Synthesising Comparisons to Develop a Generic Command and Control System

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ABSTRACT

Large and small incidents challenge emergency services around the world. Regardless of the size of the incident, command and control (C2)-systems are used to manage the situation, allowing a rapid and coordinated intervention. As all implemented actions result from the outputs of C2-systems, they are a fundamental component of the response. That is why they must be highly reliable and efficient. A research initiative is therefore addressing the approach of evaluating C2-systems on a scenario basis and using key performance indicators (KPI). To ensure that the KPIs can be applied to any form of incident control, a generic C2-system was developed by comparing and merging six German- and English-language C2-systems as well as one international standard. With this step, a comprehensive and detailed C2-system was developed, which is presented in this paper.

Keywords

C2-System, command and control, process, comparison, evaluation.

INTRODUCTION

Command and control (C2)-systems provide an important foundation for resilience and the management of emergencies and crises. By using their guiding results, e.g., decisions and plans, incidents can be steered in a suitable direction to appropriately cope with them. Moreover, poorly performing command and control systems can lead to negative developments of incidents, such as the loss of property, resources and life. Examples from the past have shown that an adaptation of C2-systems has been reactive. In other words, adaptation happened only after a critical event showed that a necessary adjustment had to be made to the C2-system. This was clearly demonstrated by the "Heath Fire" (vegetation fire) in northern Germany in 1975. A non-unified command system at the time led to a loss of control of the large incident, which spread out of proportion and even caused the death of five firefighters (Deutscher Städtetag, 1976). Subsequently, a standardized Germany-wide C2-system for the fire service was developed (Ausschuss Feuerwehrangelegenheiten, Katastrophenschutz und zivile Verteidigung, 1999). Accordingly, it is important to optimise C2-systems . This should be done before any weaknesses become apparent during a real event.

To develop or adapt C2-systems in a better and more targeted manner, it is obligatory to objectively evaluate their components. This is because only accurate feedback of the performance enables the necessary adjustment of set screws. In order to examine the relevant components, the system must first be broken down into its individual parts. This makes the interdependencies clear and shows where performance can be measured accordingly. Since there are a number of different C2-systems worldwide in use, such as the American Incident Command System (ICS) or the German "Command and Control System 100" (FwDV 100), it is first necessary to develop a C2-system that is universally valid. This universally valid C2-system represents the best-known components of existing C2-systems. Thus, it can be stated that generic properties exist in all C2- systems, which are sometimes presented differently, but are the same in their effect. One example of this is the C2-process, which in FwDV 100 closes with the order to the tactical unit, but in ICS closes with the dissemination of the Incident Action Plan (Federal Emergency Management Agency, 2017). In both cases, the final step has the goal of implementing plans that have been developed. Therefore, the final step can also be called "implementation" in a generically valid way.

In constructing the generic C2-systems, it became apparent that the different C2-system approaches have various strengths. For example, the German FwDV 100 is designed primarily for smaller firefighting operations. The ICS, on the other hand, can be applied much better to large and growing incidents with the need for interorganizational cooperation. And the British system includes the approach in which natural decision making can also be applied, instead of analytical decision making (The Stationery Office, 2008). This approach allows experienced decision makers to bypass the analytical decision process and make time-saving decisions directly based on past experience. All in all, the development of a generic C2-system not only provided the basis for an objective evaluation, but also enabled the development of a comprehensive C2-system that combines the components and strengths of existing C2-systems.

BACKGROUND

C2-systems can already be identified in early military history. Popular considerations are known from the military practitioners as well as strategists Sun Tzu (about 534 BC - 453 BC) and Carl von Clausewitz (1780-1831). Their observations and findings can still be recognised today in modern C2-systems. The systems have gained their present form through empirical observations and theories based on them - but that also makes them very simplified. A good example of this is the OODA (observe – orient – decide – act) model from the US Air Force Colonel John R. Boyd. It becomes clear that a simple model may not be able to cover all the demands of C2-systems (Richards, 2020). Nevertheless, these models provide an excellent basis for the use of the basic concept in many areas. A comparison of different models for more detail and further use in research was already carried out in 2007, when four different models were examined (Stanton et al., 2008). In concrete terms, however, this study was not about actively used C2-systems but about theoretical models that had different focuses: process model (Lawson, 1981), contextual control model (Hollnagel, 1993), decision ladder model (Rasmussen, 1974) and functional model (Smalley, 2003). As a result of the comparison, a generic C2-system was created that combined the properties of all models. A review of models and theories of different types was also conducted by the United States Army Research Institute. However, this work did not result in a direct comparison and synthesis of a generic system (Crumley & Sherman, 1990). In contrast to the scientific works mentioned above, the comparison in this paper is not based on theoretical models with different focuses but on entire C2-systems in the domain of emergency services. In model terminology, this focus could also be called an operation model.

METHODOLOGY

C2-systems are very complex because, in addition to theoretical constructs like command structures, they also include components such as technologies or the most complex component: humans. Nevertheless, in order to gain access to the processes within a C2-system, the whole system has to be abstracted and modeled. The processes in C2-systems are too complex to be grasped as a whole and as they exist in reality. Here we make use of the abbreviation feature of models, which states that the model only contains those attributes of reality that appear relevant to the user (Lenk & Ropohl, 1978, p. 246; Stachowiak, 1973, 131 ff.). The strengths of a model with the most important components can later be used to simplify the identification of key performance indicators (KPI). Two research approaches for creating a model are used: “general systems theory” as well as “cybernetics”. The research design is based on a comparison by criteria.

General systems theory is aimed at an interdisciplinary integration of the different scientific disciplines to explore complex constructs (Zahn, 1972, 8 ff.). Research in the area of C2-systems often focuses on the interaction of human-machine-environment (Gißler, 2019, p. 21). It is clearly evident that at least these three superordinate systems are involved. The subordinate systems can also be divided into further sub-systems. Since “general systems theory” aims to combine knowledge from different scientific disciplines and to represent the complex interrelationships of reality, it is a suitable approach for composing generic C2-systems. Cybernetics can be seen as a mapping tool of general systems theory, as it deals with the study of systems of any kind that receive, store and process information to carry out control on a target system (Thomas, 1978, p. 56).

In order to be able to describe the required model, it must first be delimited and it must be determined which interactions exist with the environment. For this delimitation, NATO C2-system research can be used, since a system construct with various boundaries has already been defined here. In the document “Code of Best Practice for C2 Assessment”, a distinction is made between different evaluation boundaries, which can simultaneously delimit a model (NATO, 2002, p. 92):

Table 1: Different system boundaries

Dimensional Parameter (DP)	focus on the properties or characteristics inherent in the physical C2-systems
C2-Subsystems (MoP)	focus on internal system structure, characteristics and behavior (Measures of Performance)
C2-Systems (MoCE)	focus on the impact of C2-systems within the operational context (Measures of C2 Effectiveness)
Force (MoFE)	focus on how a force performs its mission or the degree to which it meets its objectives (Measures of Force Effectiveness)
Environment (MoPE)	focus on policy and societal outcomes (Measures of Policy Effectiveness)

For the model (the generic command and control system) that has to be constructed, it makes sense to set the model delimitation at the C2-system (MoCE) as "external forces" obtain their instructions and orders from the results of the C2-system. How well or badly the external forces perform the given tasks is no longer directly in the area of influence of the C2-system. Nevertheless, the C2-system interacts with the forces by issuing tasks or receiving reports, so it interacts indirectly with the environment in this way. The C2-system can also interact directly with the environment by extracting or issuing information directly, for example by publishing public information messages.

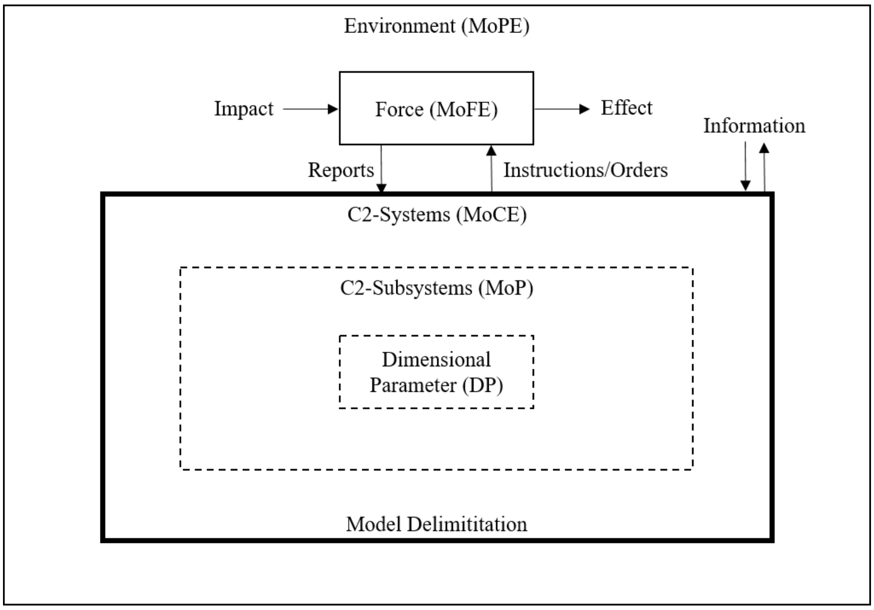

Figure 1: Limits of the system under evaluation

As a result of this delimitation, the target model contains all components that are

- physical properties or characteristics of the C2-system (in German C2-system research, these components are also called "devices for command and control" (Ausschuss Feuerwehrangelegenheiten, Katastrophenschutz und zivile Verteidigung, 1999, 43 ff.)),
- structures, characteristics as well as behaviors of the C2-system,
- and parts that influences the actions of the force and their operational effects on the environment.
- [These components are also considered as criteria extracted from existing C2-systems]

The next main step for the result described in this paper was to construct the C2-system as a process and within these boundaries so that it is coherent in its components and universally valid. Universally valid means in this context that its components are generic and occur in real systems. The generic C2-system thus enables the evaluation of any C2-process, regardless of which system is used to carry command and control out. For this purpose, the method of a comparison by criteria was used. Each C2-system examined was analyzed according to the criteria that resulted from the delimitation presented above. If a component that met the criteria was identified, it was included in the generic C2-system. Each component within the generic system has been marked so that it can be traced back to its source system, for example to the "Incident Command System" (ICS) from the USA. If a component occurred in several systems, it was marked with all of these source systems. In this case, the wording has been partially adapted to make it universally accepted.

After the generic C2-system was constructed according to the comparison by criteria, it was presented in a group interview to 4 experts, who were asked to confirm the validity of the system. All of the experts were from the emergency response sector (fire/ambulance service) and were qualified to act as incident commanders. They also had between 8 and 30 years of experience in the function of an incident commander. Two of the experts are also involved in the international standardization on emergency and crisis response. In conclusion, the generic system was considered by the experts to be valid and internationally applicable. Minor comments were made on the wording of individual components. The amendments corresponding to the comments were also marked as well as commented and the interview is video-logged to guarantee traceability.

C2-SYSTEMS SELECTED FOR THE CRITERIA-BASED ANALYSIS

There are many C2-systems in use worldwide. They can be different because of the region, but also because of the organization or sector. For example, on the one hand in Germany the FwDV 100 is in use to manage emergency operations of the fire service, on the other hand in the United Kingdom the "Fire Service Manual – Fire Service Operations – Incident Command" is the fire brigade's key document for C2-systems during the management of incidents. Furthermore, emergency response and military, for example, can be described as different sectors. Both sectors have high-performance C2-systems that differ in some ways. Nevertheless, it is easy to find overlaps, as the systems are often based on the same principles. This is evident because many first responder C2-systems have been adapted from military C2-systems that existed previously.

Because C2-systems can come from so many different regions or sectors, it is important to clarify which systems have been used to compose a generic C2-system. This is the only way to determine what the general validity refers to and how it should be assessed. In the construction of a generic command and control system as described in this paper, C2-systems used in the emergency response sector and originating from the German- or English-speaking regions were included. Finally, the international standard ISO 22320, which deals with guidelines for incident management, was also included. In detail, the following documents were used for the development of the generic C2-system:

- Leadership and Command in Emergency Operations, Command and Control System [Germany] (Ausschuss Feuerwehrangelegenheiten, Katastrophenschutz und zivile Verteidigung, 1999)
- Coordinated Incident Management System [New Zealand] (Officials' Committee for Domestic and External Security, 2019)
- Incident Command System [United States of America] (Federal Emergency Management Agency, 2017)
- Fire Service Manual, Volume 2, Fire Service Operations, Incident Command [United Kingdom] (The Stationery Office, 2008)
- Führungsbehelf, engl. Command-aid [Switzerland] (Bundesamt für Bevölkerungsschutz [BABS], 2010)
- Richtlinie für das Führen im Katastropheneinsatz, engl. Guideline for leading in disaster operations [Austria] (Bundesministerium für Inneres, 2007)
- ISO 22320:2018 - Guidelines for incident management (International Organization for Standardization, 2018)

As described in the methodology section, these documents were analyzed and a generic management system was synthesized according to the criteria. The visualized procedure can be seen in Figure 2.

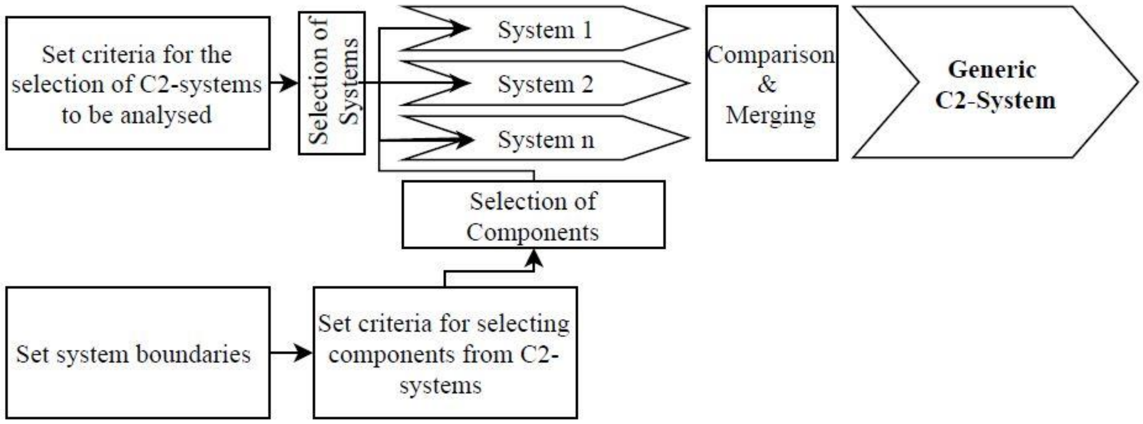

Figure 2: Procedure of development of the generic C2-system

THE GENERIC C2-SYSTEM

Due to the many source systems, the generic C2-system has become a complex model. However, this is not a disadvantage, since it is supposed to represent a complex process and does not have to cover the requirements of a didactically applicable model for teaching. Rather, it should offer a variety of approaches for research. For example, it offers an easy way to compare which components are present in a specific C2-system in contrast to others, i.e. to the generic one. It also offers the possibility of identifying KPIs that are universal to all C2-systems, not just applicable to the process of a specific one. Because of the complexity, figure 3 shows an overview of the generic C2-system. The following sections go into more detail on the individual components (A–G). Particular care has been taken to build the C2-system as a process. It is expected to make it easier to use when evaluating realistic exercises, because during these exercises, information can be seen as goods that go through the process of the C2-system until it is brought together in an action.

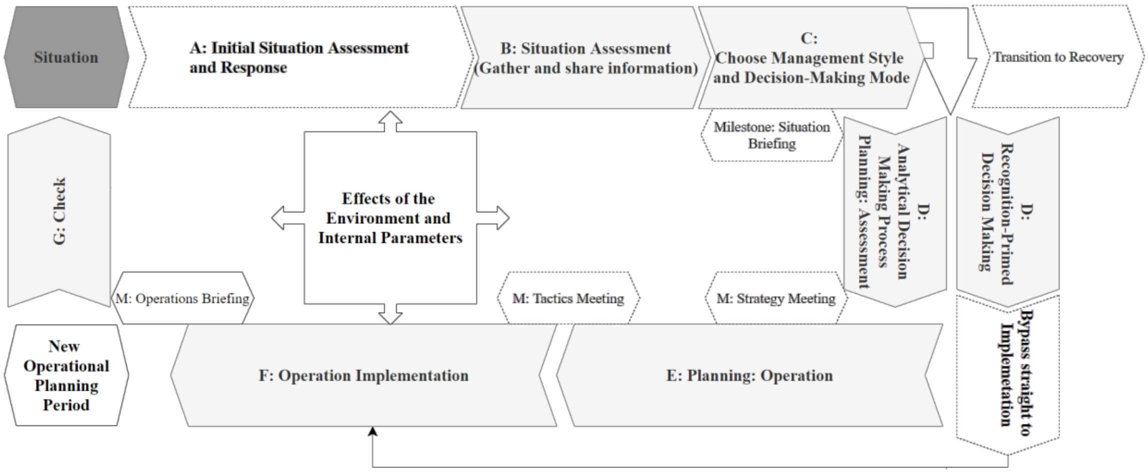

Figure 3: Simplified overview of the generic C2-system

As shown in Figure 3, the process of the generic C2-system consists of 7 main process steps (A-G). The beginning of the process is the component "Situation". The process is constantly repeated and can be applied at different levels of command. Due to its composition from different systems, the process can be applied to all sizes of incidents, such as small "one unit operations" or large disasters that require a large number of emergency personnel from different organizations.

Process steps shown in dashed lines are not mandatory. Depending on the situation, they may or may not be applicable. One example is the "transition to recovery". This step is shown as an outgoing one, because after the situation assessment, it may become apparent that the recovery (demobilization planning of resources etc.) can be initiated. Also, the various meetings after the process steps are not all mandatory. If there is only one incident commander who has not established additional command staff and handed over tasks, the situation briefing as well as strategy- and tactics meeting do not have to take place. As the operation briefing has a key function in the handover of tasks, it should always take place. For example, even if in a one unit operation where the unit leader (who in that case is also incident commander) gives tasks to the personnel of the unit.

There is a textbox in the middle of the process that shows negative or positive effects on all process steps. On the one hand, the nature of the incident (environment) may complicate parts of the C2-process. On the other hand, technical devices can support command and control and improve information processing, for example. In particular, the British (The Stationery Office, 2008) and New Zealand (Officials' Committee for Domestic and External Security, 2019) C2-systems have contributed the "environment effects" to the process. It must be taken into consideration that geographical size, severity, complexity, moral pressure as well as change per time have an impact on the implementation of the C2-process. The German system sees technical devices as an important part of a C2-system and mentions their facilitating effects on information gathering, -processing and -transmission. Since the evaluation with the generic C2-system will be carried out scenario-based in the future, these parameters must be taken into account.

A: Initial Situation Assessment and Response

Almost all analyzed C2-systems include an initial situation assessment with initial actions, which has to be undertaken. A very concise example of this is the initial phase of "Planning P" from the ICS. Only the German and British systems do not explicitly mention any initial measures in the command process. The initial measures were included in the generic C2-system in such a way that they contain the most important characteristics of the initial phases from the analyzed C2-systems. Three primarily phases were identified:

- Initial Situation Assessment
- Immediate/First Actions
- Initial Situation Briefing

The Initial Situation Assessment is particularly necessary when the situation is very dynamic. The assessment can be quick and basic at first, in order to identify the preliminary circumstances. A more precise examination of the situation should follow after the initial actions have been started. First actions can be preparatory measures for obligatory actions. The primary goal is to gain time and remain capable of acting. A simple example of this is the arrival of a fire engine at a road traffic crash. The incident commander (IC) very quickly identifies the accident in the area of fast moving traffic. In order to protect further actions, the IC immediately orders the units to close off the road while a more precise assessment of the accident vehicle is carried out. After the road closure, the IC has gathered more information and can give more precise orders for the next steps. The IC has more personnel resources, as the roadblock has already been carried out, and at the same time the incident site is safe for emergency operations. The layout of the Initial Situation Assessment can be seen in Figure 4.

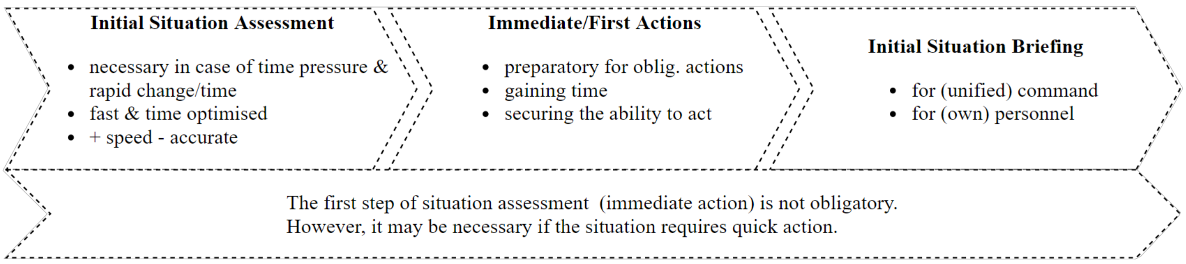

Figure 4: Components of the Initial Situation Assessment

B: Situation Assessment

As soon as there is enough time, a full Situation Assessment should be carried out. This is a process part of each of the C2-systems analyzed. However, even with extended situation assessments, it is often pointed out that information is not necessarily complete when decisions have to be made. Decision-makers need to achieve a balance between information gathering and timely use. Information can be divided into information about the incident and self-information. Self-information is, for example, information about resources and conditions of the organization. A comparison of the target and current state can be carried out, especially with incident information. For example, questions such as "What is the deviation from the target situation and how can it be handled?" should be addressed. Please note that the Situation Assessment should be carried out as continuously as possible. If circumstances occur during the Situation Assessment that require immediate action, it is possible to jump to process point “Immediate Actions”.

Once information has been collected, it must be processed accordingly. The cycle shown in Figure 5 is used to illustrate the processing. The information collected should be checked for relevance, accuracy as well as timeliness and should then be verified and, both input and output, should be documented. If the information is to be shared internally or externally, it must be prepared for sharing. This may involve, for example, adapting the vocabulary for a wider target audience. The next step is to share information. For successful incident management, it is particularly important to provide information to own staff and to cooperating organizations. To ensure information reliability, confirmation of receipt and understanding should always be provided by operating personnel.

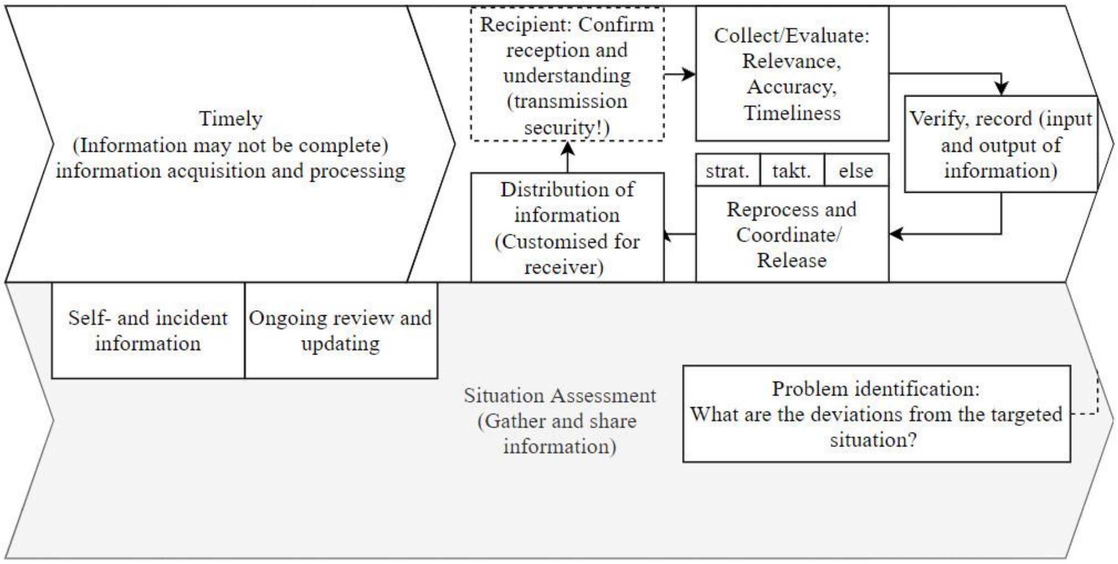

Figure 5: Components of the Situation Assessment

C: Choose Management Style and Decision Making Process

After the Situation Assessment, how the operation should be led must be determined: The management style and the decision-making mode that will be used must be selected. In parallel to the German system, the British system is very much concerned with different management styles. With various management styles, it is possible to involve personnel differently (Ausschuss Feuerwehrangelegenheiten, Katastrophenschutz und zivile Verteidigung, 1999, 8 f.; The Stationery Office, 2008, 116 f.). In general, a distinction can be made between directive, cooperative, advisory/accompanying and guiding/encouraging management styles. The management styles have their focus on the different aspects task fulfillment, needs of the group and needs of the individual. A clear example is the distinction between directive and encouraging: Whereas in directive management style, the focus is solely on task fulfilment, with no attention paid to any needs of the group or the individual, with the encouraging management style the focus is the other way around - on the group. With the directive method, staff carry out tasks on order without being able to contribute much themselves - the strength here lies in the rapid execution. The encouraging management style, on the other hand, takes time, as the group itself finds the motivation to solve the problem. In return, self-realization, learning and understanding are greatly increased.

In addition to the management style, the decision-making mode must also be chosen. Only the British system considers the experience-based decision-making process - all other systems only use the analytical way. However, considering the analytical approach alone is unrealistic, as research has shown that experienced leaders often choose the experience-based decision-mode (Klein, Orasanu, Calderwood, & Zsambok, 1993, p. 139). They do this for one simple reason: The experience-based way of decision-making is much faster. The choice of decision mode is usually made on the basis of the following conditions: Time pressure and experience regarding the assessed situation.

D: Recognition-Primed and Analytical Decision Making Process

If the decision-maker is experienced, has dealt with the situation or a similar situation before, and there is very little time to take action, the experience-based decision mode is used. For this purpose, the decision-maker carries out measures that have previously solved the situation according to experience. If anomalies arise during the situation monitoring that cannot be solved with the experiences of the decision-maker, it is necessary to switch to the analytical decision mode. (The Stationery Office, 2008, 107 f.)

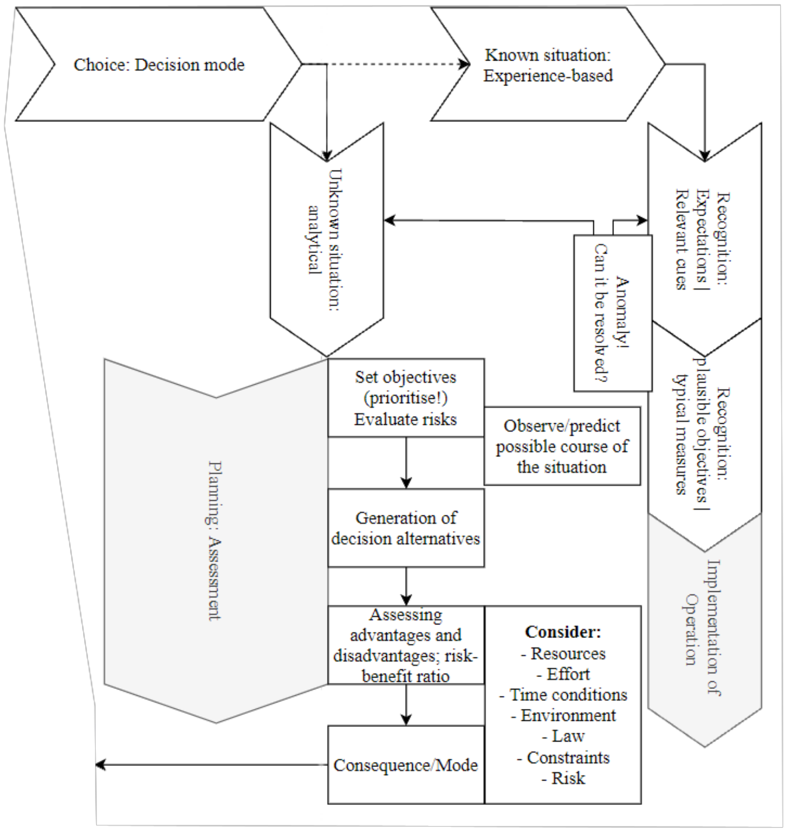

Figure 6: Components of Decision Modes for Planning

The analytical decision mode generated includes everything that is usually a common part in C2-systems. The first step is to set and prioritize the objectives that need to be achieved. In the same step, the risks that may occur when working on reaching the objectives can be assessed. All of the C2-systems analyzed use objective-based analytical decision-making. The British system has a further focus on risk assessment. According to ISO 22320, while priorities are being set, it should be aimed to think ahead about the possible development of the situation (International Organization for Standardization, 2018, p. 5). Once the objectives have been set and prioritized, decision alternatives are generated that help to achieve the objectives - different ways to reach the objectives are developed. Following this, the different advantages and disadvantages of the decision alternatives generated are weighed against each other. In the process, decision-makers can consider various issues, such as resource demand, implementation effort, time exposure, environmental impact, reasonableness, constraints and risks. With the decision for the best implementation method made, framework conditions (modes) can be determined, which have to be communicated to all personnel. For example, whether units are in attack or defense mode.

E: Planning: Operation

Once the way(s) to achieve the objective(s) has(have) been chosen, all necessary measures must be developed, planned and scheduled. At the end of this planning process, tasks should be developed that are clear and executable for all units involved. During operation planning, special attention should be paid to prioritization of tasks, organization of units, safety and resource management. Since the whole C2-system should be seen as a process, the organization of units and the management staff is also seen as a process step. It is assumed that each incident is initially led by one IC with no command staff. During the passage of this part of the C2-process, the IC must determine how the C2-structure needs to be set up and how it is to be managed. After analyzing the C2-systems, it can be identified that the IC initially holds all of the following functions, which may be handed over command staff:

Table 2: Functions of the Incident Commander

- Situation Assessment	- Public Information
	- Logistics
- Planning	- Information and Communication
- Risk Management	- Communications technology
- Safety/Welfare	- Investigation (Intelligence)
- Liaison/Cooperation	
	- Personnel / Internal Affairs
- Operations	- Finances and administration

If the IC does not hand the tasks to the command staff, the IC must handle all command tasks during the C2-process. Depending on the capacity and workload, it is possible to combine or split the tasks. According to the size of the command staff, the IC may also appoint a head of staff to supervise the work and manage information flows. If particular expertise is needed because of the kind of situation, specialists can be brought directly into the command staff. In the case of a multi-agency response, it may be useful to establish a unified command of the main acting organizations to ensure a common focus of efforts. The command type of unified command can often be found in C2-systems that are based on the American ICS. However, also with unified command, it is important that the principle of unity of command is respected. In other words, there is always one institution that has the final decision-making authority.

The operational units are located below the IC and the command staff. They can be structured in a divisional or procedural way. Divisional means all subdivisions according to space, department or the number of units. Procedural means the structure according to tasks that build on each other, similar to how it is in a factory.

As in the British and to a certain extent in the German system, it also makes sense to divide the command structure into clear political, strategical, tactical and operational levels. This supports a clear alignment of levels as well as easier collaboration with the same levels of other organizations, since the strategy level sets the tactical parameters, the tactical level guides the operations, and the operational level carries out the implementation on the incident site.

Figure 7 shows the relations during planning. Since planning can be very extensive in terms of tasks, this step primarily demonstrates how it can be divided up efficiently. Each task can also be found in the generic C2-system as a process step. In the original illustrations, which have been made available online, the individual IC tasks are color-coded to the process steps. For example, the Situation Assessment is a tactical management task that can be found at the beginning of the C2-process.

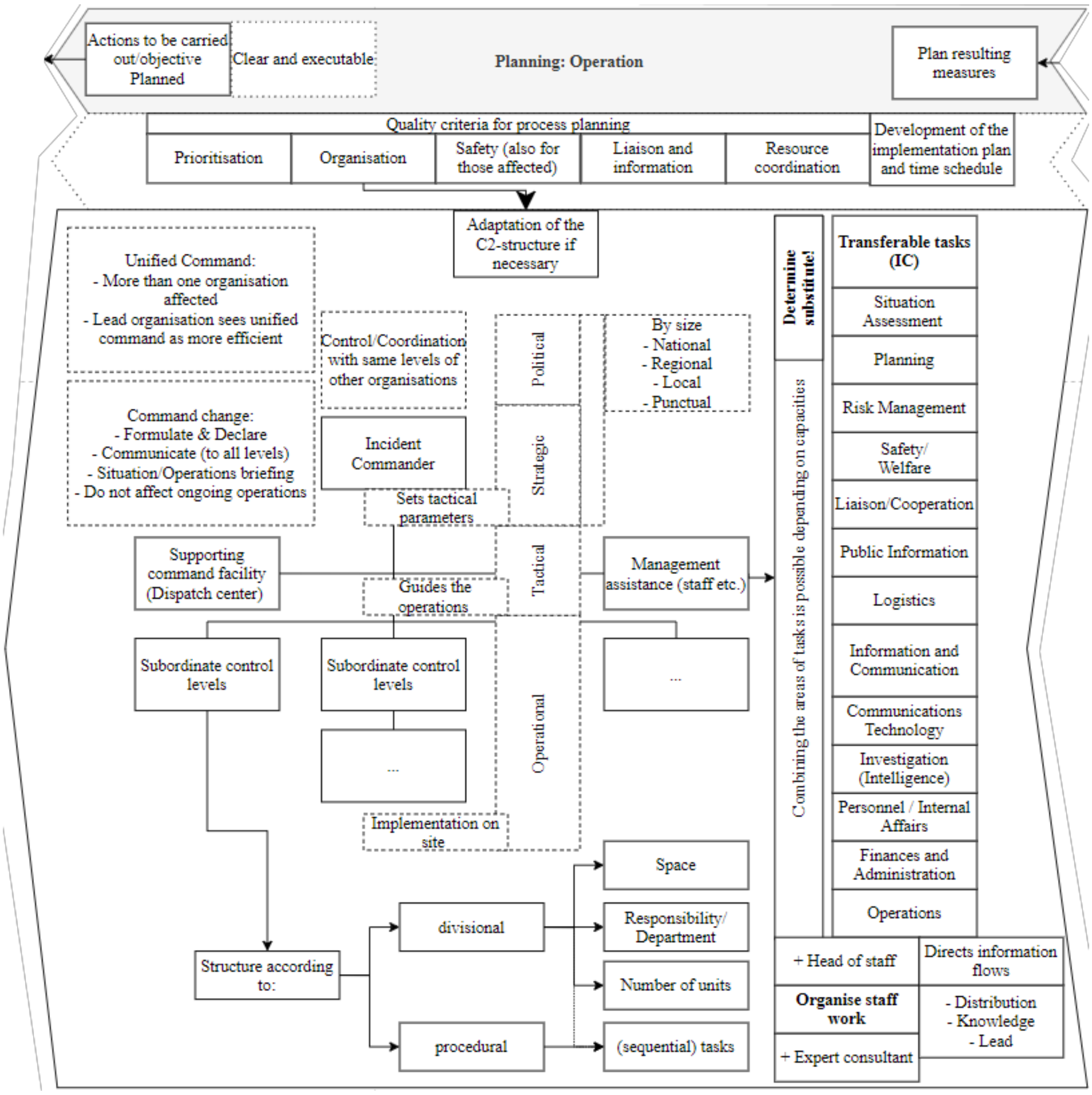

Figure 7: Components of the Operation Planning

F: Operation Implementation

The last step involves the dissemination of information and tasks to the deployed units. In summary, an Incident Action Plan (IAP) is issued. Depending on the size and complexity of the incident as well as the operation, the IAP can be issued in oral or written form. Regardless of whether the IAP is issued orally or in writing , it should always have the same content in the same order. This ensures that the important matters are covered and that nothing has been forgotten. The analysis of C2-systems has identified the following elements as important for the IAP.

Table 3: Important Elements of the IAP

- Situation	- Time schedule (with meetings)
- Objectives	- Own and further assignments
- Framework	- Resources in use
- Plan/Intention	- Special requirements

The IAP is valid for a certain period of time or up to a certain milestone. When the relevant criteria are reached, a new Operational Period starts.

G: Check

The process step "Check" is a component of quality management for the results and operation implementations of the C2-systems. This step checks whether the units performed the assigned tasks according to the orders and if the intentions of the incident control are met. Moreover, it checks whether the results of the C2-process match the situation or whether adjustments need to be made. In this respect, this process step can be declared as the end or the beginning of the ongoing process run at the same time. It is the final control of the execution, but at the same time it is also the first step of the new Situation Assessment of the next Operational Period. Both, the information for the check and for the new Situation Assessment can come from reports of the units (Force - MoFE) beyond the system boundaries.

DISCUSSION

The intention was to develop a universally applicable C2-system, primarily for the evaluation of command and control in incident-scenarios of any size. It was finally given the name "Generic C2-System". Because of this name it must be clarified what "generic" represents, i.e. from which C2-systems it derives. A specific section (C2-SYSTEMS SELECTED FOR THE CRITERIA-BASED ANALYSIS) has therefore been dedicated to this clarification. The C2-systems mentioned were carefully combined in a comparative approach according to the previously set limits and criteria. Since it was mainly text work and the merged result was evaluated in interviews by experts, the scientific approach has to be rated as qualitative. If the generic C2-system is compared with the models listed in the Background section, the first thing that stands out is its far greater scope. This results from the broad focus on an overall system that needs to be considered operationally within an organization. It does not specialise in individual components, such as decision-making, but in the whole detailed process of incident control and management.

The components of the entire process diagram of the Generic C2-System have been color-coded in such a way that it is easy to identify the source systems from which the corresponding component is derived. It must be considered that although the authors designed the system according to the contents of existing C2-systems and ISO 22320, nomenclature and merging of the components was subjective. The verification by the expert interviews aims to counteract this.

Since the entire process with all its components was too large to be presented on a DIN A4 page, it is made available digitally under the following link:

Link: https://th-koeln.sciebo.de/s/wRmasfEoVxGhtDv

OUTLOOK & FUTURE WORK

The Generic C2-System is part of an overarching research initiative that aims to evaluate C2-processes, which are observed in the context of scenarios and exercises. For this purpose, quality criteria must be extracted for the corresponding components. To a certain extent, this already took place during the analysis of the existing C2-systems. Some of the documents have indicated which attributes can be good or bad for the successful use of the system. The purpose is to develop KPIs that are assigned to the appropriate places in the process. Reference scenarios have to be developed that address the corresponding KPIs. In this way, it can be determined as a result how well a C2-system performs in the according area or component. All developments will be validated by scenario-based exercises.

CONCLUSION

The development of the Generic C2-System makes it possible to find universal KPIs for existing or new C2-systems and to place them in an appropriate place. Thus, the primary purpose of the Generic C2-System was achieved. However, the newly developed system can also be used for other purposes. Since it is detailed, it can be seen as a current state of the art. It can be identified quite quickly in a comparison what an existing system does not have or may present differently in contrast to the generic system. Nevertheless, the sources from which this generic system originates must be taken into account and it is important that the previously set limits of the system analysis be kept in mind. It is not necessarily applicable to every culture or sector.

It would be of great value if other scientists would expand the Generic C2-System if they know of other C2-systems that have not been considered so far but have additional generic properties that should be added. This would support international representativeness, as the current system is primarily based on English and German-language sources.

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