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# EMERGENCY MANAGEMENT IN EXTREME SITUATIONS – TOWARDS A MULTI TEAM LEARNING PROCESS MODEL

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**Abstract:**
Multi Causality Incidents (MCIs) are extremely challenging emergency scenarios which require highly effective coordination and synchronization of (multiple) team units. The purpose of this case study is to identify key factors that significantly limit or contribute to overall goal effectiveness. We will therefore refer to rich (observational) data of an emergency practice of an airplane firefighting at a German airport which involved more than 1000 task force members and over 250 severely injured casualties. To interpret this MCI-incident we apply the concept of multi team systems (MTS) and draw upon previous research on (organizational) resilience and bricolage as well as organisational learning. Eventually, we will elaborate on factors which we consider as crucial to successfully master such a catastrophe. Firstly, organisational structures provide overall orientation and reduce complexity for all emergency team members to effectively navigate through the chaos. Secondly, we focus on how action forces succeed in adapting to the rapidly changing situations in terms of intra-team and inter-team unit information sharing, communication, and leadership. Thirdly, based on our theorising of our empirical material at hand, we also propose ideas for advancing the design and implementation of simulation training to more effectively prepare multi team units in case of a real life MCI.

*Keywords: information sharing, communication, leadership, multi team systems (MTSs), organisational learning, emergency management, Multi Causality Incidents (MCIs)*

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## 1. INTRODUCTION

Problems that appear during emergency management (e.g., Multi Incident Causalities resulting from terrorist attacks or natural disasters) are only visible in retrospect. In general, the experiences and knowledge gained are only accessible for a limited group of executives. With our research we will make vital contributions preparing action forces coping with critical situations in extreme settings. Of particular interest is how action forces can guarantee high performance/ resilience during critical phases by swiftly changing between highly standardised operating procedures (during routines) and flexible adaption processes (during non-routine or novel situations). And even more important how to teach and train action forces dealing with critical situations? Hence, we use a high fidelity simulation to understand factors that significantly limit or contribute to effective emergency management that again serves to enable action forces for more suitable adaptability in future operations.

## 2. AIM OF THE STUDY

Empirical research that addresses both intra-team and inter-team dynamics is insufficient, but crucial, because ineffective processes *within* team units may cause coordination deficits *between* team units (Lanaj et al., 2013). With our research we intend to single out and identify significant factors that hinder the coordination and inter-operability of multi team systems that operate in very chaotic, life-threatening environments to develop an intervention in (multi) team settings. Based on our findings, we propose a 'systemic-orientated, action- and experience-based learning approach' to empower action forces coping with critical situations through a continuing processes of reflection and action.

## 3. RESEARCH SETTING

As part of a comprehensive deductive case study (Yin, 2017; Barratt et al., 2011) we observed a high fidelity simulation of a Mass Casualty Incident (MCI) to analyse the impact of within-team and cross-team interaction processes on the overall system effectiveness. In April 2016 we had the exclusive opportunity to generate empirical data on the behaviour of (multi) team units during a simulation of a large scale damage scenario. With a team of 21 researchers we participated in a six hour long high fidelity simulation conducted on the runway of a big German airport. The prepared scenario was a fatal collision between an airbus (450 crew members/ passengers) and a bus (50 passengers) which left around 250 persons severely injured. In total, the simulation of a large scale damage with a MCI involved more than 1000 first responders who were tactically divided into several team units (e.g., fire-fighting, emergency, police).

## 4. DATA COLLECTION, DATA ANALYSIS, AND MAIN FINDINGS

We handed out standardised questionnaires to all involved action forces and interviewed a sample of them afterwards the high fidelity simulation. Furthermore, on different operation sections 21 instructed researchers observed and recorded in situ interaction behaviour of the teams. Additionally, we filmed the whole dynamic scenario to analyse the video data afterwards (Knoblauch et al., 2014). The collected observational data (paper and pencil protocols, video footage) of within and inter-team interactions were evaluated on different dimensions (information sharing, communication, and leadership). The core findings demonstrate that there are more problems of inter-team interaction processes in contrast to intra-team interaction processes. Furthermore, leadership behaviour differed in various team units (e.g., the leading person of one of the patient care areas was overwhelmed by the information overload and showed poor leadership behaviour). Additionally, due to insufficient information sharing, communication and knowledge flows the personnel and material resource allocation was suboptimal (e.g., the transport of victims was delayed due to insufficient communication processes of available hospitals for emergency cases).

## 5. RESEARCH GAP AND THEORETICAL UNDERPINNIGS

Based on an extensive review of literature as well as previous studies of the corresponding authors (Schmid, 2016; Pawlowsky & Steigenberger, 2012; Pawlowsky & Mistele, 2008) the research gap is to identify crucial factors of effective coordination of multi team systems 'in the wild' (e.g., Burke et al., 2007). What are the determining factors which enable 'teams of teams' to perform optimally in highly

complex and dynamic situations? And how to teach and train these teams to effectively master critical situations?
Judged by the observation of the aforementioned high fidelity simulation it became instantly clear that both the coordination within team units and the interplay of different team units have to be taken into account.
There are several theoretical approaches and empirical studies that contribute towards an explanation how to deal with unexpected situations during the management of crises. Nevertheless, there is a need to understand more thoroughly how different teams coordinate efficiently during a crisis. Often there are studies that examine the coordination of one team type (e.g., Swedish Response Teams see Rankin et al., 2013; Software Development Teams see Faraj & Sproull, 2000; Trauma Management Teams see Faraj & Xiao, 2006) but studies that analyse the interrelated processes of several teams are rare. And furthermore, multi teamwork skills to manage critical situations in extreme environments are not adequately implemented in the design of most of the training approaches.
In order to fully exploit the potential of our data, we draw on the concept of multi team systems (see chapter 6) which we combine with research findings in the field of (organisational) resilience and bricolage (see chapter 7), and organisational learning (see chapter 8).

## 6. MULTI TEAM SYSTEMS

The multi team systems approach guides us in investigating the interdependences of within-team and cross-team processes that drive the overall system effectiveness. Moreover, it points to underlying goal hierarchies which influence the ongoing, situational negotiations between different teams units. Mathieu, Marks and Zaccaro (2001, p. 290) define multi team systems (MTSs) as “two or more teams that interface directly and interdependently in response to environmental contingencies toward the accomplishment of collective goals. MTS boundaries are defined by virtue of the fact that all teams within the system, while pursuing different proximal goals, share at least one common distal goal; and in so doing exhibit input, process, and outcome interdependence with at least one other team in the system.”
In our MCI case the MTS is composed of a super ordinate technical command and control centre unit in charge of different subunits such as care, emergency care, fire fighting or rescue work, and assembly team units (see Figure 1). Obviously, all component team units share the common goal of rescue and save all victims affected by this disastrous incident.
A characteristic feature of MCIs is that the number of casualties disproportionately outweighs the personnel and material resources of the emergency personnel. This is where ‘trans-regional’ cooperation is crucial to overcome this kind of shortage (Leow et al., 2011). The major challenge during a MCI is to orchestrate the limited personnel resources to nonetheless provide optimal medical care and/or medical evacuation. In other words: Above all, the highly skilled, effective coordination of all involved team units is of critical importance. Then again, cultural incommensurability, a lack of experience in inter-organisational crisis management per se, different tactical routines, missing continuing professional development and rare possibilities of ‘close to reality’ training typically impede failures in cooperation (Owen et al., 2013; Steiro et al., 2017). Unfortunately, those shortcomings only manifest themselves in real life catastrophes.
Another unique characteristic of a MCI is that unfamiliar teams have to synchronise their processes and allocate (limited) material and personnel resources ‘on the spot’, without any prior experience of cooperation. To give examples: The technical command centre is in desperate need of constantly updated information (e.g., number of victims, seriousness of injuries) to continuously (re-)assess the situation and accordingly to (re-)allocate resources. The fire fighting and rescue units have to extinguish the fire and get the victims out of the immediate danger zone. Only then, the emergency service unit can take up its work and provide immediate care or prepare their departure to nearby hospitals. In the meantime, the police teams have to secure the scenario from curious by-standers, keep access routes free, and identify and register injured people. At best, these chains of interactions are well-coordinated to secure smooth operation in order not to waste any life-threatening time and thereby prevent possible malpractices.
In order to manage a Mass Casualty Incident (MCI) the input and coordination of several team units have to be governed hierarchically, functionally, and sequentially. Across different stages of operations all team units are linked by an overall goal hierarchy or mission statement which informs the sub goals of different sub units. The following figure depicts all team units, their respective representatives, their task responsibilities and how they are interlinked.

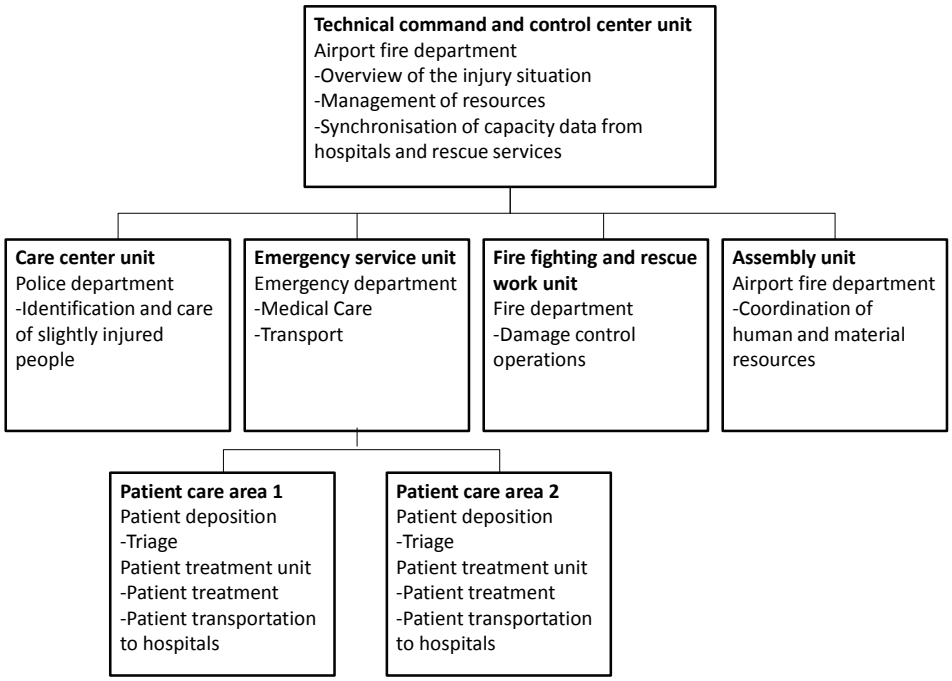


**Figure 1:** Hierarchical arrangement and task descriptions of team units

## 7. ORGANISATIONAL RESILIENCE/ BRICOLAGE

Besides of the MTS-concept, we complement our conceptual approach by drawing on literature on (organisational) resilience and bricolage. These research streams help us to deepen our understanding how team members cope and adapt to unexpected situations faced with adverse environmental circumstances.

At best, the operations within a MCI are always informed by 'structural' arrangements which provide the emergency personnel with orientation to reduce the given complexity; especially during more chaotic phases. In an ethnographic case study Danner-Schroeder and Geiger (2016 a; 2016 b) re-construct how a catastrophe management organisation enacts routines in a highly dynamic setting. They identify four critical capabilities for an effective crisis management: '(1) building up own structures following well-rehearsed routines in order to prepare the necessary ground for management crises; (2) reducing the level of perceived complexity very fast in the first phase of an operation through prioritizing tasks; (3) performing flexible routines which allow for a situation specific performance in the second phase; (4) learning from crisis and training crisis management for enabling resilient performance' (Danner-Schroeder & Geiger, 2016 a).

Nationally unified fire service regulations and guidelines (in German: FwDV) are established to manage MCIs which pre-structure the rescue mission. For example, there is a general understanding of main functional areas: e.g., the operational command center is in charge of resource allocation; the care unit should only take care of slightly injured people. There is also a general knowledge about the function and responsibilities of leadership. Main functions of leadership during crisis management are reporting the ongoing status of the amount and severity of the victims, and managing both intra-team and inter-team issues. Additionally, many MTS scenarios will very likely involve multiple levels of leadership that have the capacity to focus on either or both of these issues.

A MCI differs greatly from standard work routines of the involved teams in many regards. Usually, those teams do not have to cooperate with many other teams. They also do not deal with many severely injured casualties on a daily routine. Last but not least, they are rarely confronted with the excessive demands of such mayhem and uncertainty per se. Studies in the field of 'resilience' and 'high reliability organisations' may give us valuable insights on how to effectively cope with adverse and unexpected events by addressing aspects of resilience and mindfulness. 'Resilient' organisations are able to absorb and recover from adverse events, while assembling their structures/ routines and processes for functioning when they are faced with high stress and uncertainty (van der Vegt et al., 2015; Vogus & Sutcliffe, 2003). Based on archival records, in-depth interviews, and ethnographic fieldwork in a leading trauma centre, Faraj and Xiao (2006, p. 1156) studied how expertise is coordinated in a so called 'fast responsive organisation'. Understood as an extreme case of a high reliability organisation, the work in

such a trauma centre has to be executed error-free; aggravated by an environment marked by volatility, uncertainty, complexity, and ambiguity (VUCA). Faraj and Xiao (2006, p. 1155) are particularly interested in coordination as a structural arrangement versus coordination as an unfolding process of know-how linked with interrelated action. The authors share a coordination-practice-based perspective. Their findings suggest that efficient utilisation of distributed expertise is dependent on the coordination practices of expertise such as reliance on protocols, community of practice structuring, plug-and-play teaming, and knowledge sharing. They conclude that the adaptation to unexpected situations and error-free operations throughout extended periods of time require dialogic coordination practices such as epistemic contestation, joint sensemaking, cross-boundary intervention, and protocol breaking (Faraj & Xiao, 2006).

Research on bricolage informs us in more detail about how organisations make use of available material, cognitive, and social resources to respond to unexpected events (Bechky & Okhuysen, 2011; Baker & Nelson, 2005). A core element in bricolage is the capacity of individuals to apply experience-based resources to deal with unpredictable events. On that note, Bechky and Okhuysen (2011) highlight socio-cognitive resources.

## 8. ORGANISATIONAL LEARNING AND MULTI TEAM LEARNING PROCESS MODEL FOR TEACHING AND TRAINING MULTI TEAM SYSTEMS

To propose a 'systemic-orientated, action- and experience-based learning approach' that includes a continuing process of reflection and action we give a brief synthesis of the literature streams to derive a '(multi) team learning process model'.

Pawlowsky's model of organisational learning (2001) can be seen as a pioneering point in the (knowledge) management science area that can be transferred from the organisational level to the team level. It concludes four main phases: (1) identification/ generation of new knowledge or information, (2) diffusion of that knowledge throughout the team, (3) integration/ modification of team processes and routines, and (4) actions based on new knowledge and behaviors. The (1) 'identification/ generation phase' involves the identification of information that is key to learning and/or to the creation of new knowledge. This is the crucial phase in initiating learning at a collective level. (2) In the 'diffusion phase' information and knowledge is exchanged as a result of team processes, discussions, and actions and occurs from the individual to the collective level or at the collective level itself. In the (3) 'integration/ modification phase' knowledge is integrated into existing systems and processes at the collective level. The (4) 'action phase' involves the transformation of the new knowledge into action and the application of the knowledge to routines so that learning is embedded into the behaviour and actions of all members of the team or collective.

Based on the work of Pawlowsky (2001) McCarthy and Garavan (2008) focus on the importance of metacognition and regard team learning as a cyclical process of identification or generation of new knowledge, diffusion of that knowledge throughout the team, integration or modification of team processes and routines, followed by taking action based on new knowledge and behaviours. In a similar vein Ellis and colleagues (2003, p. 822) define team learning as "a relatively permanent change in the team's collective level of knowledge and skill produced by the shared experience of the team members". And, they emphasise that the conceptualisation of the team learning construct has to include each team member's ability to individually acquire knowledge and skill as well as their ability to collectively share that information with other team members. Knapp' s conceptual review (2010) of collective (team) learning process models underpins the importance of metacognition for team learning.

As pointed out above we derived and firstly tested a model that connects team (learning) research (Burke et al., 2011; Rosen et al., 2011) to organisational learning/(knowledge) management science (Pawlowsky, 2001).

In the next section the analytical process model of team learning is described.

In the inner circle of the model the interrelationship of goal attainment by knowledge-management practices (identification & creation, diffusion, modification, action) and the realization of the teaching and training practices (action, reflection, and learning) are illustrated as two interconnected cyclical processes, both driven by metacognition. In the outer circle emergent states (shared mental models, group potency, and mutual trust) and social and cognitive processes (situation assessment, plan formulation, plan execution, and team learning) are mapped out to show their emergent influence on team performance.

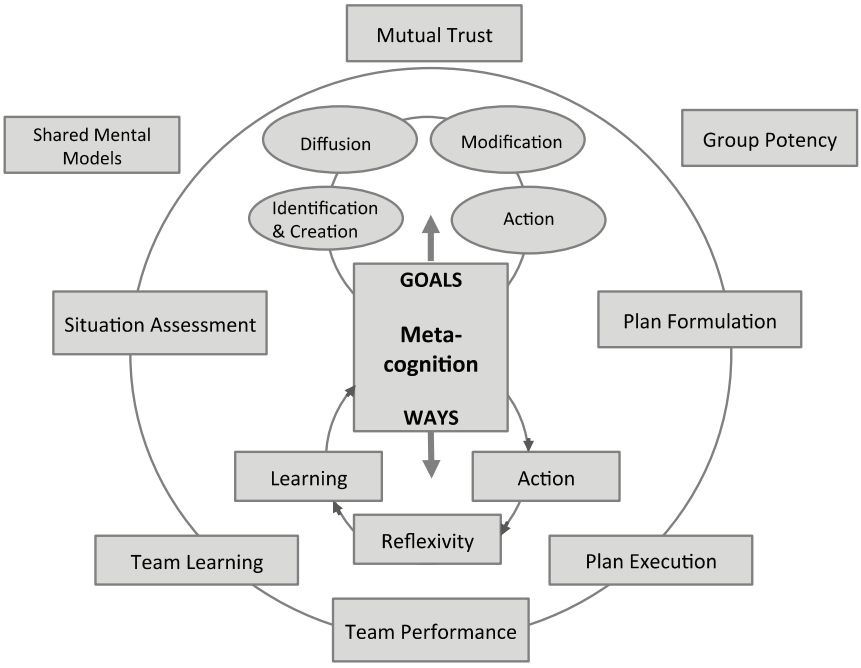


**Figure 1:** (Multi) Team Learning Process Model (based on Pawlowsky, 2001; Schmid, 2016; Knapp, 2010; Burke et al., 2006; Rosen et al., 2011; Owen et al., 2013)

## 9. CONTRIBUTION

With our research we propose a model for improving the design and implementation of simulation training to more effectively prepare multi team units in case of a real life MCI. Within this approach video records can be used for both giving feedback to the team members of the multi-team system and contributing as a powerful training tool. Further analysis and the use of quantitative model-based approaches to generate insights for research and practice are promising (Kennedy et al., 2017).

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