages can be attributed to several factors.

Organizational culture influences coordination and the sharing of information, common values, interests, and norms - which are all part of the organizational culture - make it easier to coordinate all sorts of activities among different organizations. Thereby, incompatible cultures may cause less interaction and less mutual trust across organizations [25]. Organizational culture also shapes the assumptions within an organization about information. Specifically, about what information is and how it should be managed. It also shapes the process of how information and knowledge is created and distributed within organizations [26].

Thus, culture influences inter-organizational information sharing because it shapes the creation, distribution, and assumptions of information. To measure culture within organizations in this research, the following definition will be used: “a property of the collective reflecting deeper phenomena based on symbolic meanings and shared meaning about core values, beliefs, and underlying ideologies and assumptions” [27]. This definition of culture is chosen because it can be applied on the inter-organizational level of analysis which is the level of analysis of this research [27].

Another factor that influences information sharing is trust. Several researchers examined the influence of trust on coordination [28]. This factor has been proved critical for organizational settings where risk is involved [29]. It also influences knowledge sharing directly and indirectly among organizations as it serves as a replacement for monitoring

and verifying information [30]. Researchers also suggest that communities that have strong relationships function better during a crisis because of the high level of trust. Hence, trust building among public emergency organizations is essential to overcome a crisis [31]. It also influences information sharing. Therefore, the influence of trust on inter-organizational information sharing will be measured in this research. Since this research focuses on interorganizational information sharing, the level of trust that will be measured is also on the inter-organizational level. Thereby, the levels that are developed by Sako [32] will be used to measure trust. These include: 1) knowing the other party will do what they said they would; 2) willingness to participate 3) two-way understanding; 4) being predictable [33].

The effective sharing of information across multiple organizations is essential for effectiveness during an uncertain event. If emergency responders are not in contact with each other, it is difficult to remain successful in managing a crisis [31]. Effective communication processes allow organizations to make well informed decisions about how to proceed in synergy with others in the network to achieve the overall goal of solving a certain crisis [34]. Research has highlighted the importance of inter-organizational communication when carrying out responses in a successful way [35]. During a crisis, communication does not only occur at the top levels of the involved organizations, but it occurs among almost all levels of the organizations in the network [31], due to the dynamic nature of a crisis. These organizations need to work together and communicate with each other. Many times, this results in informal inter-organizational communication among different levels of different organizations [35].

To measure effective communication during a crisis, three elements could be taken into account. The first one is measuring the output and effectiveness of the process. The second one includes measuring the impact and the last one is measuring the outcomes. One could use all the three measurement types or simply choose one that is in line with the needs of the research [36]. In this research, effective communication will be measured by measuring the output and effectiveness of the process because this research is not only about communication which makes measuring the impact and the outcomes of the communication process out of the reach of this scope. Thus, the key messages which are communicated and how (formal vs. informal communication process) will be considered. This will provide insight into how information is communicated during a crisis among organizations and will show the usability and effectiveness of the formal communication channels which are set up.

3.4 Technological Determinants

Technology is crucial during a crisis because it provides organizations to overcome communication barriers like geographic distances and enables communication with emergency responders in the field [37]. Therefore, technological determinants that could influence inter-organizational information sharing are also taken into account. Technology has the potential to transform how organizations work and facilitates inter-organizational information sharing in a networked environment. Researchers examined that in order to realize the benefits that come with the use of technology, organizations should integrate their information across organizational boundaries. Studies define the sharing of information and data integration with the emphasis on technological elements [38].

Technical infrastructure includes the structure needed to search and exchange information [31] and has the capacity to facilitate communication among organizations. This capacity is embedded in the social context in which the technical structure occurs. Some researchers argue that, in the current high-tech environment, it is important to develop robust processes that facilitate information exchange [39]. Technological determinants could influence inter-organizational information sharing positively and negatively. The benefits of technology that are associated with interorganizational information sharing are, the streamline of data management and the contribution to information infrastructure. The barriers that may occur with technology are incompatibility and inconsistent data structures [9, 40].

In order to support inter-organizational information sharing, organizations need compatible technology to communicate [40]. Technological compatibility substantially affects the performance of interorganizational information sharing initiatives. Thus, incompatibility between the technical resources of participating organizations could represent a major barrier. Compatible technology can be defined according to Rogers, as the degree to which an innovation is perceived as consistent with the existing values and beliefs, past and present experiences, and needs of the users [41]. Tornatzky & Klein [42] further elaborated on this definition and made a distinction between two types of compatibility namely, 1) cognitive compatibility. This indicates that there exists compatibility with what people feel or think about an innovation. Furthermore, there also exists 2) practical compatibility which indicates compatibility with what people do [41, 42]. Both types of compatibility will be considered to examine if the used technology is compatible during a crisis.

The second technological barrier, data structures, includes conflicting data definitions among organizations. This may result in organizations not understanding the data and information that is shared [40]. These two barriers mainly arise because of the lack of IT [9]. IT standards imply common and accepted data formats, transmission protocols and hardware that supports the sharing of information among organizations [43]. Thus, technological factors play an essential role in crisis management. The three technological factors that will be examined during this research are compatible technology, IT standards and data structures since these factors are essential within crisis response [37]. It will be examined if the used technology is compatible if there are IT standards and data structures and how these three factors either improve or worsen inter-organizational information sharing.

3.5 Political Determinants

The influence of politics has become greater over the time during crises [18]. A crisis can be seen as a window of opportunity for politics as well as the initiation of policy in the political system in which they occur. Politics seem to be infiltrating crisis management and crises therefore should be more viewed through the lenses of politics [44]. The term ‘political’ is thus intended as political or strategic interference that are not necessarily related to the crisis response activities [45]. The factors which are described in this paragraph all may lead to this interference.

Political determinants influence the sharing of information among public organizations in several ways [9]. Firstly, public organizations are influenced by the political

environment in the country wherein they operate. This influence from the central government has an impact on the decision-making processes and the collaborative network of the local agencies. Therefore, it also influences information sharing among local government organizations [46]. Since this research aims to examine interorganizational information sharing among emergency organizations within the public sector, the political environment will also be taken into consideration. There will be looked at if the central government promotes information sharing and provides the resources to share information among organizations [46].

Second, legislation and principles need to be considered. Legislation can affect inter-organizational information sharing by creating a governance framework for information sharing among different agencies [9]. Researchers argue that public agencies can only gather and store information regarding the task they have. In many cases, agencies are unaware under what law or policy they can share the information. This includes concerns over privacy. Sensitive information, like citizen identities, need to be protected [9, 47]. Some ambiguous legal frameworks can lead to sanctioning/prevention of information sharing, resulting in 1) organizations making decisions based on what they feel and understand from regulations and 2) non-collaborative organizations because of the fear of making mistakes [46].

Another barrier that influences the sharing of information is the resistance to share because information is a source of power and a symbol of authority [40, 48, 49] argue that the relationship between two or more organizations is often characterized by power asymmetry. This implies that when a more powerful organization perceives the potential benefits of information sharing with other organizations, it would exercise its power and request them to share their information. The higher the power of an organization is, the more important it is for the other organizations to maintain a good relationship even if that could bring negative consequences (e.g. opportunistic behavior of the other party) [49]. This political/power distance between organizations could also result in barriers for organizations to establish and sustain their engagement in a network for information and knowledge sharing [9]. Since organizations within crisis response also deal with organizations that have more power and authority (like within governmental hierarchy structures), this factor could also play a role in inter-organizational information sharing.

4 Results

Table 1 shows how many times a certain variable occurred during the in-depth interviews. The results in the occurrence table were drawn after coding the interview scripts. A significant result was that all the interviewees know the term network centric operations. However, the meaning of this term was interpreted in a different way by interviewees. Most significantly, netcentric operations was most frequently associated with the information sharing system that is used during a crisis named LCMS. Also, the effectiveness of network centric operations during COVID-19 was questioned by interviewees. Thereby, the lack of effective information management when using this coordination mechanism was addressed as a main concern. One of the interviewees described this concern as follows:

"Network centric operations within Safety Regions is still in its infancy. We have -in a manner of speaking- not yet outgrown the toddler phase of network centric operations ... In which manner you should manage your information and the way in which we train people to do so, should be improved significantly in the Netherlands. Also, the focus of network centric operations lays on sudden disasters. But there is no understanding of network centric operations during a long-term disaster."

-Employee Ministry of Justice and Security

Table 1. Code occurrences.

Code	Sub-Code	Definition	Total
Organizational	Culture	*a property of the collective reflecting deeper phenomena based on symbolic meanings and shared meaning about core values, beliefs, and underlying ideologies and assumptions*	33
	Trust	*1) knowing the other party will do what they said they would. 2) willingness to participate 3) two-way understanding; 4) being predictable*	14
	Communication Process	*The key messages which are communicated and how (formal vs. informal communication process) they are communicated*	51
Technological	Compatible Technology	*The degree to which an innovation is perceived as consistent with the existing values and beliefs, past and present experiences, user needs*	63
	Data Structures	*Conflicting data definitions among organizations*	9
	IT Standards	*Common and accepted data formats, transmission protocols and hardware that supports the sharing of information among organizations*	22
Political	Political Environment	*The influence from the central government on the decision-making processes*	41
	Legislation & Principles	*Legal frameworks in a certain country*	24
	Power & Authority	*Political/power distance between organization*	5

4.1 Organizational Determinants

Firstly, interviewees state that employees of emergency organizations are trained in how to share information during a crisis. These trainings emphasize the use of the information sharing system LCMS. However, they are not taught the underlying concepts of why they should share information with each other. As stated in the literature, culture influences inter-organizational information sharing because it shapes the creation, distribution and assumptions of information. With not training people in the underlying concepts of why and how information should be shared, organizations do not see the purpose of information sharing but rather see information sharing as a burden in the long run. During the COVID-19 pandemic this is exactly what happens. Interviewees stated that at the start of the pandemic, organizations shared their information with each other. However, in the long run, organizations stopped with the sharing of information because they did not see the purpose anymore. Besides the given training, organizational culture also influences the sharing of information in another manner. As reviewed in the literature, subcultures of organizations have different requirements for the use and outputs of information. Interviewees also state that different subcultures influence the sharing of information. For example, during the COVID-19 pandemic hospitals needed to share information with the operational divisions of the Safety Regions. However, since hospitals are known for their 'consensus culture' and everything needs to be discussed and agreed upon, the receiving of information from these organizations goes much slower.

Furthermore, the communication process also influences inter-organizational information sharing. Most formal communication during COVID-19 goes through the information sharing system LCMS. The shortcomings of this system are described in the previous part of the discussion. During the interviews it appeared that informal communication was much more important than the formal ones. If a crisis responder needs something from other organizations quickly, informal communication processes are being used. This results in information not being shared with the whole network. Other organizations who also need this information therefore do not receive the required information.

4.2 Technological Determinants

As stated in the literature review, compatible technology affects the performance of inter-organizational information sharing. The incompatibility of technology and the lack of IT standards result in a barrier of information sharing. All interviewees stated that the used system to share information with (LCMS) is not compatible/fulfilling enough. It is characterized as outdated and too static. Thus, the current system is perceived as a barrier to inter-organizational information sharing. However, it is also stated by interviewees that individuals who work on a daily basis with LCMS, are able to filter and find the information that they need in an effective way. Hence, the question is, if the compatibility of the system itself is the real barrier here.

Even though all the interviewees stated that the information sharing system is not compatible, the real barrier appears to be rather organizational. It is hard for organizations who do not work with the system on a daily basis, to receive the information that they want out of the system. A real drawback is that people who are using the system on a daily basis, do not want to use another information sharing system that could be more compatible.

Organizations seem to be not willing to let go the "this is how we work" idea and therefore more compatible information sharing systems cannot be implemented easily. During a long-term crisis like the COVID-19 pandemic, the inability/willingness to let go of old processes and tools results in a major drawback when it comes to interorganizational information sharing. This phenomenon may be attributed to the organizational culture. Even though organizations know that the crisis won't be over soon, and that information sharing could be done a lot more effectively if tools and processes were changed, the rigid culture within those organizations acts as a barrier.

4.3 Political Determinants

The political environment has an influence on inter-organizational information sharing and coordination of the COVID-19 crisis. The crisis structure in the Netherlands is organized hierarchically. Thus, it is set up beforehand who has authority about a crisis situation. In this case, the COVID-19 pandemic is a nationwide crisis. Therefore, the national Government takes the measures and Safety Regions can take additional measures for their region if necessary. The political environment influences inter-organizational information sharing by facilitating tools that can be used to share information among organizations. Also, when organizations are not willing to share information anymore, organizations which are higher in the hierarchy, can use their authority to pull information from other organizations. Besides the political environment, legislation and principles also appeared to be significant in this particular case study. The GDPR and the privacy of citizens were especially discussed by interviewees. Since the COVID-19 pandemic involves privacy-sensitive information about individuals, organizations are reluctant to share information with other organizations. As stated in the literature, ambiguous legal frameworks can result in 1) organizations making decisions based on what they feel and understand from the policies and 2) non-collaborative organizations because of the fear of making mistakes. Some organizations do not share information with others and use the GDPR as an argument. However, when organizations/individuals with authority or a higher rank ask for the same information, organizations are suddenly more willing to share.

5 Discussion

As stated in the literature review, network centric operations have evolved to create shared situational awareness and to adapt faster to uncertain situations like a crisis. However, network centric operations bring its own pitfalls like the threat of information overload, responsibility dilution and coordination neglect.

This case study shows that all the disadvantages of network centric operations occur during this crisis. Firstly, the problem of information overload during the COVID-19 pandemic, is associated by experts with the incompatibility of the used information sharing system (LCMS). The information sharing system is not able to create visualizations and to filter information. Although the information sharing system is perceived as incompatible, the underlying problem of information overload is not the technology that is used to manage and share information. The problem rather lies in organizations

not knowing who needs what information for what purpose and when, which can be attributed to the problem of coordination neglect. Because the information is centrally available within the network and everyone has access to the shared information without further formal communication, the gap between the information offered and information need cannot be fulfilled. One interviewee stated the following:

> *"However, there is one caveat when all the information is shared. When you share too much information, you get lost and cannot see the bigger picture anymore. The point is, the one who manages the information sharing systems must realize the following: who needs this information and what is relevant now, what is relevant later or just irrelevant?"*
>
> *-Manager Safety Region.*

Secondly, the threat of responsibility dilution also occurs during the COVID-19 pandemic among organizations. Responsibility dilution is that the sharing of information may result in false impressions among strategic levels. Interviewees state that the strategic level indeed sometimes interferes because of the information that is available. This causes strategic levels to interfere in matters while it is not their responsibility. The responsibility of these decisions lies with the operational levels, but because all information is available, organizations are sometimes inclined to interfere with the course of events. Another interviewee stated the following:

> *"Noticeable -even during a sudden disaster- is the fact that the strategic and operational levels become intertwined and this does not always contribute in a positive manner to the crisis. Directors sometimes lose themselves in the operational aspects while this is not their task."*
>
> *-Employee Safety Region*

It can be discussed that organizations within a network centric context lack the ability to manage information effectively during a crisis due to this coordination mechanism. Due to the high number of organizations involved in the network, it is hard to know who needs what information and when. Also, during a crisis, the network of organizations may change on the basis of the needs to overcome the crisis. This makes sharing and managing information even harder. What is needed is the use of a "facilitating" organization whose only purpose is to bridge the gap between the information offered and the information needed by organizations.

However, with this structure, the coordination mechanism cannot be called network centric because a central managing organization becomes included. A so-called hybrid approach like the one that is introduced by [10], could be a possible solution. Hybrid approaches retain the strengths of network centric and hierarchical coordination mechanisms while overcoming the limitations of both. This approach uses an information coordination node which links new, environment-related information to prior information and knowledge to gain situational awareness [10].

6 Conclusion

It can be concluded that in theory, netcentric operations should bring many advantages within crisis response. Especially considering the complex actor environments that crisis response today is. As the number of actors increases, the effectiveness of exchange of information becomes key. Netcentric approaches can support the effective exchange of information between actors in such a network. However, in practice, applying the principles of netcentric operations can be challenging. More specifically, over time, the netcentric operations become ingrained in process, systems and tools. While this codified netcentric approach supports the daily information exchange in emergencies, it can also reduce the ability of an organization to adapt to new circumstances. For example, when the actor environment changes.

Also, netcentric operations cause information overload, responsibility dilution and coordination neglect during a crisis with a large scope. The problems can all be attributed to organizations not being able to manage their information within the network. Thereby, the most difficult part is organizations not knowing who needs what information and when. During a long-term crisis, this part becomes even harder because the network keeps changing and the number of organizations also grows when the crisis keeps going on. The amount of available information only gets larger. Managing information in such large networks with the use of a netcentric approach becomes difficult.

Lastly, crisis responders equate netcentric operations to the technological aspects instead of the underlying concepts. This is because crisis responders are only trained on the implementation part of netcentric operations. The emphasis during the training thereby lies on processes and systems. Due to this operational inset of netcentric operations, the whole concept is institutionalized which results in the way of working becoming rigid and the adaption to new circumstances becomes difficult.

References

1. Militello, L.G., Patterson, E.S., Bowman, L., Wears, R.: Information flow during crisis management: challenges to coordination in the emergency operations center. Cognit. Technol. Work, 25–31 (2007)
2. McEntire: Coordinating multi-organizational responses to disaster: lessons from the March 28, 2000, Fort Worth tornado. Disaster Prev. Manag., 369–379 (2002)
3. Bharosa, N., Lee, J.K., Janssen, M.: Challenges and obstacles in sharing and coordinating information during multi-agency disaster response: propositions from field exercises. Inf. Syst. Front. **12**(1), 49–65 (2010)
4. Reddy, M.C., Paul, S.A., Abraham, J., McNeese, M., DeFlitch, C., Yen, J.: Challenges to effective crisis management: using information and communication technologies to coordinate emergency medical services and emergency department teams. Int. J. Med. Inform., 259–269 (2009)
5. Wolbers, J., Boersma, F.K., de Heer, J.: Netcentrisch werken in ontwikkeling (2012)
6. Calderon-Meza, G.: An analysis of the effects of net-centric operations using multi-agent adaptive behavior, vol. 213. George Mason University (2011)
7. Alberts, D.S., Hayes, R.E.: DoD Command and Control Research Program. CCRP, pp. 8–98 (2007)

8. Janssen, M., & Van der Voort, H.: Agile and adaptive governance in crisis response: lessons from the COVID-19 pandemic. Int. J. Inf. Manag. **55** (2020)
9. Gil-Garcia, J.R., Sayogo, D.S.: Government inter-organizational information sharing initiatives: understanding the main determinants of success. Gov. Inf. Q., 572–582 (2016)
10. Bharosa, N., Janssen, M., Tan, Y.H.: A research agenda for information quality assurance in public safety networks: information orchestration as the middle ground between hierarchical and netcentric approaches. Cognit. Technol. Work, 203–216 (2011)
11. Wolfswinkel, J.F., Furtmueller, E., Wilderom, C.P.M.: Using grounded theory as a method for rigorously reviewing literature. Eur. J. Inf. Syst. **22**(1), 45–55 (2013)
12. Charmaz, K.: Constructing Grounded Theory: A Practical Guide Through Qualitative Analysis. Sage Publications, London (2006)
13. Blair, E.: A reflexive exploration of two qualitative data coding techniques. J. Methods Meas. Soc. Sci., 14–29 (2015)
14. Alberts, D.S., Garstka, J.J., Stein, F.P.: Network-Centric Warfare: Developing and Leveraging Information Superiority, vol. 2. CCRP Publication Series, Washington (2002)
15. Van De Ven, J., Van Rijk, R., Essens, P., Frinking, E.: Network centric operations in crisis management. In: 5th International ISCRAM Conference, Washington, DC, USA, May 2008
16. Van de Ven, A.H., Walker, G.: The dynamics of interorganizational coordination. Adm. Sci. Q., 598–621 (1984)
17. Calderón-Meza, G.: An Analysis of the Effects of Net-Centric Operations Using Multi-Agent Adaptive Behavior. George Mason University (2011)
18. Van Santen, W., Jonker, C., Wijngaards, N.: Crisis decision making through a shared integrative negotiation mental model. Int. J. Emerg. Manag. **6**(3–4), 342–355 (2009)
19. Li, S., Lin, B.: Accessing information sharing and information quality in supply chain management, 1641–1656 (2006)
20. Gonzalez, R.A.: Coordination and its ICT support in crisis response: confronting the information-processing view of coordination with a case study. In: Proceedings of the 41st Annual Hawaii International Conference on System Sciences (HICSS 2008), p. 28. IEEE (2008)
21. Bruijn, H.D.: One Fight, One Team: the 9/11 Commission Report on Intelligence, Fragmentation and Information, pp. 267–287. Blackwell Publishing (2006)
22. Heath, C., Staudenmayer, N.: Coordination Neglect: How Lay Theories of Organizing Complicate Coordination in Organizations, pp. 153–191. Elsevier Science Inc. (2000)
23. Pardo, T.A., Gil-Garcia, J.R., Burke, G.B.: Sustainable cross-boundary information sharing. Center for Technology in Government, University at Albany, State University of New York, Albany, New York, U.S.A, pp. 422–438 (2008)
24. Drake, D.B., Steckler, N.A., Koch, M.J.: Information sharing in and across government agencies. Soc. Sci. Comput. Rev., 67–84 (2004)
25. Jamil, I., Panday, P.: Inter-organizational coordination and corruption in urban policy implementation in Bangladesh: a case of Rajshahi city corporation. Int. J. Public Adm., 352–366 (2012)
26. Long, D., Fahey, L.: Diagnosing cultural barriers to knowledge management. Acad. Manag. Exec., 113–127 (2000)
27. Ostroff, C., Kinicki, A.J., Muhammad, R.S.: Organizational culture and climate. In: Handbook of Psychology, pp. 643–670 (2013)
28. Saab, D.J., Tapia, A., Maitland, C., Maldonado, E., Tchouakeu, L.M.N.: Inter-organizational coordination in the wild: trust building and collaboration among field-level ICT workers in humanitarian relief organizations. Voluntas Int. J. Volunt. Nonprofit Organ. **24**, 194–213 (2013)
29. Huang, Y.H.: Trust and relational commitment in corporate crises: the effects of crisis communicative strategy and form of crisis response. J. Public Relat. Res., 297–327 (2008)

30. McNeish, J., Mann, I.J.S.: Knowledge sharing and trust in organizations. J. Knowl. Manag. **38** (2010)
31. Kapucu, N.: Interagency communication networks during emergencies: boundary spanners in multiagency coordination. Am. Rev. Public Adm., 207–225 (2006)
32. Sako, M.: Price, Quality and Trust: Inter-firm Relations in Britain and Japan, no. 18. Cambridge University Press, Cambridge (1992)
33. Cousins, P.D.: A conceptual model for managing long-term inter-organisational relationships, 71–82 (2001)
34. Comfort, L.K., Kapucu, N.: Inter-organizational coordination in extreme events: the world trade center attacks, September 11, 2001. Nat. Hazards **39**(2), 309 (2006)
35. Hossain, L., Khalili, S., Uddin, S.: Inter-organizational coordination dynamics during crisis. J. Decis. Syst., 383–396 (2011)
36. Paine, D.: How to measure your results in a crisis, vol. 9. The Institute for Public Relations (2002)
37. Fischer, D., Posegga, O., Fischbach, K.: Communication barriers in crisis management: a literature review. In: Twenty-Fourth European Conference on Information Systems (ECIS), vol. 18 (2016)
38. Gil-Garcia, J.R., Chun, S.A., Janssen, M.: Government information sharing and integration: combining the social and the technical. Inf. Polity **14**(1, 2), 1–10 (2009)
39. Paturas, J.L, Smith, S.R., Albanese, J., Waite, G.: Inter-organisational response to disasters. J. Bus. Contin. Emerg. Plan., 347–358 (2015)
40. Dawes, S.S: Interagency information shoring: expected benefits, manageable risks. J. Policy Anal. Manag., 377–394 (1996)
41. Agarwal, R., Karahanna, E.: On the multi-dimensional nature of compatibility beliefs in technology acceptance. Digit **16** (1998)
42. Tornatzky, L.G., Klein, K.J.: Innovation characteristics and innovation adoption-implementation: a meta-analysis of findings. IEEE Trans. Eng. Manag. **1**, 28–45 (1982)
43. Tchouakeu, L.M.N., Maitland, C.F., Tapia, A.H., Bajpai, K.: Humanitarian organizational collaboration: information technologies as necessary but not sufficient. In: ISCRAM, May 2011
44. Hart, P., Heyse, L., Boin, A.: Guest editorial introduction new trends in crisis management practice and crisis management research: setting the agenda. J. Conting. Crisis Manag., 181–189 (2001)
45. Kalkman, J.P., Kerstholt, J.H., Roelofs, M.: Crisis response team decision-making as a bureau-political process. Conting. Crisis Manag., 480–490 (2018)
46. Bigdeli, Z., Kamal, M., de Cesare, S.: Information sharing through inter-organisational systems in local government. Transform. Gov. People Process Policy, 148–176 (2013)
47. Lam, W.: Barriers to e-government integration. J. Enterp. Inf. Manag., 511–530 (2005)
48. Landsbergen Jr., D., Wolken Jr., G.: Realizing the promise: government information systems and the fourth generation of information technology. Public Adm. Rev. **2001** (2001)
49. Ke, W., Wei, K.: Factors affecting trading partners' knowledge sharing: using the lens of transaction cost economics and socio-political theories . Electron. Commer. Res. Appl., 297–308 (2007)