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Relying on ratio or reflex?

A research into the actual behaviour of fire ground commanders of the Dutch Fire Department

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Foreword and Acknowledgements

Hereby I present my master thesis "Relying on ratio or reflex? A research into the actual behaviour of fire ground commanders of the Dutch Fire Department". This thesis is written in the context of my graduation from the master Crisis and Security Management at Leiden University. From December 2019 to July 2020, I have been conducting the research and written this thesis.

I have experienced this master as an interesting program with a focus on the international context of crisis and security related issues. When I discovered that my personal interest mainly concerned national issues, I decided to focus my master thesis on such issue. The capstone on response operations by the Dutch Fire Department turned out to be the perfect match. It provided an unique insight into the fire department as an organization and the response operations that fire fighters deal with. Furthermore, it gave me the opportunity to analyse video recordings, which I find an interesting data source. I will never forget watching the first response operation and feeling the urge to keep on watching because the recording intrigued me so much. This feeling also made me realize how serious the job of a fire fighter is. Moreover, how important research into operations like these are and that it can contribute to a better outcome and professionalization of such operations.

Writing a thesis is a process that nobody can accomplish without the help of others. Therefore, I would like to thank my fellow students Anne Middeldorp, Nathalie Scheffer and Myrna van Doorn, who are all part of the capstone. I would like to thank my supervisors Jeroen Wolbers and Hans Hazebroek in particular. Thank you for your guidance, knowledge, feedback and insights into the complex world of crisis management and the Dutch Fire Department as an organization. Writing this thesis and analysing the response operations has been a very educational experience for me. For this reason I feel eager to close the chapter of studying and face the future with courage.

I hope you enjoy reading this master thesis!

The Hague, June 2020

Inge van den Boogaard

Abstract

This study concerns the actual behaviour of fire ground commanders of the Dutch Fire Department. It is investigated how fire ground commanders use different command tactics in course of a response operation. It is discussed whether fire ground commanders implement situational command and control, as they have received training to do so. To answer this question, the behaviour of fire ground commanders is analysed on the basis of their decision making process, their used command tactics and influential factors in practice.

Based on the data analysis, three distinctive patterns are discussed. First, fire ground commanders show a far more complex process of decision making than most theory argues. Second, in relation to their complex decision making process, fire ground commanders most often switch between a hierarchical command tactic and a frontline command tactic. Third, challenges occur in relation to this switching between different command tactics and lie within human factors and conflicting expectations. On the basis of these findings, it can be concluded that fire ground commanders in fact use different command tactics during response operations. Yet, this behaviour cannot always be interpreted as situational command and control as the switching does not always contribute towards an effective response operation.

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Chapter 1: Introduction

Working in an environment where time is always running out, where circumstances are constantly changing and where adequate decisions can save lives, is one that people generally try to avoid. Yet, this is recognizable for fire fighters when arriving on a scene (Cohen-Hatton & Honey, 2015). Decisions they make, have major consequences for the course of the situation. For this reason, their approach during a response operation is of great importance. Especially that of senior commanders (HOvD) and fire ground commanders (OvD), who are in charge of command and control. It is they who make tactical and strategic decisions under time pressure (Geertsema, Hazebroek & Groenendaal, 2015; Klein, Calderwood & Clinton-Citocco, 1986).

How fire fighters manage crises has been the objective of several interesting studies which mainly focus on their decision making process (Cohen-Hatton, Butler, & Honey, 2015; Groenendaal & Helsloot, 2016; Klein, Calderwood & Clinton-Cirocco, 1986). As a result, there are two relevant strands of theory. Fire ground commanders make rational-based and reflexive-based decisions. Rational-based decision making is a process in which factual information is gathered, courses of action are set out, and the carried out tasks are being monitored (Groenendaal & Helsloot, 2016; Rake & Nja, 2009). Reflexive-based decision making is a process that involves recognition, and use of heuristics such as cues or previous experience (Cohen-Hatton et al., 2015; Klein et al, 1986; Klein, 1993;). These theories stand in contrast, yet are both applicable to a commander's decision making process. Commanders are trained to make decisions rational-based but senior commanders tend to use a more reflexive-based approach during real-life responds operations (Groenendaal & Helsloot, 2016). Moreover, the commands of senior commanders are often fairly loose during large-scale incidents, leaving a great deal of the decisions to fire ground commanders (Groenendaal & Helsloot, 2016; Hazebroek, Van 't Padje, Groenendaal, Geertsema, Hagenaars, 2015). Deviation from the textbooks was also found by the Dutch Fire Department during a study into the Chemiepack fire in 2011 (NVBR, 2011). This encouraged the Fire Department to conduct extensive follow-up research into the command tactics of fire ground commanders which started in 2015.

Situational command and control, which emphasises on a more flexible employability of different command tactics, turned out to be the solution according to the Institute of Physical Safety (IFV) and the Dutch Fire Academy (Hazebroek et al., 2015). Situational command and control enables commanders to adapt specific practices or switch from one to another (Schakel, van Fenema & Faraj, 2016). This is important because crises often forces commanders to a fast-

response organization considering that the development of crises involves continuous processes of adaptation. A commander can better respond to these processes when one is able to switch back and forth between coherent sets of practices that constitute different modes of organizing (Schakel & Wolbers, 2019). It can increase the level of situation awareness by commanders (Schakel & Wolbers, 2019) and enhances organizational flexibility (Bigley & Robers, 2001). The first steps towards this approach within the Dutch Fire Department were taken in 2017 when a 'test group' of fire ground commanders attended training courses on situational command and control. However, how these fire ground commanders make use of it in the field, and thus if they adapt their approach to the situation, has not been analysed. Therefore, it is unknown whether their approach is more flexible and towards the desired situation as Hazebroek et al. concluded in 2015. This provides us with the following research question:

> *"To what extent do fire ground commanders within the Dutch Fire Department use different command tactics in course of a response operation?"*

As it is an explanatory study, sub questions can provide structure and guidance. Both in composing a thorough theoretical framework as well as in analysing the data. Therefore, the following sub questions are drafted:

> "How does the decision making process of fire ground commanders work in practice?"
> "Which command tactics do fire ground commanders use in practice?"
> "Which factors influence the behaviour of fire ground commanders in practice?"

This explanatory study focuses upon the behaviour of 'fire ground commanders' (OvD's), who are hierarchically positioned below the 'senior commanders' (HOvD's). As the data is collected by the Dutch Fire Academy, the study is limited to Dutch fire fighters. This demarcation increases the feasibility. The data coming from the Academy itself contributes to its quality and validity. As a final point, several studies stress the importance of further research into the formulation of orders by subordinates (Groenendaal & Helsloot, 2016; Hazebroek et al., 2015; Van 't Padje, 2014). By doing so, this study aims to contribute to the scientific knowledge of command tactics. The results contribute to the fire fighters' training programs, connecting them to real-life events which can be beneficial for the Dutch Fire Department and society as a whole.

The remainder of this study outlines the following chapters. Chapter two is used to further construct the theoretical framework on behaviour of fire fighters. With the use of relevant

academic literature, it clearly describes the relevant concepts to be able to answer the research question. Chapter three then provides a clear overview of the research design and research method that is being used to conduct a thorough data analysis. The chapter justifies the choices made with respect to the operationalization of concepts as required by the research design. Based on previous chapters, chapter four presents the findings conducted from the analysis and discusses patterns. Chapter five is the concluding part in which an answer to the research question is given. How the findings of this study relate to the body of knowledge is also discussed. Lastly, chapter five mentions recommendations for future training of fire ground commanders and discusses pointers for the future, as well as some limitations of this research.

Chapter 2: Theoretical Framework

This chapter outlines relevant theory on behaviour of fire ground commanders. First, subchapter 2.1 discusses crisis management done by the fire department. Then, subchapter 2.2 and 2.3 both focus on behaviour of fire fighters by discussing the decision making process, command tactics and switching between them.

2.1 Crisis Management by fire departments

A significant amount of research has been done on coordination and crisis management within fast-response organisations like police departments, fire brigades and military units. Fragmentation is one of the toughest problems in crisis management (Weick, 1993; Wolbers, Boersma & Groenewegen, 2018). During a real-life crisis management operations, tension can arise between following trained procedures and adaptation (Groenendaal & Helsloot, 2016; Klein et al., 1986). The need to make on-the-spot adaptions is crucial for making a good estimation. This requires the use of command tactics to guide the adaptation process (Wolbers, et al., 2018). Thus, activities done by fire ground commanders to manage crises mostly concerns giving commands to others in an attempt to organize the response operations.

Before further explaining response operations by fire departments, it is important to elaborate on the Dutch Fire Department and their organizational structures. The Dutch Fire Department uses a hierarchical classification in which they distinguish different functions and ranks. The repressive functions that are employable during response operations are listed below, in figure 1[1] (NVBR, 2010).

Function			**Rank**	
Dutch	**English translation**	**Abbreviation** (Dutch)	**Dutch**	**English translation**
Commandant van Dienst	(Deputy) Chief commander	CvD	(Adjunct-) Hoofdcommandeur	(Deputy) Chief commander
Hoofdofficier van dienst	Senior commander	HOvD	Commandeur	Commander
Adviseur gevaarlijke stoffen	Hazmat scientific adviser	AGS	Commandeur	Commander

[1] The original terminology is translated into English. The abbreviations are derived from the original terminology.

Officier van dienst	Fire ground commander	OvD	Hoofdbrandmeester	Leading fire fighter
Bevelvoerder	Crew commander	BV	Brandmeester	Fire fighter
Duikploegleider	Water rescue unit commander	DPL	Hoofdbrandwacht	Leading fire fighter
Manschap B	Leading fire fighter	MS B	Hoofdbrandwacht	Leading fire fighter
Chauffeur	Driver	-	(Hoofd)brandwacht	(Leading) fire fighter
Voertuigbedienier	Vehicle operator	-	(Hoofd-)brandwacht	(Leading) fire fighter
Gaspakdrager	Hazmat specialist crew	IBSG	(Hoofd-)brandwacht	(Leading) fire fighter
Brandweerduiker	Rescue diver	WA	(Hoofd-)brandwacht	(Leading) fire fighter
Verkenner gevaarlijke stoffen	Hazmat specialist crew	-	(Hoofd-)brandwacht	(Leading) fire fighter
Manschap a	Fire fighter	MS A	(Hoofd-)brandwacht	(Leading) fire fighter

Figure 1. Dutch Fire Department repressive functions, abbreviations and rank

Within this hierarchical classification, there are four functions which occupy a rank where they are in the position of giving commands during a response operations. They are listed below, in figure 2 (NVBR, 2010). These four functions (together) are referred to as 'commanders', as they are the fire fighters who actually perform command tactics. However, as the first chapter already stated, this study focusses on the behaviour of the 'OvD' which is referred to in English as a 'fire ground commander'.

Function			**Rank**	
Dutch	**English translation**	**Abbreviation** (Dutch)	**Dutch**	**English translation**
Hoofdofficier van dienst	Senior commander	HOvD	Commandeur	Commander
Adviseur gevaarlijke stoffen	Hazmat scientific adviser	AGS	Commandeur	Commander
Officier van dienst	Fire ground commander	OvD	Hoofdbrandmeester	Leading fire fighter
Bevelvoerder	Crew Commander	BV	Brandmeester	Fire fighter

Figure 2. Dutch Fire Department repressive functions with (optional) command and control

Now that the organizational aspect of response operations by the Dutch Fire Department is illustrated, the behaviour of these fire fighters is next to discuss.

2.2 Fire fighters' command tactics as behaviour

As mentioned in the former paragraph, an important aspect of crisis management is command tactics. A fire ground commander's performance is based on executing command tactics (Bigley & Roberts, 2001; Klein et al., 1986) because it covers a large part of their behaviour during response operations (Bigley & Roberts, 2001). Their command tactics arise from the decisions they make during a response operation, often under time pressure with high stakes and limited information (Cohen-Hatton et al., 2015). In order to analyse a fire ground commander's behaviour, it is important to discuss literature on decision making processes and to explain situational command and control from an academic perspective.

2.3 Behaviour during fast-response operations

2.3.1 Behaviour as decision making processes

Two different strands can be distinguished when looking at behaviour as decision making processes. The first strand of decision making theory assumes a rational process. The process involves an orderly sequence of three key phases: situation assessment, plan formulation and plan execution (Van den Heuvel, Alison & Power, 2014). This process can be explained for fire ground commanders in the following way. During situation assessment, the commander forms an understanding of the situation by fact-finding. Understanding and projecting the situation into the future provides the foundation for the selection of the appropriate plan of action. Situation assessment refers to individual processes to achieve a state of knowledge, defined as situational awareness by Endsley (1995). During the plan formulation phase, commanders are expected to identify the problem and gather possible solutions to develop a course of action. The plan execution phases then involves the implementation of the plan. Commanders communicate their course of action to those who need to implement them. The activities are controlled by the commander to ensure the plan is effectively executed. Cohen-Hatton (2015) emphasizes that in this normative theory the phases occur sequentially. This rational decision making process is conceptualized by defining the following phases; situation assessment (SA), plan formulation (PF) and plan execution (PE) (Cohen-Hatton, 2016; Klein, 1986). As mentioned earlier, this process mainly corresponds with the way commanders are trained to respond.

The second strand of decision making theory assumes a reflexive process. Klein (1993) emphasizes that decisions are connected to previous experience. Routines can break down during response operations while fire ground commanders use heuristics and cues (Suarez & Montes, 2019). Heuristics are cognitive shortcuts. They can be used when operating in a situation of uncertainty (Kahneman, Slovic & Tversky, 1982), or when time is putting pressure on the situation (Eisenhardt, Furr & Bingham, 2010). Cues are often gained from the environment and can activate or prime knowledge structures of fire ground commanders. These knowledge structures include actions, goals and expectations related to previous experienced in similar crises (Cohen-Hatton, 2016). Thus, possible solutions are not evaluated against one another. Instead, the decision to act is considered to be a reflex. The process is based on recognition and assumes an orderly sequence of two phases: situation assessment and plan execution (Cohen-Hatton et al., 2015). Fact-finding and understanding the situation, is directly followed by plan execution. A commander recognizes the situation and, as a reflex, provokes previously performed actions under similar circumstances. The decided course is not compared with other options (Cohen-Hatton et al., 2015; Klein, 1993). Klein et al. (1986) highlights that the ability of a commander to handle a response operation depends on their ability to handle decision points. Klein's study illustrates that commanders often handle such decision point by depending on previous experiences. They often recognize the situation as a typical instance of general prototypes. These general prototypes are developed through experience.

This approach is often used because it has the advantage that those general prototypes provide commanders a certain level of understanding of the unfolding crises. Commanders are able to exhaust expectations from the general prototypes, a fast process that would be described as the use of heuristics by Kahneman and Klein (2009). Those expectations help commanders to generate effective options or a course of action. Thus, it is an intuitive-based approach (Klein et al., 1986) where intuitive judgements and decisions come to mind automatically, without explicit awareness of the commander, and can arise from either experience or heuristics (Kahneman & Klein, 2009). Follow-up research into the use of heuristics and experience came with an interesting conclusion. It concluded that judgements and decisions based on heuristics, instead of experience, tend to be less accurate and can prone systematic biases (Kahneman & Klein, 2009). As a final point, the reflexive decision making process is conceptualized by defining the following phases; situation assessment (SA) and plan execution (PE) (Cohen-Hatton et al., 2015; Klein et al., 1986).

When comparing the two processes, they contain two identical phases: SA and PE. However, they have one important difference. The reflexive process does not distinguish a plan execution phase (Cohen-Hatton, et al., 2015; Klein, 1986), making the situation assessment phase of interest for this research. This phase determines whether a commander develops possible solutions or not, before proceeding to the phase of acting and commanding (Klein, 1986). The latter is precisely the part in which fire ground commanders have received training. Therefore, the decision making process is related to the fire ground commanders' command tactics.

2.3.2 Behaviour as situational command and control

The OvD test group which is cited in the first chapter is trained on situational command and control. One can define it as "the command type, i.e. 'the way in which decisions are made about the approach to the incident and the way in which commanders have these decisions implemented', must be tailored to the incident characteristics or the task environment" (Hazebroek et al., 2015, p.55). Situational command and control sheds light on large-scale fire brigade response operations from three perspectives: command type, human factors and business intelligence. This research touches upon human factors but mainly focusses on the command types.

Human factors are factors that positively or negatively influence human action in certain situations. The factors mostly concern the use of biases and heuristics in a commander's approach. The factors can provide insight in the limits of human ability under certain circumstances (Kahneman, Slovic, & Tversky, 1982). Because this research focusses on the degree of flexible use of command tactics, theory on biases offer significant added value. Tversky and Kahneman (1974) state that biases are the result of the use of judgemental heuristics, cognitive shortcuts. As discussed in the previous section, commanders rely on these heuristics and resulted biases when applying a more intuitive approach. Human factors can influence the decisions of commanders during a response operations and therefore influence their behaviour (Trevsky & Kahneman, 1974). Thus, when focussing on the behaviour of fire ground commanders by analysing the command types that are being used, human factors can play an explanatory role.

Command tactics is commonly associated with military approaches. There, it is referred to as command and control and defined as "a set of organizational and technical attributes and processes… that employs human, physical and information resources to solve problems and to

achieve goals" (McCann, 2002). In other words, command and control is an organizational structure at the executing level of a disaster relief organisation such as fire departments. Groenendaal and Helsloot refer to these different types as "making decisions about the incident response operation and ensuring that these decisions are carried out properly" (2016, p.1). There are three types to distinguish: hierarchical, commanders' intent, and swarming.

The hierarchical model emphasises standardized work procedures, and relatively limited level requirements of personal knowledge (Klein, 1993). The commanders' intent model works from the idea that subordinates understand the intended end state as desired by the fire ground commander while having the freedom to adjust their actions to achieve that end state. "Rather than relying on direct orders, the subordinates make decisions based on their understanding of the situation" (Winner, Freeman, Cooke & Goodwin, 2007, p.122). The concept swarming knows many definitions. The IFV sees swarming as a model working on principles of multiple self-managing teams. It emphasize on a participative leadership style, with variables and redundant numbers of teams, and the ability to improvise (Hazebroek et al., 2015, p.18). However, the vast majority of research on swarming does not include a leadership style. It is "a strategy where several units conduct a convergent attack on a target from multiple axes" (Edwards, 2004, p.1). As a final point, it is important to emphasise that the flexible deployment of these three types is key to organize an effective fast response (Schakel & Wolbers, 2019).

In order to embed situational command and control academically, one can discuss the similarities with fast-response organizing modes. Command tactics are ways for incident commanders to communicate what they want to achieve. In theory, such tactics ensure that orders are based on a decision-making process, often under time pressure, and implemented by subordinates as desired (Groenendaal & Helsloot, 2016). This is relatively similar to the theory of fast-response organizing modes. This theory emphasize the dilemma between hierarchical decision making with clear lines of authority, and on-the-spot decision making with informal coordination or even self-management. According to the fast-response organizing theory, "this dilemma requires adaptation on multiple occasions during a crisis by transitioning between different modes of organizing" (Bye et al, 2019 in Schakel & Wolbers, 2019, p.5). Both theories stress the influence of time and a shared goal. Time in the way that there is a sense of time pressure and a need for rapid action. Shared goal in the way that different command tactics or organizing modes are applied while the goal of the response operations remains the same. Therefore, this research applies the theory of organizing modes upon situational command

tactics. As already mentioned, there are three situational command tactics: hierarchical, commanders' intent, and swarming. They can be linked to the following modes of organizing that scholars have distinguished: designed, frontline, and partitioned (Barton, Sutcliffe, & Vogus, 2015; Bigley & Roberts, 2001; Moynihan, 2009; Schakel & Wolbers, 2019).

The designed organizing mode uses predefines lines of command to mobilize scheduled resources and designated actors and to discuss and decide upon an appropriate course of action to manage a crisis (Schakel & Wolbers, 2019, p.5). This is the most recognizable mode and often used when a crisis is thought to develop in a predictable way (Moynihan, 2009). One can link this organizing mode to hierarchical command and control as it is a standardizes work procedure (Klein, 1993). Directive command and control is used to achieve a goal.

The frontline organizing mode is used when the command is delegated to the units closest to the actual incident. At which they use ad-hoc allocated personnel who emphasize on improvisation to handle a rapidly developing crisis (Groenendaal & Helsloot, 2016; Schakel & Wolbers, 2019, p.6) In this organizing mode, the frontline has access to concrete situational details which are key for navigating through a dynamic situation such as a fast-response operation (Barton et al., 2015). The aim here is to keep up with a rapidly developing crisis while remaining space to act freely. Often, concern on standard procedures is voiced, while engaging in a set of practices aimed at a dynamic delegation (Rico, Sánchez-Manzanares Gil, et al., 2008), plug-and-play teaming (Faraj & Xiao, 2006) and role switching (Bigley & Roberts, 2001; Schakel & Wolbers, 2019). One can link this organizing mode to commanders' intent command and control, as a goal is given to the frontline units or subordinates. They take actions according to their understanding of the unfolding situation at the frontline (Winner, et al., 2007).

The partitioned organizing mode is used when the command is formed in separate pockets of control by using personnel who spontaneously engage with an unfolding crisis element. They rely on their local perceptions by doing so and do not have access to any form of consultation. This mode likely occurs when crisis-responders are confronted with a situation that is distributed on a large-scale and immediate action is necessary (Schakel & Wolbers, 2019, p.6). Most of the involved practises are aimed at on-the-spot adaptation where improvisation is key (Schakel & Wolbers, 2019, p.6). Fragmentation is used to (re-)gain autonomy of the incident (Comfort, 2007, p.195) and to protect the separate pockets of control while these pockets work parallel processed and functional compartmental based (Wolbers et al., 2018). One can link this organizing mode to swarming command and control from a military perspective. Swarming is

a military strategy defined as "a strategy where several units conduct a convergent attack on a target from multiple axes" (Edwards, 2004, p.1). Subsequently, "a degree of autonomy and self-organisation is assigned to these units" (Edwards, 2004, p.90-91). Edwards applies the concept on police- and fire departments with the example of bank robberies and fires response operations (2004, p.3).

Final point to discuss is the switching between these different modes of organizing fast-response operations and the challenges that come with it. There are two strands of theories to discuss on how switching takes place. Some scholars describe it as a static on-off adaptation or restructuring of activities when encountering a crisis (Bigley & Roberts, 2001; Faraj & Xiao, 2006; Klein et al., 2006). While a more recent study by Schakel & Wolbers illustrates that adaptation is a (frequently occurring) process of switching back and forth between the different modes (2019). Schakel and Wolbers analysed the adaptation of organizing modes in high-speed police pursuits and found two transitioning processes. First, the transitioning between designed and frontline organizing which can occur frequently during a response operation. Commanders often shortly adopted a designed mode of organizing to ensure shared situation assessment to then delegate command (back) to frontline officers. Or, commanders transition from frontline (back) to the designed mode in order to bring a plan into effect. Schakel and Wolbers found that switching is used for giving commands or assignments, and information sharing (2019). Second, the transitioning in and out of partitioned organizing. In this organizing mode, there is no ability to give commands and assignments or to share information. It is not a transition between partitioned and another mode, it is about transitioning in and out of the mode itself.

The switching between organizing modes can be challenging. Conflicting lines of command, conflicting or delayed information and decreasing awareness of the evolving crisis are challenges that Schakel and Wolbers found (2019). This corresponds with a study done by Schakel, Fenema and Faraj on switching in police work practises (2016). They distinguish challenges on three levels; the individual, the team, and material conditions. On the individual level, the ability to process information can be hampered which can result in the commander 'freezing'. This occurs when they experience stress and anxiety due to discrepant information. On the team level, it is also about discrepant information but more concerning the development of a collective understanding. When there is confusion and degrade of information sharing due to discrepancy, it hinders a joint action. This can lead to passive behaviour of the involved. Lastly, the material conditions, which can produce practical hinder of switching. Fast-response

operations are often dependant on weather conditions, (limited) infrastructure or (malfunctioning) equipment which can have negative consequences, even for well-laid plans (Weick, 1993). Moreover, physical distance can have the same effect (Schakel et al., 2016).

Chapter 3: Research Design and Methodology

This chapter outlines the design that has been used to collect the relevant data for answering the research questions. The first subchapter 3.1 describes the overall design. Then, subchapter 3.2 focusses on the methods that were used to collect and analyse the data.

3.1 Research Design

This study search for patters in switching between command tactics during response operations, allowing an explorative design and is therefore inductive (Dickinger, 2018). Based on the theory discussed in the second chapter, the different decision making phases and processes are of importance when searching for patterns. Moreover, the findings of Cohen-Hatton (2015), Klein (1986), Schakel & Wolbers (2019), and many other scholars suggest that the different phases in decision making, as well as the type of command tactic, are key when analysing behaviour during response operations. This exploratory research looks at the practice of incident command.

By analysing the OvD test group, this study aims to clarify the situational command and control tactics in practice. It seeks to better understand if different command tactics are being used, if decision making has any influence on it and perhaps find patters in doing so. This justifies a qualitative research method. “Qualitative research provides an in-depth insight; it is flexible, small-scale and exploratory” (Ruyter & Scholl, 1998). Moreover, a goal of qualitative research is to discover and identify preliminary insights on and a better understanding of ideas, objects or processes (Ruyter & Scholl, 1998).

The response operations that are analysed for this study are all different. Fire fighters handle diverse crises, such as large fires on industrial sites, explosions, radioactive incidents, but also blazing house fires. All such incidents are captured with bodycam video recording. Due to the fact that this study analyses behaviour during actual response operations, the use of bodycam video recordings allows for first-person footage observing (Cohen-Hatton et al., 2015). It makes it possible to see the incident from the fire ground commander’s perspective which is more beneficial compared to observing methods. Observing can be difficult when, for example, the fire ground commander enters a dangerous spot that the observer is not allowed to enter. Therefore, bodycams were used which resulted in video material as data. These recordings consist of detailed and information-dense material and therefore needed a type of analysis that can order such data. This justifies for content analysis (Krippendorff, 2004). Content analysis

enables to make a replicable and valid inference of detail-rich data. It summarizes patterns in condensed content (Krippendorff, 2004). In order to find any existing patterns, content is classified in categories established in a codebook (Holsti, 1969). The following paragraphs explain the research design in more detail.

3.2 Research Method

3.2.1 Case selection

The research focusses upon the Dutch Fire Department. There are many different ranks to distinguish within the Department and therefore discussed in the second chapter. The objective of this study is the behaviour of fire ground commanders during middle to very large response operations. During such response operations there are three ranks actively involved and authorized with command tactics. The senior commanders are the highest rank of front-line commanders and are in charge of up to four fire ground commanders. Fire ground commanders are then in charge of crew commanders and their team which form the actual ground-respond apparatus[2]. Each crew commander is in charge of a fire truck. Each fire truck is equipped with crew A and crew B, who are both pairs. As already justified, this study focusses on the fire ground commanders and their command tactics during response operations. Their situational approach has not been analysed yet and it is, therefore, unknown whether they use a more flexible approach as they have received training to do so.

3.2.2 Data collection

The data emanates from the response operations and is therefore supplied by the Dutch Fire Academy. The data itself is not accessible for everyone. It is collected for research within this specific subject and thus presumably useful and reliable (Jensenius, 2014). The data consists of bodycam video recordings of actual responses by fire ground commanders to middle to very large crises, between July 2017 and December 2018, within the safety regions Drente, Gelderland-Zuid, Haaglanden and Kennermerland. The length of the recordings varies between 30 and 180 minutes in which (part of) the response operation is recorded. This research is part of a capstone from Leiden University. Working together with three other CSM-students made it possible to collect data from twenty incidents, of which this study analysed ten incidents. The usage of bodycam video recordings guarantees objectivity. This, together with validity are key

[2] Derived from Art: 2:1, 3:1-2 & 4:4 Besluit personeel veiligheidsregio's [Dutch law]

concepts within content analysis (Roe & Just, 2009). In sum, the data consists of primary field data which is solely used for analysing behaviour.

3.2.3 Data Analysis

To analyse the bodycam videos, this study uses the method of content analysis. This method involves ordering and organizing the data so that it can be understood more easily (Krippendorff, 2004). A method that matches the complex concept of behaviour. To assure a solid analysis, it is a three-step process. First, the video recordings have been collected by the Dutch Fire Academy and IFV of which twenty incidents were selected.

The second step consisted of transcribing the video recordings alongside the codebook[3], presented as appendix I. The codebook has been used in the following way. First, the event was described and then analysed alongside the analytical framework as displayed in the this chapter as figure 3. Then, the code was categorized by its phase as situation assessment (SA), plan formulation (PF) or plan execution (PE). These three categories also have subcategories to give the situation a detailed category. Next to this categorization is the level of situational awareness in which the codebook distinguishes three levels. Last category in the codebook concerns the situational command type. Whenever the level of situational awareness and, or, command type changed it was marked. Each code also received a timestamp to ensure they can be traced back to video recording. Each capstone member transcribed ten incidents alongside the same codebook. As a result, each incident is analysed by two capstone members. This has the advantage that all the transcripts can be compared to ensure validity.

In the third step, ten transcripts have been analysed individually in the search for used command tactics and patterns in order to answer the research question. Therefore, this study focussed on specific parts of the codebook transcriptions. Figure 3 shows a list of indicators of interest that have been derived from the codebook. It functioned as a framework for identifying possible patterns (Holsti, 1969).

[3] The codebook is written in Dutch, by J. Wolbers and H. Hazebroek who are both involved in this capstone. In the appendix it is translated to English.

Decision making phase	**Indicators of interest**	**Analysis results** [example from response operation 3]	**Identified organizing modes during operation**
Situation Assessment; cues	*Is conflicting information recognized?*	The fire ground commander receives the information that there is a key. It was previously noted that there was none	designed, frontline and partitioned are used
Plan Formulation; goal formulation	*Are goals named?*	Fire ground commander: "the final goal is to create a division line"	
option awareness	*Are suggestions made to the OvD by others?*	The emergency room suggest not to use the 'WT'	
Plan Execution; decision	*Which decisions are made?*	The fire ground commander decides to scale-up to large fire.	
communication	*Directive, participative, suggestive, or authoritative commands?*	The fire ground commander gives the directive command to clear the street	
	Which information does the OvD share with HOvD and BV?	The fire ground commander sketches the situation and deployment of fire fighters on paper and shares information on requested material with commanders (BV)	
Emotions	*Is the OvD experiencing stress?*	The fire ground commander is confronted with many questions, expectations and suggestions and gets stressed.	

Figure 3. Analytical Framework

As the analysis is done based on video recordings, the type of command tactics is derived from what a fire ground commander said or did. It is therefore necessary to operationalize the different types of command tactics in order to identify them in the response operations, as well as to fill in the framework shown in figure 3. Therefore, figure 4 illustrates the operationalization of command tactics. It distinguishes the three organizing modes and is connected to the codebook so that they can be detected.

Decision making phase	**Indicators**	**Organizing mode**		
		Designed	*Frontline*	*Partitioned*
Plan Execution; organizing	*1. How are the roles divided?*	Based on hierarchy	Based in highest level of relevant professional knowledge	Based on individual pockets of control
	2. How are tasks delegated?	By (H)OvD	By (H)OvD or by frontline	Self-management
	3. Is there a need for consultation?	Possibly	Likely	Impossible
	4. Is the organizing mode adjusted?	Transition to frontline	Transition to designed	Only in and out of partitioned

Figure 4. Operationalization Command Tactics

The data was analysed alongside the codebook, framework and operationalization scheme. This resulted in lists of codes of interests with regard to the (changing) command tactics. These results were combined and synergized in the search for patterns. It formed the base of the analysis discussed in chapter four and the conclusion discussed in chapter five.

Chapter 4: Analysis

The results of the analysed data collection are presented here. The sub questions stated in the first chapter are used as a guideline when categorizing patterns in the data. First, subchapter 4.1 discusses the decision making process of fire ground commanders. Then, subchapter 4.2 discusses the command tactics that fire ground commander use. Finally, subchapter 4.3 discusses factors that influence the behaviour of fire ground commanders.

4.1 Decision making processes in practice

This section aims to answer the first sub question on how the decision making process works in practice. As previously discussed there are two processes; the rational decision making process and the reflexive decision making process. The driving forces in the search for patterns are the phases of situational assessment, plan formulation and plan execution as stated in the codebook.

4.1.1 Rational based decision making process

The rational based decision making process involves an orderly sequence of three key phases: situation assessment, plan formulation and plan execution (Van den Heuvel et al., 2014). It is also the process that mainly corresponds with the way fire ground commanders are trained to behave during response operations. When analysing the bodycam video recordings, this orderly sequence of the three phases occurs in every response operation. How this rational process occurs, and how it reflects the behaviour of fire ground commanders can be divided into two ways.

First, many response operations show examples of the rational based decision making process. Empirics show a short orderly sequence of situational assessment, plan formulation and plan execution. Here, it concerns small parts of the overall approach. A fire ground commander assess the situation by, for example, questioning the access to the building to a subordinate. Subsequently, the fire ground commander formulates a plan on how to access the fire inside that building. During the plan formulation phase, multiple approaches can be considered or weight against each other. Then, the fire ground commander decides which plan is going to be implemented and executed, for example deciding to enter the building from two sides. This is then shared with subordinates. Looking at this process, response operation seven stands out here because there are multiple examples which indicate that the overall decision making process is rationally based. This particular response operation involves a very large fire

department service including several platoons. According to the involved commanders it concerns an exceptional incident: "*Such a large-scale performance is rare in the Netherlands, so you are lucky to participate".* The fire ground commander carrying the bodycam was called to the site, along with his platoon, for support. There was little time pressure so the three fire ground commanders in place took their time to tackle this operation 'according to the book'. The few decision moments that arise during the operation were all approached from a rational perspective, in accordance with the way they are trained to approach such major incident. The start of the operation illustrates the overall approach best:

> SA: Three fire ground commanders are wrapping up their assessment of the situation and notice how narrow the streets are . They are clearly mapping the situation: *"Let's take the map for a second .. Yes, put it here. Okay, where are the platoons? They are here and here, and the fire is going in this direction. I believe they are trying to keep it from spreading."*
>
> PF: A relatively long consultation starts between the three in which they discuss deployment of crews, set a priority (inside of the building), and formulate their goal (keep a line of demarcation). They state that they are ahead of the game and informed enough to formulate a plan: "*You do not need more, that is about it.".* Together they decide to keep two platoons on standby for relieve. *"Shall we do two things? One is quite simple, we have to make sure it does not expand.. Easy to fix with .. water cannons?"* They also agree that two fire ground commanders is sufficient.
>
> PE: After agreeing on the goal and priority, they execute their plan by organizing the two platoons. *"The second task is the exploration inside. I am going to tackle the outside. You do inside."*

During the whole response operation there are relatively few executions according to plan. However, the decisions that are being made all have the same process prior to the decision moment. The situation assessment phase followed by plan formulation and plan execution. Thus, the situation is addressed in a rational way by formulating a plan of action before executing it. Therefore one can argue that the overall approach is rational based. The fact that it concerns an exceptional large operation with many brigades, calls for a well-organized approach. A well-organized approach needs planning which explains the orderly sequence where situation assessment is followed by plan formulation and then plan execution. It is a response operation where routine and scripts are key in order to successfully organize all

brigades and actions. Therefore, one can argue that in this case the size of the response operation, together with little time pressure, triggers a rational based approach.

Second, every response operation shows at least one, some multiple, example of the rational based decision making process. The fragments show decisions that mostly concern side issues of the fire departments approach. For example the contact with experts, municipalities, or media. But also logistic matters such as the arrangement of catering, the replacement of (tired) crews or the positioning of vehicles and crews. However, these examples are often short moments and therefore also small decisions within the entire response operation. An example in support of this is the following fragment from response operation five:

> SA: The fire ground commander explains the situation to the second crew commander (BV 120). During his explanation he is still assessing the situation as they are walking around the building: *"If you look over there, you see that roof? That might become a risk."*. He informs the BV 120 about this risk: *"Take into account what I just said."*.
> PF: The fire ground commander gives BV 120 a target: *"expansion to the other part must be prevented"*.
> PE : The fire ground commander then gives the precise location where BV 120 must perform the task: *"you must line up here"*. The fire ground commander makes a decision and command based on the formulated goal.

Another example is found in response operation eight:

> SA: The fire ground commander sees yellow liquid in the extinguishing water: *"I think it is pesticide. … Let's use the small test-kid to see if this yellow liquid is toxic. I think I have one in my truck."*.
> PF: The result of the test indicates that the liquid can be toxic. The fire ground commander than consults the senior commander: *"I think we should inform the hazmat scientific adviser … We only know that the liquid is toxic. Let them decide what we are dealing with here, or do you want to assume it is pesticide? … Let's call the experts … It if is toxic indeed, it cannot leak into the trench … We have to inform the owner right away."*.
> PE: The fire ground commander decides that he wants an expert to take a look so he commands to inform the regional environmental authority and hazmat scientific adviser. The decision was made after discussing it.

These two examples show a rational based decision making process where the three phases occur in a sequential order. But, examples like these are scarce. Both these fragments continue in the codebook by showing more non-rationally driven sequence of phases. In odder words, no situation assessment followed by plan formulation and plan execution. Instead, the three phases continue in another sequence. As for response operation five, such clear follow-up of the three phases as highlighted in the fragment only appeared one time during the whole operation. As for response operation eight, it only appeared twice. So when zooming-out and analysing the whole operation, they appear to lean towards a different overall decision making process. This is not only the case for these two. Out of all ten response operations, nine do not show evidence of having an overall decision making process that is rational based. This automatically leads to a different decision making process.

4.1.2 Reflexive based decision making process

The pendant of the rational based decision making process is the reflexive based decision making process. It emphasizes that decisions are connected to previous experience (Klein, 1993) and that heuristics and cues can break down routines during a response operation (Suarez & Montes, 2019). The decision to act is considered to be more of a reflex (Cohen-Hatton et al., 2015). The second chapter explains the process in more detail. When analysing the bodycam video recordings, an arising reflex during the situation assessment phase triggers plan execution. This occurs in nine out of ten response operations. Here too, the process is reflected in the behaviour of fire ground commanders in two ways.

First, nine response operations show examples of the reflexive based decision making process. Three operations stand out because they all show behaviour that indicates an overall reflexive approach. It concerns response operation one, three and five where many of the decision are triggered as a reflex. The following fragment from incident five shows such reflex:

> SA: The fire ground commander has heard from the owners of the farm that there is no asbestos in the shed.
>
> PE: The fire ground commander informs the control room that there is no asbestos in the shed, according to the owner. However, he decides to have the special units called to the scene: *"I want them notified just in case".*

What is important in this example, however not visible in this short fragment, is that the police informed the fire ground commander about their suspicion of asbestos when he arrived at the

scene. It is therefore plausible that the fire ground commander is biased. His intuition, when assessing the shed and hearing from the police, is that there is a possibility for asbestos. This intuition can be the result of previous experience. The fire ground commander's situation assessment triggers a decision that is not coherent with the factual information hitherto, ignoring the statement of the owner. This behaviour is common during the response operation. The fire ground commander largely acts from his interpretation and takes no opportunity to consult. He breaks down the routine when his own assessments triggers the executed plan. The fact that incident five is also discussed in the previous section also emphasizes that multiple approaches occur in one response operation.

Another example illustrates a reflexive based approach even more. Response operation one only shows reflexive based decisions. It concerns a report of a small explosion in a laboratory, located in a large and crowded public building. This explains why the incident is immediately labelled as a large fire. For a long time, the fire ground commander has little knowledge on what is going on exactly. After they think a crashed computer caused the explosion, the threat is considered to be cleared according to the fire ground commander. However, there is still little information on what could be the underlying problem causing a lab computer to crash. Then the following fragment occurs:

> SA: The fire ground commander receives information that the lab personnel heard another explosion in their lab: *"I hear there has been another explosion, this time in a stove".*
> PE: The fire ground commander immediately responds by sending his first crew back inside: *"110, you are going up again".*

Clearly the fire ground commander is triggered by the information of another explosion. The decision to send fire fighters back inside the building is immediately executed. However, the fire ground commander still has little knowledge on what exactly happened during the first explosion, nor is there any information on what could have caused the explosion that was just reported. Moreover, there is no indication that it is safe to send fire fighters back inside, nor is there any plan formulated. The fire ground commander therefore relies on something else than plan formulation when making the decision to send the crew inside. He must indicate the situation as not too serious, otherwise the fire ground commander would be triggered to proceed with caution. Perhaps evacuating the building while trying to get more information, instead of sending fire fighters back in. Thus, his expectations are possibly guided by a general prototype

developed through experience. Throughout this response operation, the fire ground commander barely implements any form of plan formulation. Any sequences of the three supposed phases, situational assessment, plan formulation and plan execution is not visible, making rational decision making processes not evident. Decisions are often made based on information shortage and most likely triggered by previous experience. Assessment of the situation is often followed by a decision or execution of a command. This indicates a general approach of the fire ground commander that is reflexive based.

Second, the other six response operations that show example of the reflexive based decision making process cannot be categorised as having this approach throughout the whole response operation. There are examples within these operations where the fire ground commander is triggered in his assessment phase that results in a decision without any plan formulation. However, the analyses also shows many decisions making processes that are not defined as reflexive-, nor as rational based as discussed in the second chapter. These response operations along with the fire ground commanders' behaviour do not correspond with the theories on decision making. Their behaviour shows signs of another, far more complex, form.

4.1.3 Complex decision making process

When analysing the behaviour of fire ground commanders by coding the phases of situation assessment, plan formulation and plan execution, these phases also occur in different formats than what the rational- or reflexive based process describes. The process visible in empirics is therefore not rational- or reflexive in nature as it is not an orderly sequence of situation assessment, plan formulation and plan execution nor of situation assessment and plan execution. Instead, it is a process in which phases follow in all kinds of sequences. To be more specific, plan formulation does occur which eliminates an overall reflexive approach. Though, the plan formulation phase is followed by both plan execution and situation assessment which eliminates a rational approach and making the plan formulation phase key when deepening the occurring process. For example, situation assessment is followed by plan formulation, to then go back to situation assessment before finally executing the plan, or formulating another plan to execute. Thus, in practice plan formulation occurs often and is then followed by either plan execution or situation assessment. It is mainly a loose follow-up of phases and developments.

First, when plan formulation is followed by situation assessment, it is in most cases followed by plan execution. Leading to the following process: plan formulation, situation assessment,

plan execution. This process does not match a rational process that emphasizes on an orderly sequence of situation assessment, plan formulation and plan execution, nor does it match a reflexive process that is often found in other studies because there is a plan formulation phase. A fragment from response operation ten illustrates best how such process evolves in practice:

> PF: The crew commanders address what needs to done to stop the fire: *"We can draw a line here, I'm sure it is only a lot of smoke and easy to stop it from spreading".* The fire ground commander responds *"I want to finish the assessment first, before formulating a plan. Are they done on the inside?".*
>
> SA: Based on his assessment the fire ground officer states: *"I think it is mixed garbage, little fire and a lot of smoke".*
>
> PE: The fire ground commander then monitors where all crews are deployed, using a tablet. He then agrees with the suggested plan: *"I want you to first hold it here"(pointing at the suggested line).*

This example shows that the situation assessment phase is between plan formulation and plan execution. The commander reverts to assessment to gather more information. Based on multiple examples where something similar occurs, it seems that fire ground commanders are looking for confirmatory information on the formulated plan before executing it. Moreover, this indicates a tendency towards confirmation bias. In that case, fire ground commanders search for signals that confirm the proposed plan before executing it. In their search for these signals, it is tempting to ignore other signals. This sequence of phases is not distinguished by leading studies discussed in chapter two and will be discussed in detail in chapter five.

Second aspect of this loose follow-up of phases is plan formulation being followed by plan execution. Even though this might theoretically seem part of the rational based approach, the evidence shows differently. In practice, the situation assessment phase is not involved anymore. The six response operation that do not clearly match a rational- or reflexive based approach show a long period of time in which only the phases of plan formulation and plan execution occur. Only occasionally they go 'back' to assess the situation. This often leads to a situation in which the fire ground commanders are convinced that they are in control. When this is also the actual situation, scaling down takes place and the fire ground commander sometimes even starts to reflect on the overall performance. When this is not the actual situation, and the fire ground commander is not in control over the situation, it can lead to a relapse. Then, the senior commander interferes for example. It can also lead to a situation where subordinates partly

takeover plan formulating tasks of the fire ground commander. Response operations four and eight are best examples and mainly show the sequence of plan formulation and plan execution. There, it is also the case that the plan formulation phase is initiated by a lower rank, such as a crew commander or a crew member. The following fragment from response operation eight shows a situation in which there is no situation assessment phase prior to the plan formulation phase:

> PE: The fire ground commander is telling the commanders to communicate with each other: *"Mutually agree on a plan of action and communicate with each other."*.
> PF: One of the crew members reports himself with the proposal on how to place the fire trucks: *"I suggest we place them here and here."*.
> PE: The fire ground commander approves this proposal by saying: *"Yes, do that."*.
> PE: The fire ground commander tries to radio call 110, 120 and 130 for consultation three times. It takes several minutes until they all reply. The 120 only replies after the fire ground commander starts yelling his name across the scene.
> PF: Now that all the crew commanders are together, the fire ground commander asks them if they need any support. All three commanders indicate they have their tasks under control and do not need support.

Taking into account that this is only one fragment, it does however illustrate that a fire ground commander often has to deal with various tasks within the overall operation. As a result, there is a lot of plan formulation and plan execution in which the fire ground commander receives questions and suggestions from various angles. Examples are; police officers, ambulance staff, the emergency room, crewmembers and commanders of the fire department. This creates all kinds of loose decision making processes which all require the attention of the fire ground commander. As a result, the fire ground commander is unable to address all these questions and suggestions at the same way, using the same decision making process. This creates situations in which multiple processes are used throughout, often seen in the analysed operations. Fire ground commanders sometimes are occupied formulating a plan or answer to one question, while almost at the same time being triggered to make a decision without a clear plan or answer for another question. All those questions, suggestions and developments make a response operation very complex. Especially when a fire ground commander is not aware of the complexity of the situation, it leads to a less effective approach. The fire ground commander tries to be above the situation by, for example, putting the initiative on a lower rank without asking. While, when a fire ground commander is in fact aware if the complexity of the situation,

and thus actively mandates the initiative to a lower level with the explanation that only the frontline is able to approach certain aspects of the operation, it can actually lead to a far more effective cooperation and response operation. When complexity is recognized by a fire ground commander, evidence shows that the subordinates are more likely to take active initiative by for example formulation plans.

4.2 Command tactics in practice

This section aims to answer the second sub question on how different command types are being used in practice. As discussed in the second chapter, there are three different types of command connected with theory on organization modes. The hierarchical tactic connected with the designed organizing mode, the commanders' intent tactic connected with the frontline organizing mode, and the swarming tactic connected with the partitioned organizing mode. The operationalization framework shown in figure 4 is the driving force in the search for the use of different types in practice. Furthermore, all referred to theory in this section is previously discussed in the second chapter.

4.2.1 Hierarchical command tactic and designed organizing mode

This command tactic is characterised by two aspects. It is based on standardized work procedures and commonly used during predictable incidents (Klein, 1993). As response operations are in fact the core business of the fire department, they are trained in how to perform such operations. In addition, the fire department is originally an organization with different ranks, which means it is a hierarchical organisation. Therefore, it is naturally that the hierarchical command tactic often occurs in practice. In all ten response operations, such tactic is used at some point. Two patterns are clearly visible here.

First, in nine out of ten cases the fire ground commander uses the hierarchical command tactic at the start of their response operation. Emphasizing on the beginning of their response operation, because in all these cases the fire ground commander switches to a different structure later on. The switching however, is discussed under section 4.2.4. To return to the subject, relying on hierarchy at the beginning of the response operation is remarkably common. It is seen in practice when the fire ground commander relies on a standardized structure when making the first decisions and organizing the deployment of brigades or crews. The following fragment from response operation ten illustrates how a fire ground commander uses this structure upon arrival:

SA: The fire ground commander arrives at the scene and receives an explanation of the situation from the first crew commander. Water extraction appears to be a problem and there is a lot of smoke development. The first commander states that they are now inventorying the inside of the building. The fire ground commander also receives some information about the building in general along with the following statement from the first commander: *"We cannot do that much now."*. The fire ground commander questions the situation on the roof.

PF: The fire ground commander then inquires the first crew commander about the water extraction problem: *"Do we continue to scale up?"*. The crew commander explains why he is mainly focussing on inventory.

SA: Reacting to the explanation of the first commander, the fire ground commander asks whether there already is any image of the other side of the building.

PF: The crew commander argues that he does not see any reason to scale up. The fire ground commander disagrees and says: *"We are not going to stare at a mountain of apples here while taking a lot of risk".* The crew commander responds by arguing that he does not want an aerial work platform (which comes to the site due to up-scaling). The fire ground commander understands, but also states: *"I want to make sure we have enough water.". …*

PE: A few minutes later, the fire ground commander gives the police the order to clear the streets from traffic. Large fire trucks are about to enter the site, because of the scale up.

This fragment clearly shows how the fire ground commander uses his (hierarchical) position to outrank the first crew commander. He ignores the first crew commander's suggestion not to scale up. The crew commander's suggestion is based on his situational awareness. Giving the fact that the crew commander is the first one that arrives at the site, and the fire ground commander just got there, the fire ground commander should be able to rely on the crew commander's insights. Instead, he decides to do the opposite of what the crew commander recommends by scaling-up[4].

This behaviour, of the fire ground commander ignoring a bottom up plan formulation and almost clinging to hierarchy, is a phenomenon that comes back occasionally. It is most evident

[4] N.B. there is no valued judgement as to the correctness of this decision. This example is purely illustrative of how a fir ground commander uses a hierarchical structure at the start of a response operation.

for the beginning of the fire ground commander's action and when the crisis is developing quickly. If the latter is the case, fire ground commanders want to act firmly and be in control of the situation. By implementing plans that they formulate themselves, from their own situational assessment, they radiate a level of control or situational awareness. However, evidence show that this behaviour does not mean that they actually are in control and that opposite is often visible. The fact that the bottom up suggestions are being ignored also disrupts the intended cooperation between different ranks. To refer back to the incident from which the fragment originates, there are multiple events where cooperation does not evolve as desired. The fire ground commander is confronted with resistance a number of times. For example, when a brigade does not line up at the by the fire ground commander designated spot, but draws up its own plan instead. The fire ground commander responds by saying *"I was already afraid of that"*, which indicates that he expected such resistance. Eventually, during this particular response operation a second fire ground commander takes over the command. A structured plan of action was initiated that was based on the suggestions made by subordinates. The fact that clinging to hierarchy in early stages of response operations is common explains why such hindering cooperation is a recurring phenomenon during these operations.

Second, a clear pattern is visible in all response operations that the fire ground commander is sometimes forces to use this hierarchical command structure when performing tasks in which he is positioned to make. This mostly involves up- or down-scaling and expanding the fire service deployment. Fire ground commanders are the only one in the position to take such measures. When more trucks, fire fighters or experts are necessary, fire ground commanders are in control of making such decisions. But also managing other aid organizations such as the police and ambulance is part of a fire ground commander's duties. The fire ground commander is trained to be the pivot in these middle- to very large operations. Thus, they are expected to regulate these aspects. Scenarios are designed or standardized this way. In spite of the fact that these commands are taken on the bases of hierarchy, it does not determine the organizing mode towards the crisis at the frontline.

4.2.2 Commanders' intent and frontline organizing mode

This command tactic is characterised by relying on improvisation to handle radical developments for which the frontline holds situational keys to adapt to these developments. The second chapter discusses this organizing mode in more detail.

The evidence showed that circumstances are constantly changing during response operations, especially at the frontline. For example the smoke development in a building, which can increase rapidly and cause the need for breathing air. Another example is the influence of wind on the fire development, which can also quickly change a situation. It is therefore natural that the commanders' intent tactic often occurs in practice. All ten response operations use a commanders' intent tactic at some point. For example, in determining a safe distance for bystanders, determining how many windows must be smashed in order to burn the fire in a controlled manner, determining how much water is needed to prevent spreading, or determining the positioning of trucks or aerial work platforms. The recordings show that fire ground commanders often use this tactic whenever they have little overview themselves. The executed plan is then based on suggestions made by the first commander on the scene. This is mostly the first crew commander, as they are first to arrive. The following fragment from response operation four shows how a fire ground commander relies on the insight of the frontline:

> PF: The fire ground commander gives the first crew commander freedom to consult with the company about the approach: *"Do whatever you think is necessary, I do not have insight into the situation."*.

This fragment raises the question, whether the approach changes if the fire ground commander does get insight into the situation. More generally, is commanders' intent only used in the absence of a fire ground commander's insight, or does it also arise from the opinion that the frontline's insight is more accurate in some cases? The main answer based on the evidence is that commanders' intent, as described in the second chapter, is used both ways. It also arises from the opinion that the frontline is better capable to rely on their insights. However, the fire ground commanders tend to frame this type of command as 'swarming'. In multiple response operations the use of swarming is mentioned while in fact the actual organizing mode is more considered to be commanders' intent. Main aspects here are the facts that some degree of communication is still used between the brigades and that the incentive is actively placed at the frontline. Some examples that show this type of command are the following: *"I am officially using swarming as my command type",* fire ground commander said to a crew commander while three minutes later the fire ground commander corrects a fire fighter by saying *"You need to direct the hose more towards that way".* Or, *"This is part of it, the structure comes naturally. It may seem messy, but it is not",* a fire ground commander explaining swarming to a commander while throughout the operation the fire ground commander repeatedly gave directions like *"I want you to take the nursing staff to the third floor", "Perhaps it is useful to*

let them do their part so you can focus on yours" and "*Follow the instructions the personnel gives you okay?"*. These command structures are framed as swarming by the fire ground commanders while in fact it more related to a frontline or commanders' intent approach because of the consultation and guidance that is given.

Another way in which this tactic often occurs in practice is, when the situation develops so quickly, that the fire ground commander leaves the detailed approach to the frontline. In such case a fire ground commander formulates the goal but leaves room for the subordinates to make decisions based on their understanding of the situation at the frontline. This is connected to the confusion between the concepts just explained. The following fragment from response operation two shows how a fire ground commander formulates such a command:

> PE: Fire ground commander gives instructions to the crew commander about the line-up on the rear of the building: *"It is jour job, I do not know"*. He then indicates that the aerial platform truck will be on the site soon and formulates the goal for the deployed brigade: *"Try to keep the fire out of this part of the building",* after which he walks away.

To summarize, the frontline organizing mode has a number of characteristics that are visible in practice. First of all, there is commanders' intent in the way that the fire ground commander formulates a common goal but leaves the actual approach up to the frontline. The last fragment mentioned above shows this. Second, there is commanders' intent in the way that the fire ground commander has little overview themselves and as a result leaves the initiative to the commanders on the frontline. Third, there is commanders' intent in a way that the fire ground commander is aware of the fact that he is unable to command the operation as a whole. This can be because the crisis develops (too) quickly, is (too) complex or, the area is (too) wide. In that case the fire ground commander consciously moves the initiative to the frontline in order to create an approach that is able to manage the crisis (by multiple). However, fire ground commanders do not always designate this mode as commanders' intent. The empirics show several cases in which the term swarming is linked to this, as showed with a number of example quotes. Even though fire ground commanders frame it as swarming, it is still an organized approach executed at the frontline with a goal implication. It can therefore be linked to the frontline organizing mode.

4.2.3 Swarming and partitioned organizing mode

That the use of commanders' intent and swarming is sometimes difficult to distinguish in practice, is already mentioned in the previous paragraph along associated findings. The empirics discussed here, all show the use of swarming as discussed in the literature in the second chapter.

Out of the ten response operations, eight showed the use of the swarming tactic at some point. In practice it mostly occurred in pockets of control or self-organization, initiated by the fire ground commander. The fire ground commander creates couples to generate a fragmented approach. Couples that have been seen in practise are for example between fire trucks and water transports and between ambulance personnel and fire department crews. Response operation six stands out as it concerned an evacuation where swarming is used. The fire ground commander initiates the plan to evacuate a part of the building. For it concerns an elderly care home, close cooperation with ambulance personnel is necessary. In the following fragment, the fire ground commander uses fragmentation to ensure a smooth evacuation and to regain control over the unfolding situation:

> PE: The fire ground commander initiates swarming as the tactic that he is going to use in order to conduct a smooth evacuation: *"We are going to link every fire crew to an ambulance. Every pair will then take care of the evacuation of a resident. Guys, you are available to the ambulance personnel, so make sure you organize it with them yourself."*
> PE: When the fire fighters start their own organization, the fire ground commander states to the senior commander that they regained control over the situation: *"We have now removed the first stress".*

The important part that distinguishes it from the frontline organizing mode, as discussed in previous paragraph, is that the fire ground commander indicates he has no organizing role. During the evacuation itself, there is no communication between the separate pockets of fire fighters and ambulance personnel, and the fire ground commander. They are partitioned whereby command or control no longer is arranged.

Another example shows how swarming is used when they address a large-scale event where immediate action is needed. Response operation two shows that self-organisation is key:

> PE: The fire ground commander indicates via transceiver where the fire trucks must line-up and which brigade is going to 'feed' it with water. He is organizing four pockets of control to cover all sides of the building: *"130, the fourth fire truck is coming your*

way. If you estimate that your water extraction is declining, you have to use the fourth and let them get it for you.".

The same distinguishing factor applies for this fragment. The fire ground commander indicates he no longer has an organizing role. There is no communication between the separate pocket of third- and fourth brigade, and the fire ground commander. The command is entirely at the pocket of control without interference of the fire ground commander during the operation.

To summarize, the partitioned organizing mode has one important characteristic that distinguishes it from the practical use of the frontline organizing mode. It concerns the ability to communicate, command and control by a fire ground commander. The fire ground commander emphasizes the absence of this to the subordinates. An important consequence of this is also worth mentioning. The lack of overview of the fire ground commander is an additional disadvantage of swarming. The fire ground commander must rely on the situation assessment and situational awareness of the separate pockets of control. Tacking back command and control can also be problematic or challenging. The use of 'CoPi consultations' during large-scale and fragmented response operations can provide a solution here. Such consultations help to maintain (some) degree of overview between different actors. In the example of the evacuation of the elderly care home, response operation six, this was also used and will be discussed again in the next paragraph.

4.2.4 Switching

It has been established that all three command tactics, respectively all three organizational modes, are being used in practice by the fire ground commanders. Each response operation shows the use of multiple structures. In other words, switching between different command structures is taking place. This switching mainly happens in two ways, between hierarchical- and commanders' intent tactics and moving into swarming tactics.

First to address is the switching between hierarchical- and commanders' intent tactics. The switching back and forth between a designed- and frontline organizing modes occurs frequently in many response operations. During the response operations, fire ground commanders can switch from a designed structure to a frontline structure when their overview of the situation is lower than that of the (first) crew commander. Consciously, but also unconsciously, the organizing modes switches from designed towards frontline. For example, when the fire ground commander deliberately leaves the initiative at the frontline. Or because the (first) crew

commander indicates plan suggestions which results in a structure where the (first) crew commanders employ their own plan via the fire ground commander. The fire ground commander only approves, while having a passive attitude in initiating a plan. Those two ways of switching, deliberately leaving initiative at the frontline or making suggestions instead of clear commands towards the frontline, can be illustrated with the following fragments.

The first example, where the first crew commander gives suggestions, comes from response operation eight and occurs several times throughout:

> PF: Via transceiver, a crew commander requests the arrangement of breathing air to the fire ground commander.
> PE: The fire ground commander arranges breathing air by reporting it to the control room.
> …
> PF: A crewmember comes up to the fire ground commander and makes a suggestion on where to line-up the fire trucks.
> PE: The fire ground commander responds by saying: *"Just do that."*.
> …
> PF: The senior commander suggests to the fire ground commander that the 110 must be relieved, replaced by another brigade. The fire ground commander agrees and says that he will do so.
> PF: Instead of doing so, he consults the crew commander of the 110 by asking if he needs to be replaced. The crew commander sees no need for replacement.
> PE: As a result, the fire ground commander decides not to replace the 110.

In between these fragments the fire ground commander uses the designed organizing mode to arrange and control non-frontline related matters. The first matter being breathing air, is for example a request the crew commander can only submit to the fire ground commander. Leaving the decision to use breathing air hierarchical at the fire ground commander. Even though the initiative is at the frontline, the fire ground commander needs to make this decision based on hierarchy, triggering a temporary switch from frontline to designed. Opposite is happening in the last part, where the fire ground commander consults with the crew commander before making a decision about relieving the crew. Here, the fire ground commander has (hierarchical) authority to decide on this matter. Instead of following the suggestion made by his superior, he consults with the crew commander at the frontline to see if they share the same thoughts. Instead of making the decision based on the designed structure and thus adopting the suggestion from

the senior commander, it is made based on knowledge which is more accurate at the frontline by the crew commander. By doing so, a temporary switch is triggered again by leaving the decision at the frontline. This example shows that even though the actual decision has to be made by the fire ground commander, it can still arise from the frontline or be forwarded to the frontline, both triggering a shift in the command structure. Here, a positive effect on the interaction as a result of the switching is visible. Initiative comes from both sides and the fire ground commander makes optimal use of it.

The second example, comes from response operation four and occurs several times throughout. A similar switch as the latter example is visible in this fragment. Only this time the initiative is not coming from both sides, instead, it is forced upon the frontline triggering a switch from designed to a frontline approach:

> PF: The first crew commander asks the fire ground commander about the safety of bystanders in connection with smoke development. The fire ground commander indicates that the crew commander can simply estimate this himself.
>
> …
>
> PF: The fire ground commander commands the demolition of parts of the building to regulate the fire. When the crew commander asks which parts of the building and how, the fire ground commander responds by saying that the commander should arrange it himself.
>
> …
>
> PF: The first crew commander asks the fire ground commander about the deployment of a crane. The fire ground commander, again, responds by saying that the crew commander should consult this himself. The crew commander responds by saying: *"*[name of fire ground commander] *how do you see this?"*. Clearly, the crew commander wants the fire ground commander to decide upon any plan execution instead of himself. The fire ground commander initiated the commanders to actively take decisions a couple of times. Now, the crew commander initiates the fire ground commander to take control: *"You are the chief here".* The fire ground commander then agrees with the proposal of the crew commander. The crew commander walks away while saying: *"Quite a job he has, he pushes everything off".*
>
> …

> PE: The fire ground commander explains his expectations to a crew commander and decides that not all material on the spot is necessary: *"I think we do not need all the material so I'm going to scale down".*
>
> …
>
> SA: The crew commander reports: *"There is yellow liquid leaking out of the barn".* The fire ground commander walks towards the barn to see it himself
>
> PE: The fire ground commander decides to cover the liquid, perform a quick test and then decide to inform experts. ..*"We have to inform the owner right away".*

This example shows the fire ground commander deliberately leaving initiative with subordinates. Where in the first example it created a positive interaction, here the subordinates clearly are annoyed and pushing initiative back towards the fire ground commander. The attempt to switch the organizing mode to the frontline actually fails. The crew commanders insists on a designed approach. Eventually, the initiative shifts (back) to the fire ground commander, which results in a hierarchically driven, designed approach.

Overall, these examples show that the switching between a designed- and frontline mode occurs in different ways and with different effects. Not only the interaction and cooperation between different ranks is affected by the switching in a negative way. If fire ground commanders and crew commanders are aware of how switching can sometimes contribute to the response operation in a positive way like the first example, it shows the use of situational command and control as trained for.

The second way in which switching takes place involves the use of swarming. The partitioned organizing mode is never an overall approach, as there is no ability to give commands or share information between ranks (Schakel & Wolbers, 2019). However, the structure is often used, in eight out of ten response operations as discussed in section 4.2.3. The switching in and out of this mode takes place from both the designed- and the frontline mode. Response operation six shows examples of the organizing mode switching from a designed approach into swarming and back. The following fragments illustrate this switching:

> PE: The fire ground commander immediately takes the lead and asks the crew commanders to come together for consultation. The fire ground commander: *"I want us to create and coordinate a proper plan".* Throughout the consultation, the fire ground commander is in charge and decides. He ends the consultation with multiple instructions for the crew commanders in order to facilitate a smooth assessment.

…

PE: After the assessment the fire ground commander initiates swarming as the tactic that he is going to use in order to conduct a smooth evacuation. *"We are going to link every fire crew to an ambulance. Every couple will then take care of the evacuation of a resident. Guys, you are available to the ambulance personnel, so make sure you organize it with them yourself."*

PE: When the fire fighters start their own organization, the fire ground commander states to the senior commander that they regained control over the situation. *"We have now removed the first stress".*

…

PE: The fire ground commander informs the first crew commander that he will be back with more information after the CoPi consultation.

PF: The CoPi consultation starts. Present are the senior commander, fire ground commander, director of the organisation, ambulance coordinator, police and a representative of the municipality. During the consultation they reflect on what actions were taken and what still needs to be done. They end the consultation being well informed and sharing a level of situational awareness: *"We have a good overview of the situation. I suggest we see each other again at* [time]*, everyone can go back to their cell."*

PE: The fire ground commander reports himself at his cell. He takes back the command and control by complimenting the commitment of the fire fighters during the evacuation and deciding to scale down. He also decides to create a fast labour hygiene process to make sure the brigade can go home as soon as possible.

This fragment shows that the organizing mode is hierarchical based at the beginning. The fire ground commander is in control and makes the decisions during the first consultation. Next, he sends them off to conduct a smooth evacuation using a fragmented approach, swarming. In order to regain control later on, he already mentions that he will receive important information during his absence. When arriving at the crew commanders after the consultation, he immediately makes decisions based on his rank, as designed.

Response operation five shows examples of the organizing mode switching from a frontline approach into swarming and back. The following fragments illustrate this switching:

PF: The second crew commander takes over the command and control: *"I think I have better insight and overview of the situation."*. The fire ground commander allows the second commander to draw the situation and explain a plan it into detail. The fire ground commander then takes over his proposal.

PE: The fire ground commander implements the second crew commander's proposal *"Okay, we are going to do it this way"… "Is this clear for everyone?"*.

…

PF: The fire ground commander receives a question about water extraction. He responds by saying *"I am not sure what is bests to do, can you arrange it yourself? .. "I suggest I leave it to you and rely on your approach"…."I will be available but only if you need more material"*.

...

PF: A crew commander asks the fire ground commander whether there is any plan now that water extraction is secured and the spreading of the fire is prevented.

PF: The fire ground commander responds by saying: *"You may consult it with your crew what you think is best to do."*.

This fragment shows that the organizing mode is frontline based at the beginning. The fire ground commander agrees that the second crew commander has more situation awareness and thus implements his approach. Next, he uses the mode of swarming to let a brigade figure out what to do. The fact that he emphasizes that he is only available for material requests insinuates a fragmented approach. Later on, the brigade reports back and they switch back into a frontline approach with the fire ground commander promoting frontline initiative.

Although they mostly change back to the latter structure when coming out of the partitioned mode like both examples showed, this is not always the case. In some fragments all three organizing modes alternate. For example from designed mode into partitioned mode to then switch to frontline mode. Next fragment from response operation ten illustrates an example:

PF: A crew commander shares his situation awareness with the fire ground commander. He also makes suggestions like: *"We can stop the fire here"* ,*"I think we need to go back inside again"* and *"I also need more water"*. The fire ground commander agrees by saying a lot of *"yes, indeed"* during the conversation and ends with asking *"So you are going back inside?"*. The crew commander agrees.

...

PE: There is a lot of smoke development and the fire ground commander is not sure what the effects are . He asks a crew commander: *"The effect of all the smoke is your responsibility now. Please make sure to arrange what is necessary".*

...

PF: The crew commander who was responsible for the smoke development walks past the fire ground commander. The fire ground commander decides to give him a (new) order as the smoke development is dealt with: *"Can you look inside the building using a heat lamp?".* The crew commander answers he will take to fire fighters with him.

This fragment shows that the fire ground commander first uses a frontline based approach before shifting in partitioned mode by mandating any decision concerning the smoke development towards the crew commander. When shifting out of the partitioned mode, they do not go back to the latter mode but instead shift towards a hierarchical modes by the fire ground commander giving direct commands to the crew commander. The fragment is messy as a lot is happening at the same time making the operation complex. However, as mentioned multiple times, this is common when organizing modes switch. Moreover, even though switching occurs a lot of times during this response operation, there is no particular pattern visible when they switch between all three organizing modes, or when they just go back to the organizing mode that was in place before a partitioned approach was implemented.

To summarize, although the partitioned mode is commonly used there is no pattern to distinguish in the way fire ground commanders switch towards the partitioned organizing mode in practice. It seems that it cannot be captured in any (underlying) pattern as the situation is often to complex. The partitioned mode occurs out of the frontline- and designed mode, and does not necessarily switch back to the latter mode as the last fragment shows.

4.3 Factors of influence

This section aims to answer the sub question on which factors influence the behaviour of fire ground commanders. The behaviour of fire ground commanders is analysed alongside their decision making process and the used command tactics. It is discovered that their decision making process is often more complex than being rational or reflexive in nature and that multiple command tactics are used during a response operation as fire ground commanders switch between them. As discussed in the second chapter, there are factors that influence the

behaviour of fire ground commanders, such as human factors and switching-related challenges. The findings related to influential factors are now presented.

4.3.1 Human factors

Human factors influence the fire ground commanders' behaviour and mostly concern the use of biases. It can provide insight into limitations of human ability. In the response operations, there are multiple examples where fire ground commanders are influenced by these human factors. Especially when they express an expectation or make a decision that is the result of experience or heuristics. This is related to a reflexive decision making process as it is part of the reflex that triggers a decision or command. A few response operations show clear fragments where human factors influence the decision making and, as a result, influence the used command tactic. It concerns response operation three, four and nine. The behaviour of the fire ground commanders in these response operations show how human factors can be key when analysing behaviour.

The next fragment from response operation three, demonstrates the interaction between decision making, command tactics and human factors in a short time period. The operation concerns a fire in a large industrial area. More than an hour into the operation, the fire ground commander still has little overview on the unfolding fire:

> SA: The fire ground commander receives information from the frontline that the risk of the fire spreading across the building is considered to be present.
> PE: The fire ground commander decides not to deviate from the original plan.
> PE: Two minutes later, a fire fighter walks up to the fire ground commander asking if he is still of added value within the operation. The fire ground commander says: *"I do not know".* The fire fighter responds: *"You should know this!?".*
> PE: The fire fighter then decides to leave. A decision he makes on his own initiative.
> PF: Four minutes later, the fire ground commander expresses an expectation: *"I think we will contain it here, the fire load is becoming less".*

Multiple things are happening in this fragment. First of all, the decision making process concerning the spread of the fire is a reflexive process as situation assessment is followed by plan execution. The fire ground commander ignores the information about a possible spread. Instead, the fire ground commander decides to stick to the plan. This decision is a reflex, as there is no explicit plan formulation phase, and possibly the result of previous experience or

expectations. Moreover, during the response operation it is clear that the fire ground commander has almost no overview of the approach used at the frontline. This suggests the presence of confirmation bias. Fire ground commanders translate every (new) signal into the existing plan when operating in a situation of uncertainty. Second of all, the command type changes during this fragment. The decision to stick to the plan is clearly based on hierarchy, indicating the designed mode. However, when the fire fighter asks about his tasks, the fire ground commander insinuates not to have any overview, leaving the decision to the fire fighter himself. This indicates that the fire ground commander assumes that the fire fighter himself is better capable to make a decision, based on his knowledge of the situation. A command type that is driven by commanders' intent, indicating the frontline mode.

At the same time, this fragment again shows a conflict in expectations concerning the organization mode. Ranks having different expectations on who takes initiative and is on control is a common phenomenon. Lastly and perhaps most important, is the expectation the fire ground commander states at the end of the fragment. This expectation is not based on facts, considering the risk of the fire spreading across the building is present at the beginning of the fragment. The fragment states all the information that is shared during that instant, indicating that the risk of the fire spreading across the building is still present. Thus, the expectation the fire ground commander shares must be an example of confirmation bias. Especially when taking into account that he has no overview and is therefore operating in a situation of uncertainty. The fact that the fire ground commander's behaviour is a result of biases, affects the decision making process by not deviating from the plan. It also affects the command structure as the fire ground commander moves the decision, and consequently any feeling of responsibility, towards the frontline. For these reasons, and illustrated by the latter fragment, the human factor of confirmation bias is considered to be key when trying to understand the fire ground commanders' behaviour.

However, it only concerns three out of ten response operations where this interaction or something similar is detected in such a clear manner. Therefore, it is an interesting discovery but not enough for this study to distinguish any particular pattern.

4.3.2 Switching challenges

Besides being influenced by biases, switching between command types can also be challenging. These challenges occur on a team level and affect material conditions.

The concept of passive behaviour, which is a challenge on the team level, has been noticed regularly during the response operations. This is evident in a number of fragments that are discussed earlier. Discussion and resistance can be a result when a fire ground commander leaves initiative with subordinates at the frontline. For example the fragment above shows signs of this, but also the featured fragments out of response operation four and two. In these cases the fire ground commanders show passive behaviour due to confusion and little knowledge about the unfolding situation. Corresponding quotes are for example: *"Do whatever you think is necessary, I do not have insight into the situation"*, from response operation four, *"It is jour job, I do not know", "I have not been inside, I leave it with you"*, from response operation two, and *"I do not know"*, from response operation three. All these quotes are answers to questions or suggestions made by subordinates at the frontline. Even though these quotes are coming from fire ground commanders, they are not considered to be active commands or assignments. Instead, they are considered to be passive reactions. It can therefore be argued that it affects the command structure as it moves the initiative from the fire ground commander to the subordinate or frontline. Which, in some cases, is not appreciated by these subordinates and can cause friction as some examples already showed. The mood and tone of the quotes can clearly be deduced without adding the entire fragments, it explain why such friction occurs between ranks. Out of the ten response operations, six show examples of such friction, in which three show severe friction. The already states quotes from response operation three: *"You should know this!?"* and four *""Quite a job he has, he pushes everything off"* serve as examples of such severe friction that is expressed in words.

Last to discuss is the practical hinder from material conditions. The communication via transceiver turned out to be a practical hinder multiple times. One example is stated under 4.1.3, coming from response operation eight. The consequences however are little as it does not affect the command structures or decision making processes. Furthermore, sometimes the commanders were not tuned into to the same radio channel, which delayed the formulation and execution of plans. However, any effect on the overall operation is negligible.

Chapter 5: Conclusion and Reflection

This final chapter is divided in three subchapters. Subchapter 5.1 provides the conclusion of this research and answers the posed research questions. Subchapter 5.2 provides the discussion of the research findings. Subchapter 5.3 points out areas that could be the base for further research.

5.1 Conclusion

5.1.1 Decision making

The sub question connected to the decision making reads as follows: "How does the decision making process of fire ground commanders work in practice?". The reflexive decision making process and the rational decision making process are present in the actual behaviour of fire ground commanders. Furthermore, this study also argues the existence of a complex process of decision making. Evidence show that it is often not the follow-up of situation assessment and plan execution, or with plan formulation in between those two. Instead, many response operations reveal a more complex process in practice.

Although the phases of situation assessment, plan formulation and plan execution can all be distinguished, the tracing of a recognizable reflexive or rational based process is often not the case when analysing the response operations as a whole. As a consequence, it can be concluded that the decision making phase is often not a clear follow-up of phases. Instead, a complex process of decision making is often seen in practice. The identification of this complex form is therefore the first distinctive pattern that this study presents. In this form, all three theoretically assumed phases occur in all kinds of order. A recurring pattern is plan formulation, followed by situation assessment, followed by plan execution. A pattern in which fire ground commanders search for confirmation before execution a plan and can lead to confirmation biases. Another recurring pattern is a sustained period of plan formulation and plan execution. This pattern shows how complicated a response operation can be from the fire ground commanders' perspective, how many developments are taking place at the same time and how complex the decision making can become. In other words, the behaviour of fire ground commanders when analysing their decision making process is not so much a framed process that is rational or reflexive based.

5.1.2 Command structure

The sub question connected to the command tactics reads as follows: “Which command tactics do fire ground commanders use in practice?”. It can be concluded that the fire ground commanders use all three command tactics. Both the designed-, frontline-, and partitioned command tactic are present in the response operations. Evidence show that fire ground commanders almost always use the hierarchical approach at the beginning of the operation. Additionally, fire ground commanders are sometimes forced to use this hierarchical structure when performing tasks in which they are positioned to make, for example up- and down-scaling, or expanding material. As for the frontline approach, three practices are to distinguish. There is commanders’ intent when the fire ground commander formulates a common goal while leaving the actual approach up to the frontline, when the fire ground commander has little overview himself and thus leaves the initiative at the frontline, and when the fire ground commander frames it as swarming. The latter is seen in practice when the fire ground commander is aware of the fact that he is unable to command the response operation as a whole and thus consciously moves the initiative to the frontline in order to manage an effective approach. Fact that there is still a level of organization, communication and consultations however makes it a frontline approach. As for the partitioned approach, actual swarming occurs in practise when immediate action is needed. Here, the fire ground commander indicates there no longer is an organizing role or shared goal. This is the characteristic this study finds to be the distinguishing factor from the frontline organizing mode.

Last conclusion that is drawn for the command tactics concerns the switching. It can be concluded that fire ground commanders use multiple organizing modes during a response operation which induce switching. When swarming is used, the switching cannot be captured in any underlying process as it happens in many different ways. Switching back and forth between the hierarchical- and the commanders’ intent tactic however, occurs regularly throughout response operations and is therefore the second distinctive pattern of this research. Even though switching sometimes causes friction and wrong expectations between ranks, there are signs that it also improves the overall operation. Some examples do show that if fire ground- and crew commanders are aware of how switching can contribute to an effective response operation, it resembles the use of situational command and control is trained for.

5.1.3 Influential factors

The sub question connected to influential factors reads as follows: “Which factors influence the behaviour of fire ground commanders in practice?”. Focussing in the human factors, it can be concluded that the influence of confirmation bias is seen in practice. The analysed fragments here show that confirmation biases affects the fire ground commanders’ decision making process by (not) deviation from the plan. It also affects the command structure as the fire ground commanders moves the decision and feeling of responsibility towards the frontline. In other words, when a fire ground commander is biased in this way, it affects their behaviour on multiple levels; their decision making process and used command tactics. Therefore, this human factor is considered to be key when trying to understand the fire ground commanders’ behaviour during response operations. The fact that this observation is not seen on a large scale makes it impossible for this study to distinguish any particular patterns. Nevertheless, these signs do suggest this is a factor of interest.

As for challenges concerning the switching between different command tactics, a pattern of passive behaviour and friction between ranks as a consequence is distinguished. As passive behaviour is common when fire ground commanders experience confusion or have little knowledge about the situation, it can cause a switch in the command structure as already explained. Such a switch, without reasoning from the fire ground commander, is not always appreciated by subordinates and can cause friction. That being the case, this study indicates that these challenges are key when aiming to explain certain behaviour.

To summarize, it can be concluded that there are multiple signs suggesting that human factors and switching challenges do influence the decision making process and command tactic. This study argues that they play a pivotal role in the behaviour of fire ground commanders.

5.1.4 Overall conclusion

Finally, the main research question can be answered. It reads as follows: “To what extent do fire ground commanders within the Dutch Fire Department use different command tactics in course of a response operation?”. This research first concludes that fire ground commanders use different command tactics during response operations. Second, switching between those command tactics is a common phenomenon during response operations. Moreover, when looking at the aspects connected to the fire ground commanders’ behaviour, this study concludes three distinctive patterns. First, fire ground commanders frequently show a far more

complex process of decision making. Second, in relation to their decision making process, fire ground commanders most often switch between the hierarchal command tactic and the commanders' intent command tactic. Third, an important challenge in relation to the switching between different command tactics is passive behaviour and consequently friction between ranks. Therefore, this study emphasizes that the use of different command tactics does not necessarily lead towards a more effective response operation. Fire ground commanders showing signs of passive behaviour or confirmation bias can trigger switching that is not proven to be beneficial for the overall response operation.

Thus, fire ground commanders do in fact use different command tactics in practise. However it cannot always be conceptualized as situational command and control as switching between different command tactics does not always induce a more effective response operation considering the challenges and human factors.

5.2 Discussion

The discussion of this study consists of two parts. First, the used method and its limitations are discussed. Next, the findings of this study are discussed in light of the existing literature. The theoretical implications of the results are discussed there.

5.2.1 Methodological discussion

Reliability and validity are both embedded the following way. The data consists of real-life events which makes every response operation different. It is therefore difficult to repeat such research in the same way (Cypress, 2017). Yet, the usage of content analyses as a research technique makes it possible to conduct replicable conclusions from data to the context of their use which contributes to the reliability (Krippendorff, 2004. p. 18). Using a codebook, framework and operationalization scheme secures reliability and consistency. Internal validity (Bryman, 2012) is ensured as this study is part of a capstone and in collaboration with the IFV, who collected the data. Analyses are discussed between capstone members to ensure consistent measurements.

The first limitation of this research is the fact that out of the whole test group, only a small amount of response operations were handed over by the members of the test group. Out of the twenty response operations selected by the supervisors of this capstone, 'only' ten were analysed for this study. Despite the fact that these operations represented a wide range of

incidents fire ground commanders deal with on a day to day bases and can therefore be considered as a good reflection, it remains a small selection from the entire group of fire ground commanders that received training in situational command and control. Therefore, the reader must be careful when generalizing the findings of this study upon the entire test group of fire ground commanders.

The second limitation focussed on the submitted bodycam material. One can argue that the voluntary participation has an influence on the analysed material. Moreover, bodycam recordings do not provide any information about the thinking process inside of a commander's mind. These presumptions are supported by incidents where fire ground commanders hold their hand over the camera and microphone on purpose. Consequently, fire ground commanders are more inclined to submit material in which they categorize their own behaviour as 'appropriate' or 'according to the guidelines'. In all likelihood, recorded response operations where little to no switching is applied, are probably not submitted. This arguably has an effect of one sided view (Luff & Heath, 2012) and should therefore be taken into account when reading chapters four and five. Also worth mentioning in terms of the use of bodycam material is the possibility of technical problems or users forget to activate them. These issues however do not outweigh the benefit of cameras being a reliable measurement source as it records facts without interpreting the data in a certain way.

The third limitation focusses on content analysis as the used method. Content analysis is an unobtrusive technique (Krippendorff, 2004, p. 40). It becomes clear from the codebook that a lot is happening during a response operation. Despite the use of a clearly defined codebook, the observations may be contaminated to some extent. For example, due to the lack of experience of the researcher in doing content analysis (Krippendorff, 2004), especially when it concerns video recordings. Another aspect of the used method concerns the fact that the video recordings are the only used data. The analysis of influential factors and particular the search for patterns would have benefited from an extra source. If this research would also have conducted interviews with the fire ground commanders, it might have provided more insight into the factors that influenced their behaviour. The recommendation section elaborates more on this.

5.2.2 Theoretical discussion

The findings of this study contribute in various ways to the current scientific knowledge. It mainly indicates that both the decision making process and the command and control tactics

are not a clear order of phases. For this reason it questions the credibility of model-based structures as it is an idealized representation of the reality.

First to discuss are the models concerning the decision making process. The findings of this study strongly emphasizes on the existence of a complex process where the phases of situation assessment, plan formulation and plan execution appear, but in all kinds of orders. It therefore questions the credibility of the rational based model assumed by Cohen-Hatton (2016) and Van den Heuvel, Alison & Power (2014) to explain decision making during response operations. This study indicates that a rational based decision making process does occur in practise, but does not endorse it as a model that frequently describes the overall process applied by fire ground commanders. On the other hand, the reflexive model assumed by Klein (1993), Kahneman, Slovic & Tversky, (1982) and Cohen-Hatton (2016) emerges more often in practice. Even though both processes occur in practice, this study does not consider these two processes sufficient enough when analysing a fire ground commander's decision making process. It tends to endorse the existence of a far more complex process. This complex decision making process can be placed next to the rational- and reflexive process and serve as an addition as empirics show all three processes.

Second to discuss are the models concerning the use of command tactics. Theory often conceptualize the use of command tactics during response operations in models. Most of this research is known as naturalistic decision making (Brehmer, 2005; Montgomery, Lipshitz & Brehmer, 2005; Zsambok, C. E. and Klein, G. 1997). Combined with research on command tactics, it presents models that explain behaviour during response operations. In order to explain behaviour alongside a model, it assumes a partially fixed process in which different steps follow each other. As this study analysed comparable data as Groenendaal & Helsloot did in 2016, it is of interest to compare both findings. Especially considering the fact that the study of Groenendaal & Helsloot (2016) used the FADCM model to explain command tactics used by fire fighters during response operations. This model is an abbreviation for finding, analysis, decision making, communication and monitoring and appoint these five functions as primary within situational command and control. There are two points of discussion this study raises towards the research of Groenendaal & Helsloot (2016) and the usage of such models.

First, it states that the behaviour of commanders during response operations can be explained on the basis of this model, indicating that their behaviour is a sequence of the five functions. Their findings state that in 45% of the analysed cases they were unable to draw conclusions on

the command tactics. In other words, for almost half of the analysed cases, the command tactic could not be explained by the FADCM model. Instead of questioning the FADCM model, as 45% is a fairly high percentage, the explanation was sought in other factors. Stating that the commanders rarely executed orders and subordinates often used a different approach than commanders communicated, for example. This study does not deny the existence of such behaviour, as it also recognizes it. However, this study sees command tactics as a far more complex process than the FADCM model assumes. The analysed process is more in line with the findings of Schakel & Wolbers (2019). It therefore rejects the FADCM model as an explanation for command tactics. As stated in the previous paragraph, there is no straightforward model that conceptualizes behaviour during response operations. Besides, the influence of confirmation bias when operation in a situation of uncertainty is seen as described by Kahneman et al. (1982) and Trevsky & Kahneman (1974). Thus, the model used by Groenendaal & Helsloot (2016) is idealizing the reality. The fact that their study does not question this model is a major shortcoming because it affects their findings.

The influence on their findings is the second point of discussion this study argues. Groenendaal & Helsloot conclude that the influence commanders have on the frontline should not be overestimated as many variables determine what frontline workers do. The study therefore rejects the benefit of training commanders in frontline-management (2016). This argument conflicts with one of the main findings of this study, as it emphasizes that fire ground commanders are the pivot of the complex processes involved in a response operation. Thus, the behaviour of a fire ground commander cannot be captured in any model like naturalistic decision making theories do. Instead, it stresses the importance of interaction between commanders and the frontline workers. Training in coordination of expectations of both sides will improve the command tactics in practice. The training in situational command and control that the test group received is therefore considered to be a step in the right direction. Although the lower ranks should not be forgotten. This argument is further elaborated in the recommendations.

Before discussing recommendations, there is the phenomenon of double use of the swarming concept during the response operations that needs to be discussed. Fire ground commanders sometimes frame a type of frontline command tactics as swarming. They consciously move initiative to the frontline because of their own inability to command the operation. It is still a frontline command tactic as there is a level of organization, communication and consultation. Yet fire ground commanders indicate it as swarming. This phenomenon can be explained by

the previous mentioned definition of swarming used by the IFV, stated in the chapter two. The IFV indicate swarming as a participative leadership style, with variables of redundant number of teams and the ability to improvise (Hazebroek et al., 2015, p.18). Knowing that the IFV is also involved in the training in situational command and control, explains why this tactic is seen in practice as a frontline approach, where leadership is still in place. This confusion lends itself for a recommendation in the next section.

5.3 Recommendations

Recommendations can be made in the field of future training and future research. Starting with future training. The results show that situational command and control is put into practice by the test group to some extent. Therefore, this study recommends implementing the training on national scale. Not only for the purpose of a general approach among fire ground commanders within the Dutch Fire Department. Especially because the video recordings are full of valuable examples that every commander can learn from. However, this study also emphasizes that the use of situational command and control as desired is not seen in large numbers. In addition, this study indicates challenges that cannot be ignored. Future training should inform fire ground commanders about the challenges connected to confirmation biases and passive behaviour. Fire ground commanders should not be training in forcing a switch in command and control, in order to create the 'desired' situational command and control. Instead, fire ground commanders should be trained to better conduct a smooth cooperation and effective approach. In order to do so, switching between command tactics is a way to achieve such. Another recommendation on future training concerns the crew commanders. This study emphasizes on the benefits of also educating crew commanders on situational command and control. By doing so, it can bring the expectations of the different ranks closer together and prevent friction during a response operation. Moreover, as hierarchy is very intertwined in the organisation, training crew commanders can make them more capable of contributing to an effective response operation. Last recommendation on future training concerns the conceptualizations of the different command tactics. By teaching swarming as a structure without consultation, there is less confusion between a frontline- or a partitioned approach during response operations.

Continuing with future research, for which this study has previously hinted thoughts. One important recommendation can be made based on the findings of this study. The influence of human factors does appear to be present. Therefore, further research into the interaction between decision making, command tactics, and human factors is recommended. Fire ground

commanders show signs of confirmation biases which is proven to influence their overall behaviour. The way in which biases or other human factors influence fire ground commanders is not the main research question of this study. Consequently, the used method is not sufficient enough for this study to identify any clear patterns in how human factors relate to the fire ground commanders' behaviour. The results of this study do however stress the importance of the interaction between human factors and behaviour. In order to provide more insight in this matter, this study recommends to add interviews as a research method in future research. This enables fire ground commanders to explain certain behaviour to the observer. It also enables the observer to expose any found patterns and check them with fire ground commanders. Both can lead to new insights in this interaction. That is why future research should first of all focus on human factors when conducting follow-up research into the behaviour of fire ground commanders.

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Appendix I - Codebook

Time stamp	Observation	Analysis	Phase command and control	Level of Situational Awareness	Command type
xx:xx	Description of event	Which signals are picked up? Which signals are not picked up? What information is used to make a decision? Is conflicting information recognized?	Situation Assessment (SA): Cues	**Level 1:** Perception of elements: status, attributes and dynamics of specific elements (not connected) **Level 2:** Comprehension of situation: significance of elements for goal (holistic / interrelated) (meaning of elements) **Level 3:** Future projection: pattern recognition	**Hierarchical:** standardized work procedures, relatively limited level requirements of personal knowledge **Commanders' intent:** subordinates understand the intended end state as desired by the commander and have the freedom to adjust their actions to achieve end state **Swarming:** several units conduct a convergent attack on a target from multiple axes along self-management
		Exploration: has the situation been viewed all around? Which considerations are communicated? Which risks are seen? Which questions are asked? (about situation and deployment) Does the OvD take distance to zoom out?	Situation Assessment (SA): Assessment		

		Which problems are placed with the OvD? Are goals defined? How many goals are set (simultaneously)? With regard to cognitive load	Plan Formulation (PF): Goal formulation		
		What expectations are expressed? Are expectations adjusted, are assumptions checked? What (how many) setbacks does the OvD face?	Plan Formulation (PF): Expectations		
		Which options are recognized? Which options are identified & considered? What suggestions are made to the OvD by others? Are consequences of actions foreseen?	Plan Formulation (PF): Option Awareness		
		Time pressure, how long does it take to make a decision? What is not known yet? Need extra information? Which decisions are made? Is it decided to provide extra support / safety net?	Plan Execution (PE): Decision		

		Active viewing / asking wheter decisions are implemented / having an effect Are orders adjusted as a result of monitoring? Does the OvD have an eye for its people (BV / replacement)	Plan Execution (PE) Monitoring		
		Explications of commands (directive / participative) Suggestions or authoritative? What information does OvD share with Bv or HOvD? Note the first contact with BV / HOvD statements Is the action plan shared? Does the OvD listen to others? Non-verbal behaviour (hand signals, raising your voice, breathing)	Plan Execution (PE) Communication		
		Division of roles / are tasks shared and communicated Who is responsible for what? Time of up-scaling (proactive / reactive) Delegation Need for consultation, especially from multi Is structure adjusted (giving units a different role)? Safety net (arranges the OvD support)?	Plan Execution (PE) Organizing		

		Stress / calm Atmosphere: formal / informal positive / negative / humor Dealing with setbacks Manners: knowing each other, informally or not Write down statements that show emotion	Emotions		
		How many / which tasks does the OvD receive or set?	Cognitive load		