Comparative analysis of safety culture in fire fighters from Romania and European countries

Lucian Trefaș[1], *Alexandra Simona* Trefaș[2], and *Lucian-Ionel* Cioca[1]*

[1]Lucian Blaga University of Sibiu, 550024 Sibiu, Romania
[2]Nicolae Bălcescu Land Forces Academy of Sibiu, 550170 Sibiu, Romania
[3]Lucian Blaga University of Sibiu, 550024 Sibiu, Romania

Abstract. Implementing safety measures has proven itself to be a difficult task in most domains, but the field of emergencies management is surely one that stands out. This article aims at providing a thorough analysis of both the challenges one faces in order to implement safety measures in an otherwise chaotic environment and the different ways this aspect is being handled in various countries across Europe. Nonetheless, while looking at both the protective materials and the behavioral measures taken, this study also aims at demonstrating that safety measures are most efficient when being treated as a part of the action flow, rather than one of the steps that can be ignored once checked. In reaching the results, our study researches the different approaches of various countries regarding the use of safety equipment and the role of safety measures in any work procedure being implemented, with an emphasis on working in and around explosive atmospheres. At the end of the research, we provide a science-backed list of recommendations that aim at using international know-how in optimizing the safety measures in emergency situations management workplaces.

1 Safety of the rescuers

As we strive to provide an analysis of the protective measures required to ensure safety standards in a firefighters' unit, it is important to address the differences between various countries in safety culture. While not suggesting that the fire departments in some countries are more or less focused on implementing safety measures, one must be sure to acknowledge that the risk factor is different country wise.

Therefore, the emergencies a service is involved in managing plays an important role in assessing the risks the personnel are facing. Table 1 of this article provides a comparison between the situations the fire departments manage in Romania, France and the US according to their annual reports. One could easily notice that all the examples chosen are services that operate heavily in the field of first aid assistance, but can also see clear differences in percentage of certain emergencies they respond to. It is important to notice that, besides the main categories, the other emergencies are usually risks that manifest

* Corresponding author: lucian.cioca@ulbsibiu.ro

themselves seldom, but require special measures in both training and the use of special equipment in order to manage them [1].

Table 1. Emergencies comparison.

	Romania	**United States**	**France**
Medical assistance	81%	75%	83%
Fires	5%	4%	7%
Other emergencies	14%	21%	10%

1.1 Risks for safety

The risk has been defined in the safety and security literature as the probability that a work process has to lead to an accident or professional disease, at specific rates and severity of consequences [2, 3].

It is common knowledge that fire fighting is an occupation that resides with a high risk. Furthermore, the organization must have clear boundaries between acceptable and unacceptable risks. The assessment of risks is a detailed analysis of both severity and probability [4], as shown in the figure below.

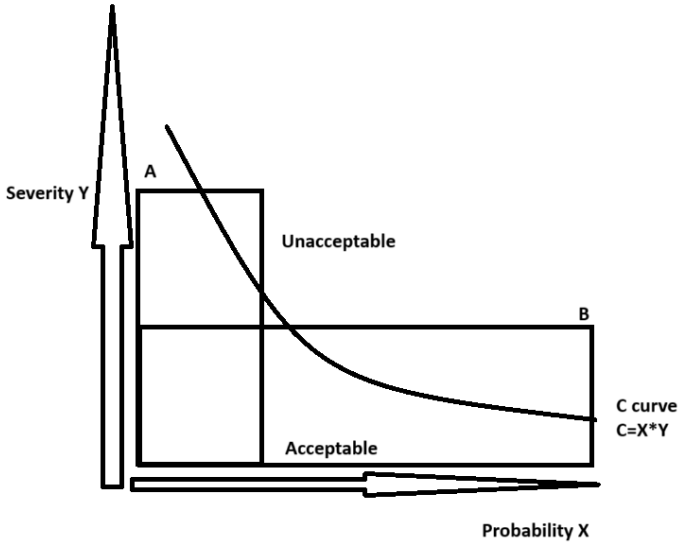

Fig. 1. Severity/probability of risks.

The severity must be analysed in regard of the consequences an accident has and can be divided into seven categories:

- Negligible (less than 3 days of work incapacity).
- Small (3 to 45 days of work incapacity that requires medical assistance).
- Medium (45 to 180 days of work incapacity that requires medical assistance and hospitalization).
- High (third degree invalidity).
- Severe (second degree invalidity).
- Extremely severe (first degree invalidity).
- Maximal (death).

Furthermore, the frequency is divided into six categories:

- Class 1 (once over 10 years).
- Class 2 (once every 5 to 10 years).
- Class 3 (once every 2 to 5 years).
- Class 4 (once every 1 to 2 years).
- Class 5 (once every 1 month to 1 year).
- Class 6 (once every month or less).

Therefore, as most work fields, the emergency management structures comply with the rules of analysing and mitigating occupational risks. Every operation and every work station must be put through a severity and probability filter in order to establish reduction means.

1.2 Implementing safety politics

History has been marked by differences in the equipment used by different emergency services. Therefore, the standards have always been at the level of the economic development. Countries like Romania struggled to ensure adequate protective equipment up until the beginning of this century, while developed countries maintained a constant high standard in terms of protective equipment. Modern times have seen most countries arrive at a similar level of access to state of the art technologies used in building the most efficient protective equipment.

On the other side, the differences are still visible when it comes to the means of intervention structures can use. Therefore, developed countries continue to have access to modern fire engines and acquire specific intervention means to each type of mission they are faced with, while other countries need to adapt work procedures in order to be able to manage emergencies with the means they dispose of in safe conditions.

Another domain that generates differences in safety measures implemented by the emergency management structures is the safety culture of the countries they operate in. Therefore, one cannot separate the historical way a country operates in general from the risk level emergency management structures are willing to take. The most obvious example to prove the statement above is the fact that a world power like the United States of America tends to adopt offensive strategies in the emergency management operations, while Romanian fire fighters tend to defer to defensive strategies when fighting fires.

The last criteria one must consider is the type of structures every country has. All the countries we refer to have a mixture of professional and volunteer emergency management structures. All United States, France and Romania have military structures that manage situations in the bigger urban establishments, but implemented a volunteer system in the smaller communities.

2 Fire fighting long term specific risks

The common knowledge when talking about adapting behaviours in order to reduce the risks associated to emergency management refers to actions in the present to prevent a negative incident from happening. This article aims at looking into the specific behaviours of emergency situations workers that have long term effects. One of the main characteristics of fire fighters' work is that it is continuous. Therefore, the personnel are exposed to circadian rhythm interference while they are obliged to answer the calls regardless of moment in the day.

In order to provide a list of tools that mitigate the negative effects on emergency management personnel, one must first understand the particularities of such work. There are a high number of studies on the long term effects of shift work, but one must

acknowledge that fire fighters are a very specific brand of shift workers, while they usually have rest hours during the shift, but are forced to answer calls during these hours.

2.1 Circadian rhythm

As Satchin Panda illustrated in his book "Circadian Code" [5] all processes in our body are oriented on a 24 hours rhythm. All living organisms spend their 24 hours doing the featuring:

- procuring energy (fuel or food).
- optimizing the use of energy, using a part to ensure functioning and storing the rest.
- protecting from malign agents or predators.
- healing or growing.
- reproducing.

The daily rhythms have specific features for day-time and night-time as presented in the figure 2.

Body temperature grow
Memory consolidation
Deep sleep
Skin repair
More growth hormone
Intestinal activity drop
Saliva production drop
Gastric acid peaks
Body cools
Melatonin starts rising

Melatonin drops
Intestinal activity increases
Cortisol spikes
Better glucose regulation
Better immune response
Increased alertness
Muscles ready for physical activity
Motor coordination spikes

Fig. 2. Human body daily rhythms.

2.2 Fire fighters as shift workers

The *Randomized, Prospective Study of the Impact of a Sleep Health Program on Firefighter Injury and Disability* [6] treated fire fighters as both shift workers and persons in need for special care for sleep disorders. Trying to see if education and a sleep scan can reduce the number of work absences caused by injuries, the study identified that 42% of the fire fighters suffer from a form of sleep disorder. The most common of the sleep disorders encountered in fire fighters is sleep apnoea, and over 80% of the cases in the United States go undetected [7].

When looking at the circadian rhythm, one must say that most of the people in the world are a kind of shift workers. There have been many attempts to define shift work, but the most relevant are those referring to it as a way of scheduling work hours that is not the classic 9 to 5 or those that define shift work as a schedule that happens in rotations and for extended periods of time.

Most shift workers studies address the effects of certain work schedules on personnel. Despite having a long history of working in shifts across work places, there are a number of particularities for fire fighting. First of all, the need to be alert at the time of an incoming

emergency call brings a misalignment of the circadian phases. The long hours and the effects of hard work are linked to road accidents, both during the missions and in between the shifts, on personal time [8].

The most relevant particularity of fire fighters' work derives from the fact that, despite mainly working on 24 hour shifts, the work hours are programmed to include rest time. Nonetheless, despite having rest hours included in the working shift, fire fighters are often being brought out of sleep in order to answer emergency calls. This way of life means that fire fighters need to come from the state of deep rest to alertness and even high intensity activities. On the same note, the architecture of sleep is being affected by the incertitude of whether the sleep bout will last long or will be suddenly interrupted. This stress factor makes the rest hours during the work shifts less restful than expected. Furthermore, the resting periods of fire fighters during their shift seldom take place in a space with no artificial light or noise. On the contrary, many of the times, independent of the personnel required to answer the call at hand, the entire unit is being alerted, this means that the rest interval of the entire unit is being interrupted regardless if their presence is needed or not.

2.3 Long term effects on fire fighters

It has been shown that attending an education session on sleep is enough to reduce the number of days a fire fighter is out of the workplace due to an injury with up to 24% for the fire fighters working in intervention units and over 40% for control stations fire fighters.

More than that, fire fighters are exposed to a number of long term effects that cannot be unplugged from the specificity of their work. Despite being a cohort of highly trained persons, fire fighters are prone to sleep disorders when also cumulating common risk factors as body composition and age [9]. There are also studies that show that metabolic disorders and cardiovascular diseases [10] as well as hypertension or even reproductive dysfunction are highly associated to the work specificities of fire fighters.

Furthermore, when looking at the associated effects to the work of fire fighters, one must mention that there is a very strong psychological component. The situations to which they respond often include tragedies and, despite organizational formal support, it is very common for fire fighters to suffer from post-traumatic stress disorder. On the same note, scientists have shown that high demanding activities in terms of use of dopamine and adrenaline have a downsizing effect on the other side, meaning that the job of a first responder basically depletes the individual from such resources.

3 Behavioural tools to reduce risks

There are a large number of tools one can use to change the architecture of sleep [11], but we will only focus in this article on the behavioural tools one can use to mitigate the downfall effects of fire fighters shift work on their sleep.

With a career dedicated to the study of sleep, the author of the book "*Why we sleep",* Matt Walker concluded that there are four important aspects one should consider when analysing their sleep: quantity, quality, regularity and timing. Based on his research and other findings in the field, one can formulate a number of behavioural tools [12] to improve fire fighters' sleep:

- First of all, the fire department must treat resting and sleep as a marker of the operational capacity of the unit, just as professional and physical training, and address the matter in both evaluating and preparing for it.
- Adaptations must be installed in order to provide the worker with enough quantity of sleep in the shifts that do not require their intervention.

- There should be an emphasis on the quality of the sleep one can achieve in the unit, meaning that the resting spaces should strive to reduce light and noise, as well as separate the personnel on the criteria of their mission in order to interrupt the sleep of only the ones needed for the call at hand.
- The fire fighter units should have an assessment tool that looks into the state of sleep for their members, this tool must look at the resting intervals both on and off the job.
- As numerous studies have shown that naps can be extremely beneficial for the total rest sleep can provide, the fire units should allow naps of 30 up to no more than 90 minutes.
- Shift scheduling and overtime work should be planned with regard to the overall state of sleep of the persons involved.
- Acquire tools to monitor the sleep of the personnel in all quality, quantity, regularity and timing.
- Schedule the resting time of the personnel in accordance with the resting time on days off, in order to ensure as much regularity as possible.
- Create a ritual for the period before the sleep interval than can be applied both on shifts an on the days off, this will down-regulate all aspects and increase the quality of sleep.
- Explore meditation or non-sleep deep rest protocols in order to make resting periods more efficient, especially for those who do not use naps during the day.
- Use light in ways that align with the circadian rhythm, sunlight or bright light during the first minutes of being awake and dim or red light before going to sleep.
- Make use of caffeine in order to bust energy without disturbing the sleep, recommend drinking coffee before entering the last 8 to 10 hours of day time. It has been proved that even those who can fall asleep normally after ingesting caffeine have disturbed sleep architecture because of it.

4 Conclusions and discussions

The article represents an operating starting tool to use in order to assess different approaches in safety protocols applied by fire fighter structures. Nonetheless, it is shown that safety and security are highly influenced by a number of factors, such as organizational culture, technological development, as well as the tools used to implement safety policies.

In order to verify the comparative analysis, we looked into the activity of three fire fighting structures from Romania, France and the United States. These structures proved to be rather similar in terms of mission architecture and schedule implementation, which made it clear that implementing similar adaptations should lead to similar improvements in the way long term effects can be reduced.

Fire fighting is a special kind of shift work and the research of the literature and practical know-how indicate that there are a number of long term risks associated to the specificities of the work, such as metabolic disorders, cardiovascular diseases or even reproductive dysfunctions.

With a comprehensive analysis of the literature, the article provides the reader with a science backed list of recommendations that aim at mitigating the long term effects on fire fighters' health. From the need to acknowledge the importance of rest and recovery to the use of small, but significant environmental or organisational changes in order to make fire fighters more efficient without reducing any of the operational capacity, we identified and suggested ways of doing that.

In order to further test the importance of implementing such means, we consider continuing the research with an applied component that will look into the real effects of the

recommendations by conducting a field study. As human research is rather challenging, this component will strive to see if there is a correlation between missing work due to injury and following the recommendations in this article.

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