Task Forces in Subsurface Operations – A psychological Analysis of Specific Factors

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Abstract: Operations in subsurface areas are increasingly relevant challenges in national crisis management. This study recorded task forces' risk perception and the perceived competence regarding amok and terrorist scenarios. The results based on data of 324 task forces show that general risk perception and the subjective experience of competence are lower in subsurface than above-ground operational scenarios.

Keywords: Subsurface Operations, Public Emergency Services, Armed Forces, General Risk Perception

1. Introduction

Public Emergency Services (PES) include many operational organizations such as fire departments, police departments, and rescue services. The term thus encompasses several complementary professions that are entrusted with the defense against internal dangers in the course of their professional operations. Due to the cooperation of PES with military units, which is often necessary for extreme operational scenarios, PES are also regarded as the basis of national crisis management (Necas et al., 2006; Zoller, 2019).

PES have become the focus of numerous discourses in recent years, primarily due to developments in the deployment structure that cannot be ignored: for example, the also publicly available statistics show a steady increase in the volume of emergency calls and operations, which can mainly be observed in the fire department, police, and rescue service (Kox et al., 2019; Sefrin et al., 2015). In addition to a large number of diverse minor incidents (i.e., operational situations that are not associated with any particular challenges and thus form the basis of routine operational activities), a non-negligible number of special operational scenarios are also increasingly being reported (Höfner et al., 2015). These include large-scale incidents associated with an increased number of injured persons and considerable damage to property (DIN 13050:2015-04, Terminology in Rescue Services). As examples of these operational situations, often amok and terrorist attacks, natural disasters, or also threat situations involving the use of various hazardous substances are mentioned, whereby - depending on the prevailing conditions - major traffic accidents can also be counted among the special operational situations (Brückner, 2019; Lasogga & Von Ameln, 2010; Löwe & Jahn, 2022). In addition to the extent of corresponding operational scenarios, it is of fundamental importance in the context of tactical considerations to take into account the local conditions of related operations in a specific way.

Subsurface areas are of great importance to societal functioning due to the growing number of underground network structures and the so-called underground infrastructure (Bobylev, 2009, 2016; Doyle, 2016). Due to the increasing use of these areas in an economic and organizational sphere, the possibility of mission-related confrontation with the corresponding special underground conditions must be assessed. Currently, the research literature on the psychological aspects in the context of underground spaces refers primarily to findings relating to a segment of the population regularly exposed to these conditions, without including potential threat situations. Following the impressive effects of underground conditions (see, for example, Küller & Wetterberg, 1996; Lee et al., 2017), even in the context of short-term exposure to corresponding conditions, non-negligible effects on experience and behavior must be assumed.

The present work is dedicated to the awareness of emergency forces in the context of the potential confrontation with subsurface operational situations. For this purpose, the construct of general risk perception as the perceived probability of occupational conflict with a selection of operational scenarios differing in type and localization was focused on. The subjective experience of competence in corresponding

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operational situations was also recorded. The constructs were intended to give an impression of possibly prevailing differences depending on the localization of operational scenarios. The psychological stress in the professional context, the subjectively perceived preparedness of different instances, and the expected consequences in case of amok and terror were also recorded. The variables now last mentioned were selected to include the area of extreme violent events in the considerations of special operations situations.

2. Method

From November 11, 2021, to January 31, 2022, a total of 518 professionals from fire, police, rescue, and military units participated in an online survey, with only the 324 fully completed records considered for further analyses. The sample was composed of 255 Austrian (78.70%) and 69 German (21.30%) task forces (54 women, 270 men). The mean age of the participants was 39.81 years (SD = 11.30, range = 18-65). At the time of data collection, respondents were engaged in full-time employment in fire (32.40%), police (34.30%), emergency medical services (28.10%), or military units (5.20%). The average work experience was 15.51 years (SD = 11.18, range 0-44). The requirements for participation were full-time employment in the described operational organizations with direct operational confrontation and the ability to understand the German language. Due to the funding of the fundamental project (see acknowledges), study participants' recruitment mainly occurred via scientific partners and cooperation partners. Also, police stations, fire departments, and rescue stations were contacted (digitally) and asked to participate in the survey.

All participants provided informed consent before data collection.

To assess the general risk perception, the subjective experience of competence, and the operational experience, participants were presented with eight operational scenarios taken from the German alerting regulations of the PES as potential operational messages. The scenarios comprise a total of four large-scale incidents and four medium-scale incidents with imminent danger. They were adjusted regarding their localization (above-ground vs. subsurface). The operational situations were explicitly selected for the field of activity of persons working in the fire department, police, and rescue service. Due to the very specific operational activities of military units, only the operational situations related to amok and terror were presented to the militaria sample. By the chosen operationalization of the described constructs, participants gave (a) an assessment of their perceived probability of being confronted with the specified operational situations in the course of future services within the next year (general risk perception) and (b) an assessment of their own, self-organized action in corresponding scenarios (subjective experience of competence) during the specified operations. For this purpose, a percentage scale was available in each case, whereby 0 stood for a low and 100 for a high expression of the corresponding construct. During the statistical analyses, the data were averaged according to the classification by localization (above-ground vs. subsurface) to obtain an overall score and allow a direct comparison of the variables described. To consider the respondents' operational experience, the scenarios were also given to ascertain whether corresponding deployment situations had already been experienced during professional activity. The question was asked using a dichotomous nominal scaling.

To identify the psychological stress in the professional context, the irritation scale of Mohr et al. (2007) was used. This scale describes work-related stress as a state of mental fatigue, which includes both cognitive and emotional components. The instrument contains a total of eight items, which are rated on a seven-point Likert scale (from 1: "Does not apply at all" to 7: "Fully applies") regarding the subjects' agreement with the given statements. The total score of irritation relevant for further analyses as an indicator of the overall psychological stress present in the occupational context was determined by summing up the responses.

The preparedness of various authorities and the consequences perceived as possible in the context of an amok or terrorist situation were surveyed using a specially constructed scale. The respondents were asked to rate the extent of the corresponding items on a five-point Likert scale (from 1: "Very poor preparation" to 5: "Very good preparation" or from 1: "Very low probability" to 5: "Very high probability"). Perceived preparedness includes an assessment of individual preparedness, readiness of one's organization, area of responsibility (city, state, federal), and cooperation with other PES and military units. Potential consequences should be assessed as the possibility of losing one's life, physical injury, long-lasting psychological and physical impairment, and material consequences. The information on the variables was averaged to produce an overall score of preparedness and the extent to which the expected consequences of amok and terrorist scenarios are expected to occur.

The presentation of the investigation materials now presented was in the order described.

Data were analyzed using IBM SPSS 28.0.0.0 and an alpha level of .05 for all statistical tests. Besides descriptive statistics, pairwise comparisons were conducted to capture differences in the variables of interest of general risk perception and subjective experience of competence. Pearson correlation coefficients were also computed to assess possible relations between the study variables. For this analysis, bootstrap confidence intervals were generated on the basis of 10.000 bootstrap samples.

3. Results

The results of the responses in the context of the presented operational scenarios for recording general risk perception and subjective competence experience are shown in Tables 1 and 2.

The scenarios' averaged according to their localization resulted in a mean reported general risk perception of 60.07 (SD = 17.59) and a mean subjective competence experience of 67.73 (SD = 15.07) for the deployment scenarios formulated above-ground. For the subsurface operational scenarios, a mean reported general risk perception of 33.81 (SD = 18.68) and a mean subjective experience of competence of 54.37 (SD = 20.06) were obtained. It becomes clear that in the context of the subsurface formulated operational scenarios, the probability of being confronted with corresponding operational situations in the course of future operations is rated to be lower compared to the above-ground operational scenarios ($t(306) = 24.17$, $p < .001$, $d = 1.45$). Subjective experience of competence was also found to be low in the subsurface compared to the above-ground operational scenarios ($t(306) = -15.29$, $p < .001$, $d = 0.75$). Accordingly, subjects reported perceived lower competence in subsurface operational scenarios.

Table 1: Descriptive statistics of the general risk perception of the presented operational scenarios

Predefined deployment scenarios and classification according to type and localization	***n***	**Min**	**Max**	***M***	***SD***
Large-Scale Incidents					
Localized Above-Ground					
Traffic accident with several vehicles and trapped persons (e.g., in the center of a city)	307	0	100	68.61	27.49
Amok or terrorist attack in objects with special risk (e.g., in schools, hospitals)	324	0	100	27.53	24.16
Localized Subsurface					
Traffic accident: mass pile-up in highway tunnel	307	0	100	62.16	27.84
Amok or terrorist attack in underground infrastructure (e.g., in subway stations)	324	0	100	17.30	21.63
Medium-Scale Incidents with imminent Danger					
Localized Above-Ground					
Fire in a building, confined to one room (e.g., kitchen fire, room fire)	307	0	100	75.38	27.10
Accident at work with a trapped person in an industrial area	307	0	100	69.55	28.05
Localized Subsurface					
Tanker accident without substance leakage in a highway tunnel	307	0	100	32.93	25.88
Explosion without fire in a presumably abandoned underground car park	307	0	100	43.74	33.81

Note. Range 1-100. Higher values represent a higher general risk perception.
n = 307 emergency personnel from PES, n = 17 members of military units.

Table 2: Descriptive statistics of the subjective experience of competence of the presented operational scenarios

Predefined deployment scenarios and classification according to type and localization	***n***	**Min**	**Max**	***M***	***SD***
Large-Scale Incidents					
Localized Above-Ground					
Traffic accident with several vehicles and trapped persons (e.g., in the center of a city)	307	0	100	75.80	19.03
Amok or terrorist attack in objects with special risk (e.g., in schools, hospitals)	324	0	100	43.94	26.35
Localized Subsurface					
Traffic accident: mass pile-up in highway tunnel	307	0	100	65.71	25.40
Amok or terrorist attack in underground infrastructure (e.g., in subway stations)	324	0	100	34.46	25.36
Medium-Scale Incidents with imminent Danger					
Localized Above-Ground					
Fire in a building, confined to one room (e.g., kitchen Fire, room fire)	307	0	100	76.52	22.65
Accident at work with a trapped person in an industrial area	307	0	100	75.34	19.55
Localized Subsurface					
Tanker accident without substance leakage in a highway tunnel	307	0	100	56.68	25.89
Explosion without fire in a presumably abandoned underground car park	307	0	100	61.42	25.44

Note. Range 1-100. Higher values represent a higher experience of competence.
n = 307 emergency personnel from PES, n = 17 members of military units.

Subjective experience of competence of the overall operational activity: M = 78.10, SD = 15.39.

Also, in the context of the amok and terror situations, which were given as individual items and were directly comparable, significant differences in both the general risk perception (mean values and standard deviations see Table 1) and the subjective experience of competence (mean values and standard deviations see Table 2) were found: Thus, subsurface amok and terrorist scenarios are characterized by a lower probability of occurrence ($t(323) = 10.67$, $p < .001$, $d = 17.26$)) and also a lower experience of competence compared to attacks above-ground ($t(323) = 10.98$, $p < .001$, $d = 15.53$).

Concerning the operational experience of the sample, it becomes clear that a large part had already been confronted with the given scenarios of a traffic accident with several vehicles and trapped persons (75.60%), a fire in a building (82.10%), or an industrial accident with a trapped person (72.80%). In addition, 39.50% of the subjects stated that they had already experienced a traffic accident in the form of a pile-up in a highway tunnel during their professional activities. The tanker accident without substance leakage in a freeway tunnel (30.90%), as well as the explosion without fire in a presumably abandoned underground car park (30.60%), is to be assessed as a relatively rarely experienced operational scenario. The amok and terrorist situations classified as major incidents have already been experienced by 9.30% in objects with special risk and by 7.10% in underground infrastructure. Overall, the operational scenarios above-ground can be classified as having already been experienced by most emergency forces. However, it must be noted that operational scenarios below ground (in some cases under extreme conditions) are also part of the everyday operational situations of the surveyed authorities.

The descriptive statistics of the perceived preparedness of various instances as well as the expected consequences in case of amok and terror are presented in Tables 3 and 4. To account for the variables during further analyses, total scores of preparedness and expected harm in the event of amok and terror were calculated by averaging the correspondingly assigned items.

Table 3: Descriptive statistics of perceived preparedness in case of amok and terror

Presented Instances	***n***	**Min**	**Max**	***M***	***SD***
Individual Preparedness	324	1	5	3.21	1.11
Preparedness of own Organization	324	1	5	3.27	1.20
Preparedness of the City	324	1	5	2.70	1.08
Preparedness of the Country	324	1	5	2.69	1.09
Federal Preparedness	324	1	5	2.80	1.08
Cooperation with other PES (e.g., emergency response agencies)	324	1	5	3.13	1.09
Cooperation with Military Units	307	1	5	2.70	1.14

Note. Range 1-5. Higher values represent a higher level of perceived preparedness.
n = 307 emergency personnel from PES, n = 17 members of military units.

Total score of preparedness in case of amok and terror: M = 2.93, SD = 0.65.

Table 4: Descriptive statistics of the expected consequences in case of amok and terror

Possible Consequences	***n***	**Min**	**Max**	***M***	***SD***
Loss of own Life	324	1	5	2.37	1.05
Physical Injuries	324	1	5	2.84	1.12
Long-lasting physical Impairments	324	1	5	2.74	1.04
Long-lasting psychological Impairments	324	1	5	2.97	1.05
Material Consequences	324	1	5	2.69	1.02

Note. Range 1-5. Higher values represent a higher level of perceived consequences.
n = 307 emergency personnel from PES, n = 17 members of military units.

Total score of perceived consequences in case of amok and terror: M = 2.72, SD = 0.70.

For a more specific understanding of the described topic around specific operational scenarios, the study-relevant variables were correlated to each other. Significant correlations were found between the constructs recorded using specific operational scenarios, the expected consequences, and the readiness of various authorities in the event of amok and terror. These are shown in table 5.

It becomes clear that the self-related risk perception and the subjective competence experience of the precisely specified operational situations are strongly associated with each other in the above-ground and subsurface areas which creates a strong link between the awareness of the possible occurrence of corresponding scenarios and a related sense of competence. Psychological stress in the occupational context is correlated only with the perceived preparedness for diverse instances in the event of amok and terror.

Table 5: Pearson correlations of the study-relevant variables recorded by the presentation of specific operational scenarios, the preparedness of various instances, and the expected consequences in case of amok and terror

		1.	2.	3.	4.	5.	6.	7.
1.	GRP: Above-Ground Operational Scenarios	–						
2.	GRP: Subsurface Operational Scenarios	.47*** [0.37, 0.56]	–					
3.	SEC: Above-Ground Operational Scenarios	.42*** [0.29, 0.53]	.31*** [0.20, 0.41]	–				
4.	SEC: Subsurface Operational Scenarios	.20*** [0.06, 0.32]	.46*** [0.36, 0.55]	.69*** [0.61, 0.78]	–			
5.	Psychological stress in the occupational context	-.06 [-0.17, 0.04]	-.01 [-0.12, 0.11]	-.09 [-0.21, 0.03]	-.02 [-0.13, 0.09]	–		
6.	Perceived Preparedness (Amok and Terrorism)	.05 [-0.08, 0.16]	-.09 [-0.21, 0.04]	.07 [-0.05, 0.19]	.01 [-0.13, 0.14]	-.17** [-0.30, -0.03]	–	
7.	Expected Consequences (Amok and Terrorism)	.06 [-0.07, 0.18]	-.08 [-0.20, 0.06]	-.09 [-0.20, 0.02]	-.26*** [-0.36, -0.13]	.11 [-0.05, 0.27]	-.03 [-0.16, 0.10]	–

Note. GRP = General Risk Perception, SEC = Subjective Experience of Competence.
n = 307 emergency personnel from PES, n = 17 members of military units.

Descriptive Statistics of the Psychological Stress in the occupational context:
M = 23.94, SD = 6.91; Min = 9, Max = 46 (Range 8-56).

BCa Bootstrap 95% CIs (based on 10.000 bootstrap samples) reported in brackets.
**p < .01. ***p < .001.

4. Conclusion

The results indicate that subsurface operational scenarios, although rare, must be regarded as existing in the everyday operational life of persons working in PES and military units. However, these are rated as less likely for future operations by both deployed personnel from PES and military units and are also associated with a perceived lower level of competence.

The preparedness of various instances in the event of amok and terror can still be improved. This especially applies to the required cooperation with military units in such situations. The descriptive statistics of the expected consequences in corresponding operational scenarios can be seen as self-describing. Due to further analyses, there was a strong correlation between the general perception of risk and the subjective experience of competence – variables that also seem crucial for the actual behavior shown in corresponding scenarios (Arezes & Miguel, 2008; Bye & Lamvik, 2007; Rundmo, 1997). The perceived readiness of various authorities in the event of amok and terror also appears to be a relevant variable in job-associated psychological stress.

The results underline the high relevance of a basic awareness of the possible occurrence of underground operational situations. Overall, it is recommended that the topic of underground operational scenarios be addressed in greater depth in the context of tactical interventions to familiarize trained personnel with the special conditions of underground spaces in a targeted manner. The further consideration of psychological constructs in the context of the described topic is also recommended to create fundamental statements for the development of mission-related interventions by revealing existing connections and interactions.

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