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# International Good Practices in the Activities of Fire and Disaster Management Organisations[1]

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*All over the world, different countries protect themselves, and their citizens from the effects of fires and accidents with the help of their fire and disaster management services. While executing firefighting or technical rescue and disaster relief tasks, these services use several methods and technical solutions during intervention. The aim is to find the best practices and solutions in the field of technical equipment, organisation and method. The applied methods are the analysis of international publications, papers from the previous years and the author's own domestic and international experiences. The good solutions found in this research that raise the effectiveness and the safety of the fire services (especially in Hungary) are demonstrated in this paper.*

**Keywords:** *fire, fire protection, disaster management, intervention, technical rescue, personal protective equipment, technical equipment, organisation*

## Introduction

Irrespective of continents and economic situations, each state ensures preventive and rescue fire protection and disaster response with the forces established for this purpose. The common elements of each accident, disaster management and fire brigade intervention are the limited available information, the scarcely available forces and equipment, their technical and applicability possibilities, and the issues of logistics. Based on the gained experience, countries and states protect themselves and their citizens from the effects of fires and dangers with the best and most effective methods and possible technical solutions, as well as intervene in firefighting or technical rescue and disaster relief tasks. The experience gained in each country gives birth to good practices, which can also be useful for fire brigade and disaster management organisations in other countries. The presentation of the individual adaptable international solutions, the examination of the possibilities and the application of their adoption can make firefighting in each country more efficient with little effort, equipment and cost. Adaptable fire service development solutions examined

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and presented in this paper can be very wide, ranging from individual special technical solutions (vehicles, special equipment) through organisational issues (such as organisational elements) to personal protective equipment and legal background regulations. The author intends to present the general fire accident situations, taking into account the international differences. The current publications and research results of international authors to be found in this field are primarily performed for international analysis. The conclusions and good practices that can be applied at international level and good solutions to the individual national needs are presented hereby. The author's own on-site, international research results will also be used in the paper. By publishing the article in an international language (English), a wide range of good practices and solutions, which can appear in the fire brigade, equipment or current research activities of each state even in a short time, will be available to professional and scientific readers.

## Methods

The used methods in this paper are the analysis of international and Hungarian publications in English, and professional publications from the past years in the field of fire services and disaster management.

The author also used his own domestic (Hungarian) and international experiences in this field. The illustrations by the author were taken on-site.[3] The pictures demonstrate the solutions, equipment, etc. and the use of their possibilities for adaptation.

## Results – The good experiences found in publications

A review of the international literature in recent years in the field of firefighting, fire protection, and disaster management leads to the following conclusions.

In connection with the fire protection and firefighting activities, Gergő Érces and his co-authors examined the background of each fire protection solution in the built environment, taking into account the life cycle of the buildings. As a good fire protection solution, the use and consideration of actively used passive fire protection equipment are recommended, especially in high-rise buildings or multifunctional buildings that accommodate large numbers of people.[4]

In connection with the topic of preventive fire protection and the analysis of the life cycle of buildings from the fire protection point of view, Gergő Érces and Ágoston

[3] Péter Pántya: Fire, Rescue, Disaster Management. Experiences from Different Countries. *AARMS*, 17, no. 2 (2018). 77–94; Péter Pántya: A katasztrófavédelem beavatkozó hatékonyságának fejlesztése a tűzoltósági területen. *Hadmérnök*, 13, "KÖFOP" Issue (2018). 109–144.

[4] Gergő Érces et al.: The Effects of the Actively Used Reactive and Passive Fire Protection Systems Established by Innovative Fire Protection Methods for Whole Life-Cycle of Buildings. *Műszaki Katonai Közlöny*, 28, no. 4 (2018). 47–58.

Restás emphasised the real consideration of building–man–fire factors during design.[5] In a building that has been in use for decades or more, so-called "white spots" can be detected in the fire protection area, which significantly affect safety. Using the virtual world, digital systems can detect and manage hidden defects and various situations that pose fire hazards in a timely manner.

During various fires, large amounts of heat and smoke are generated in enclosed spaces, which pose a significant direct threat to human life, also causing escape and firefighting difficulties during the intervention. Remaining in the built environment, but with the active participation of firefighters, a case study was published by Rajmund Kuti and his co-authors. In the present research, the issue of artificial, pressurised ventilation has been investigated by mobile devices compared to traditional firefighting without these devices. The significant effectiveness of mobile ventilation fans in extinguishing building fires has been established and precisely demonstrated. The extinguishing time, the air quality and temperature inside the building, the amount of extinguishing agent (water) used, and the operating time of the fire pump are all supported by the effectiveness of the pressurised ventilation during the test. If we consider the secondary damage (fire water damage), then it can be seen from the data published in the article that only 58 litres were needed to suppress the fire for pressurised ventilation compared to the 146 litres fire water use in case of a conventional fire, so about one-third of the expected secondary damage.[6]

There are also several pieces of work on the various fire brigade and disaster management organisational elements and their development in the researched period, considering the past years. In the following, I summarise their main results.

Tamás Igaz-Danszky and József Hesz examined the development possibilities of the operation control in Hungary. By exploring foreign adaptation opportunities, the various applied models and protocols can be improved during an operation, thus there is a chance to increase the life-saving effectiveness. Attention is also drawn to the fact that there is a great deal of research and publication in the field of firefighting tactics and methods, but only a few studies or other investigations have been conducted about the time period and process from the request for assistance to the arrival of the first firefighters.[7]

Ferenc Varga carried out a study about the volunteer fire brigades and their organisational–operational model in Hungary. Based on his research, the role of voluntary fire brigades is outstanding in several respects. It indicates faster arrival and intervention times, and good local knowledge. In addition, the special knowledge and skills of voluntary fire brigades and their members can be well applied in various other types of incidents, such as floods. In terms of maintenance and operation, he underlines that the volunteer fire

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5 Gergő Érces – Ágoston Restás: The Assessment of the Buildings Life Cycle in the View of Fire Protection. *Zeszyty Naukowe SGSP*, 61, no. 1 (2017). 57–69.

6 Rajmund Kuti et al.: Assessing the Impact of Positive Pressure Ventilation on the Building Fire – A Case Study. *International Journal of Geomate*, 15, no. 48 (2018). 16–21.

7 Tamás Igaz-Danszky – József Hesz: Development of Operation Control at Hungarian Disaster Management. In László Bodnár – György Heizler (eds.): *Proceedings of the Fire Engineering and Disaster Management Prerecorded International Scientific Conference*. Budapest, Védelem Tudomány, 2021. 483.

brigade is a highly cost-effective form, given that its members are not paid and can earn their revenue from several sources.[8]

In the topic of civil emergency planning, Tomasz Zwęgliński and Chris Arculeo examined the application of risk management and its effectiveness by comparing the practices in Poland and the United Kingdom. In addition to many partial results, it was found that in general there are many common elements between the two countries, even if the way of each terminology or if certain sub-acts and activities are different. These differences originate from historical or organisational development reasons. It can be seen that great similarities could be discovered for other countries in terms of common life and property protection goals.[9]

Identifying firefighters and fire trucks on the fire scene is also a useful and important issue in the field of firefighting. Péter Pántya and Péter Tomka demonstrated the background and possibilities of this problem in cases of incidents requiring several fire units.[10]

Ferenc Kanyó and his co-author Ildikó Vásárhelyi-Nagy researched about the physical ability test method of firefighters. Their analysis turned to the so-called V4 countries. It means that experiences from similar, close and neighbouring countries can be gained, practically from Hungary, Slovakia, the Czech Republic and Poland. The reader can receive detailed information about the testing phases and the results of the participating firefighters. The authors demonstrate that increasing the effectiveness of firefighting can also be reached through the recruitment processes. A diagnostic tool is needed to test the recruits' ability to perform the special and known rescue activities with the same or similar load.[11]

Paul Grimwood is the author of a significant number of international studies, research and textbooks in the field of firefighting. Examining the past years, it is worth considering the main findings of two of his works relevant to the present topic. He examined the projections of fire spread and its intervention in larger buildings, for example office buildings.[12] In a broader analysis of firefighting tactics, he currently describes good solutions for different situations. Every firefighting and technical rescue is different, but there are still common factors, such as the design of the built environment. The interventions in similar circumstances are described by the author and the possibilities to minimise the danger and raise the effectiveness of firefighting.[13]

In the past decades, photovoltaic systems and the fire suppressions of lithium-ion batteries have attracted more attention. Shohei Namikawa collected and published last year's best practices in the field of photovoltaic systems in terms of firefighting. Good solutions

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8 Ferenc Varga: Structural and Operational Model for Volunteer Fire Brigades. *Hadmérnök*, 13, no. 2 (2018). 345–359.

9 Tomasz Zwęgliński – Chris Arculeo: Risk Management as a Tool of the Civil Emergency Planning in the United Kingdom – Comparison with the Polish Approach. *Internal Security*, 12, no. 2 (2020). 55–82.

10 Péter Pántya – Péter Tomka: Identifying Firefighters and Vehicles on the Fire Ground. In László Bodnár – György Heizler (eds.): *Proceedings of the Fire Engineering and Disaster Management Prerecorded International Scientific Conference.* Budapest, Védelem Tudomány, 2021. 487.

11 Ferenc Kanyó – Ildikó Vásárhelyi-Nagy: Research for New Physical Ability Testing Method for Firefighters in the V4 Countries. *Műszaki Katonai Közlöny*, 29, no. 1 (2019). 161–166.

12 Paul Grimwood: *Euro Firefighter 2. Firefighting Tactics and Fire Engineer's Handbook.* Jeremy Mills Publishing, 2017.

13 Paul Grimwood: Structural Fire Engineering: Realistic 'Travelling Fires' in Large Office Compartments. Technical Perspectives. *International Fire Professional*, no. 25 (2018). 40–44.

and sources of danger have been presented.[14] Related to this, Casey C. Grant studied direct, on-site fire interventions in solar power environment, their potential and specific personal hazards. He has special and direct advice in movement of staff and executing firefighting tasks.[15]

Mohammadmahdi Ghiji et al. examined the fire protection and fire hazard of lithium-ion batteries, and also presented the best options for extinguishing a fire in these special circumstances. As we know, after physical damage or shock a fire can be ignited without any hot temperature. To suppress fire, there are a lot of obstacles and the cooling time takes extra time, hours or days.[16]

Gergő Érces et al. examined the current technical evaluation methods of the Hungarian disaster management organisation. In addition to the preventive situation, the current possibilities and basic goals were presented.[17] To find further directions of development, László Bodnár and Ágoston Restás published solutions in connection with fighting forest fires. In the special issue, the detection of forest fires and their methods of suppression are also presented, preventing them from becoming more widespread and helping to control and suppress them more easily.[18]

Also in the more specialised firefighting areas, the main related results of two works are as follows: In the first case, Mónika Szalai et al. presented an analysis of the danger of rare but severe dust explosions. They cover precisely the analysis and presentation of the whole process of explosions, the feasibility of each examination and the testing mode.[19] The powder can also be combined with firefighter foam as an extinguishing material. László Pimper presented the possibilities and background of this method considering long ranges. In several cases, especially those containing flammable fluids, the range of the firefighting powder is not enough, but using special, combined solutions the range can be extended.[20]

## Special technical equipment and solutions of other countries

Different countries, regardless of continents, have technical equipment that is basically very similar to general firefighting and/or technical rescue activities. The emphasis in

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14 Shohei Namikawa: *Photovoltaics and Firefighters' Operations: Best Practices in Selected Countries.* 2017.

15 Casey C. Grant: Fire Fighter Safety and Emergency Response for Solar Power Systems. *The Fire Protection Research Foundation,* May 2020.

16 Mohammadmahdi Ghiji et al.: A Review of Lithium-Ion Battery Fire Suppression. *Energies*, 13, no. 19 (2020).

17 Gergő Érces et al.: The Technical Evaluation Methods of Disaster Management in Hungary. In Ioan Chirilă – Rudolf Gräf – Alexandru Ozunu (eds.): *12th International Conference on Environmental Legislation, Safety Engineering and Disaster Management.* ELSEDIMA 17–18 May 2018, Cluj-Napoca, Babeș-Bolyai University, 2018. 67.

18 László Bodnár – Ágoston Restás: Examination of the Forest Fires Detection: The Relationship between the Fire and the Detection. In Domingos Xavier Viegas (ed.): *Advances in Forest Fire Research 2018.* Imprensa da Universidade de Coimbra, 2018. 995–1001.

19 Mónika Szalai et al.: Danger of Dust Explosion and Importance of Testing for Explosive Dusts. In László Bodnár – György Heizler (eds.): *Proceedings of the Fire Engineering and Disaster Management Prerecorded International Scientific Conference.* Budapest, Védelem Tudomány, 2021. 134–142.

20 László Pimper: Dry Powder-Foam Dual Agent Firefighting: If the Throw Range of Dry Powder Is too Short. In *Ipari Létesítményi Tűzoltóságok 8. Nemzetközi Konferenciája,* Százhalombatta, FER Tűzoltóság és Szolgáltató Kft., 2015. 1–11.

this section is on which individual technical devices, technical solutions and the use or standby of these solutions are not common, but can prove to be useful for fire brigades in other countries. During the adaptation of these possibilities and their integration into fire protection systems, the safety of the injured people and the interveners may also increase. The firefighting, technical rescue processes and interventions can become faster and more efficient, which result in a lower damage value and a higher saved value.

The images presented in this section were taken on the author's own research trips and illustrate existing, systematic, tested and continuously applied technical tools and solutions. The elements discussed in this subsection primarily serve to open professional and scientific thinking in this direction as worthy and promising sub-areas. The exact technical types and contents to be adapted for each equipment and solution must be preceded and supported by further targeted research.

## *Lighting for a long period at a large area on site*

In the event of poor visibility (e.g. at night), especially in case of protracted fire intervention for at least several hours, the various lighting devices help in terms of both safety and more efficient operations. There are many international solutions from handheld and helmet lights to installable mobile reflectors to fixed solutions built on vehicles. We can find good practical experience for ambient lighting that covers a larger area and ensures the most even light distribution.

*Picture 1: Exercise by a voluntary fire and rescue unit in Romania*
*Source: Photo taken by the author, 2016.*

In the case of its application, more people should be involved and more time should be allocated for installation and later reassembly. Its operation requires no special supervision and its lighting efficiency is significant compared to Picture 1, a smaller and faster, easier-to-install mobile lighting device. Given that the use of this solution is not necessary for the majority of general fire brigade tasks, it may be sufficient to be available at a regional level to support the long-term interventions in poor visibility conditions.

## *Organisational form, technical operation and support of dispatch units*

Examples of merged tasks can be found in several countries. In some regions of Germany, in special cases of Romania (e.g. life-threatening road accidents) or in the United States, ambulance and traditional fire brigade tasks are typically handled by one organisation. In Hungary, dispatch units of professional disaster management (fire department) and police services operate in a common location and the Ambulance Service is a different organisation.[21]

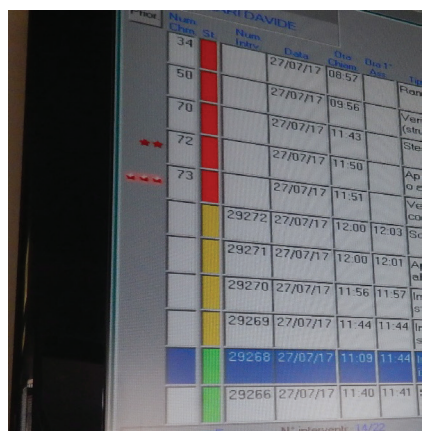
*Picture 2: Dispatch unit in Romania commonly used by the fire department and the ambulance*

*Source: Photo taken by the author, 2016.*

[21] Oszkár Cziva: Doctors in Budapest FB Are not Paramedics. *Védelem- Katasztrófa- Tűz- és Polgári Védelmi Szemle*, 2 (2010). 1–2.

In Romania, the fire department organisation uses ambulance vehicles operated by the fire department in life-threatening cases, which also require the special expertise of the firefighters. The traditional ambulance service is also present in this country. The fire department dispatch units co-operate with the ambulance dispatch units, assisting each other by the officers on duty. A good illustration of this solution is in Picture 2.

Thinking differently about dispatcher units, incidents of different types and severity naturally require the intervention of firefighters. The distinction of fire, technical rescue and lifesaving cases in terms of firefighting force demand in Hungary is defined between 1–5 levels of alarms (in more special cases with the note "Highlighted"). All countries have a similar, ascending classification. In Italy, with a much larger population and number of cases compared with Hungary, only three grades appear to determine the resource requirements for each intervention. Picture 3 illustrates a display at the communication centre in Rome, Italy.




*Picture 3: Fire interventions on a display in Rome at the Central Fire Department – the alarm level is displayed on the left*

*Source: Photo taken by the author, 2017.*

Based on a simple comparison of these two systems, a new research field may arise. A later study can analyse whether it is worth thinking about refining and reorganising the individual national fire brigade evaluation scales. Can a modification in this field make a positive effect on the daily firefighting, technical rescues, or on the individual background processes?

## *The issue of the internal organisational culture of the fire brigade organisation, the motivation of the staff and the strengthening of the recruitment*

The fire brigades in different countries all over the world have a very long tradition. Based on my assumption, this is also proved by the display of long-used, old technical equipment,

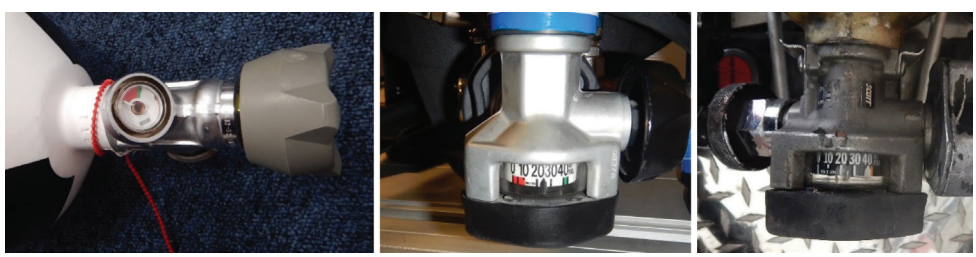
personal protective equipment and diplomas in common rooms. Ensuring organisational attachment can clearly strengthen community affiliation, which can be accompanied by some extra effort that can be deployed during individual preparations and disaster interventions in addition to retaining strength in the organisation. Organised cooperation between the fire brigade organisation and the nearby, protected population, participation in joint events, and voluntary involvement of those interested in fire brigade activities and trainings help to ensure the long-term support.

The extensive poster placement, wide public information and preparatory written publication of the Liverpool Fire Brigade in the United Kingdom to inform the public and ensure the recruitment of firefighters is a good example.

## Technical development opportunities of the fire brigade field

### *Respiratory systems, self-contained breathing apparatuses (SCBA)*

In several countries, system-held respiratory solutions can be found, where the amount of carried air is displayed in different ways. For example, on the neck of each air bottle it can be read immediately and easily; there are more solutions on Picture 4–6. Of course, this is a more costly design compared to simpler bottles, however, in the case of a planned bottle replacement at a regional or national level, a larger order may result in cost reduction. Faster and clearer cylinder pressure readability can be utilised in both routine maintenance and operation at the on-site environment, although clearly to a lesser extent in terms of efficiency gains.



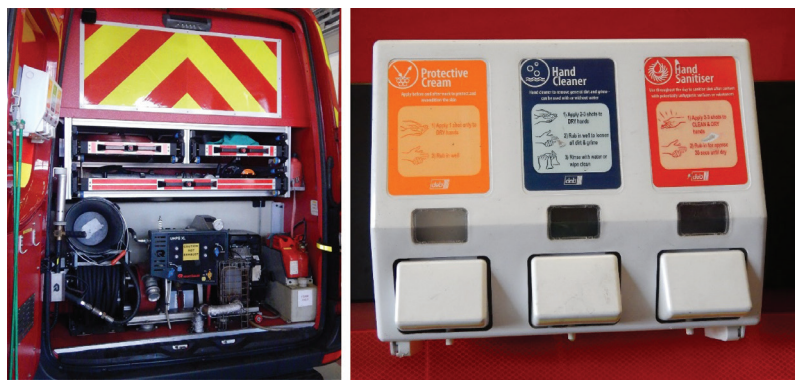
*Picture 4–6: Different solutions to show the internal air pressures (the first and second pictures were taken in Europe and the third one in the United States)*

*Source: Photo taken by the author, 2017.*

Incident environments are not sterile in all cases and in all countries, they can be contaminated in different ways. Briefly reviewing some examples: intervention due to collision and fire ignition of road vehicles, intrusion into closed rooms in an industrial area for firefighting, rescuing people from a smoke-filled high-rise building, extinguishing vegetation fires in a wooded area. Different incidents can even affect the same emergency fire brigade and, what is common, there is no guarantee of individual hygiene protection or a higher level of cleaning of firefighting equipment between different incidents. There

are several good solutions regarding ensuring personal hygiene to the minimum extent necessary, such as disinfecting hands and faces. For this purpose, there are hand-washing and sterilising units with the necessary liquids on emergency fire trucks.

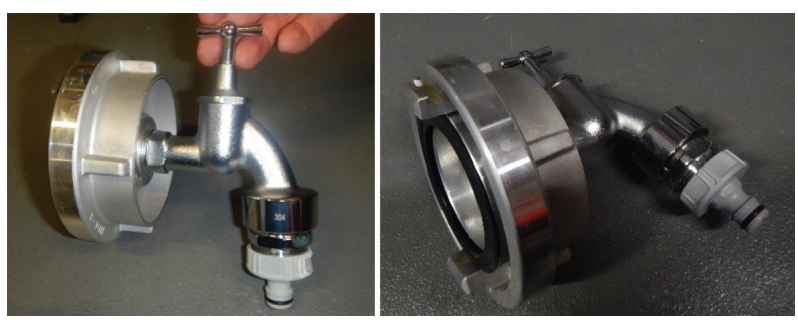
The possibility of basic cleaning at the site of the incident by providing basic cleaning this way also provides a more stable basis for subsequent fire or technical rescue, lifesaving event but also improves the eating and rest conditions of firefighters in case of protracted interventions. There are more good practices in this field in Germany or the United Kingdom, as shown in Picture 7–8.




*Picture 7–8: Installed hand cleaner and sanitiser unit on a fire truck in Newcastle, United Kingdom*

*Source: Photo taken by the author, 2018.*

In connection with this, a device was invented that can be attached to a fire hydrant, by which the available water in the fire hydrant water network – for example, near drinking water quality in Hungary – can be easily accessed, used and conveyed. This tool can be stored in fire trucks, like in Germany (Picture 9–10), but in some places, in Budapest, Hungary they are already installed in fire hydrants. In this latter case, anybody at any time can use the hydrants to have water supplies.



*Picture 9–10: A hydrant faucet tool from a fire engine in Berlin, Germany*

*Source: Photo taken by the author, 2019.*

The use of motorcycles in fire departments is another area recommended for more detailed research considering its goals and necessity. There are already examples how they are implemented. Firefighting tactics can play a role in quick arrival, reconnaissance, or minimal intervention with minimal force. As can be seen in Picture 11, we can find a past example of motorcycles for fire brigades at a fire department in the United Kingdom, which was not used during the period under my review. Based on personal consultations with the relevant U.K. professional fire chiefs, and taking past experience into account, it is justified to keep them in an appropriate environment (e.g. large cities, significant traffic, availability of adequate firefighters).


*Picture 11: Fire motorcycles in the workshop in Liverpool, United Kingdom*

*Source: Photo taken by the author, 2017.*

In a previous study, the author supported the increase in the level of multi-criteria safety and firefighting efficiency that can be achieved by providing the population with free smoke detectors. Continuous awareness of such devices, other fire protection devices and solutions, in general, can be displayed either on the fire brigades' own buildings or, as shown in the example in the following photo, Picture 12, on fire trucks that move frequently in cities and have a large display surface (such as shutters).


*Picture 12: Fire engine with advertising in London, United Kingdom*

*Source: Photo taken by the author, 2017.*

Another example, in the field of ergonomy – also from the United Kingdom – will also be displayed to promote the widest possible use of different firefighting equipment for firefighters with different physical abilities. These changing criteria may include shorter people as well the increasing number of females entering the field of firefighting. Pictures 12 and 13 illustrates different solutions to reach or handle fire tools, equipment. This issue is especially topical in view of the process of recent years, when eligibility criteria of becoming firefighters are being expanded in more and more countries, and the restrictions on admission are being reduced.


*Picture 12–13: Handles and lifted/tilted shelves for easier access of the fire equipment in London, United Kingdom*

*Source: Photo taken by the author, 2017.*

The use of telemetry has been available in the fire departments for many years. In case of firefighters wearing respiratory protective equipment, their existing air volume, and panic alarms can be monitored at an external, safe control point with the typical solutions at the incident sites. Due to the nature of the fire brigade's activity, the command and control points and locations are constantly changing, as are the people supervising firefighters wearing safety and respiratory protection equipment. There are international solutions for the permanent installation of telemetry devices on each fire truck as illustrated in Picture 14. A good practice and example is the solution of some fire brigades in the United Kingdom, where the driver of the vehicle (operator of the pump) can perform this task as well as perform his/her other activities.

*Picture 14: A Draeger Merlin system installed in a fire engine in Liverpool, United Kingdom*

*Source: Photo taken by the author, 2017.*

*Picture 15: Different types of Draeger respiratory telemetric systems in Blyth, United Kingdom*

*Source: Photo taken by the author, 2018.*

Different service, rescue and law enforcement areas and activities may require telemetry systems of different designs and sizes, for which several solutions are illustrated in Picture 15.

Education, training and further training are important areas in all areas of life, but this is especially true in the field of firefighting, which is a dangerous activity carried out to protect persons and property. In many cases, it is necessary to have a high level of skills that can be continuously applied in the standby positions of the fire brigade and disaster management areas. For those holding such positions, it is useful to create an environment as realistic as possible during the various trainings. There are different but good solutions for this field internationally.

Providing firefighters with direct intervention skills at the highest possible level in different fire and rescue incidents and their different environmental conditions have a direct and positive impact on the people to be rescued, the values to be rescued, and on the firefighters intervening in hazardous conditions themselves.

*Picture 16–17: Drill building and Search and Rescue field for firefighters at the Fire Training Academy in Washington, D.C., United States*

*Source: Photo taken by the author, 2017.*

With the durable training tools illustrated in the following pictures, the same phase (e.g. passing through closed doors, extinguishing a building fire, searching and rescuing from ruins) can be practiced multiple times without major damage or wear to the training tools.

What is common in these described training tools and facilities is that they are basically stationary, it is necessary to travel and accommodate the firefighters to be trained. Simulating real building fires or a larger ruined area requires more serious investment and in this case, it is also important to organise proper occupancy. The Main School of Fire Service in Poland has educational equipment and facilities. The images above illustrate training buildings built along similar lines of thought in other countries similarly to those in Poland.

Acquiring the skills required to perform high-altitude firefighting duties is aided by an indoor training range not exposed to the current weather. A good solution for the implementation of weather- and time-independent training is the design in the closed hall, illustrated in Picture 18 below.

*Picture 18: Multiple drill installations simulating tall buildings in a closed hall at the Firefighting Academy of Hamburg, Germany*

*Source: Photo taken by the author, 2017.*

*Picture 19: Installed or transportable practice door in the Central Fire Station, Haifa, Israel*

*Source: Photo taken by the author, 2017.*

Basically, the fire brigades of every nation need to prepare their forces for the expected and country-specific incidents. Countries with longer coastlines and busier traffic should have plans with special training in rescuing, firefighting, or rescuing other objects from water. As shown in the pictures below, they can design a variety of practice tracks, including e.g. boats, and vehicles that can be used to simulate realistic conditions.

*Picture 20–21: Drill ship for simulating open water circumstances and a drill car to be saved at the Firefighting Academy of Hamburg, Germany*

*Source: Photo taken by the author, 2017.*

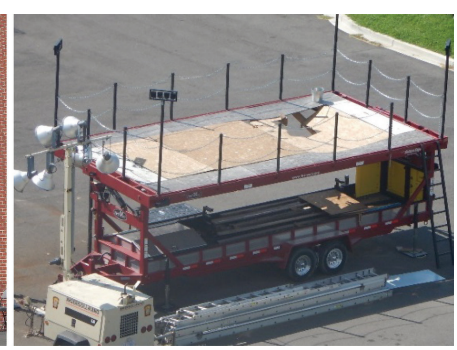
The mobile design of these training tools for application to the affected, trained or retrained firefighters can also be solved, given that generally it is sufficient to repeat specific training a few times a year for the same firefighters. Mobile practice tracks (like in Picture 22) with modifiable design and content ensure the most varied, yet close to reality incident conditions.


*Picture 22: Firefighter practice track in a vehicle combination at the Firefighting Academy of Hamburg, Germany*

*Source: Photo taken by the author, 2017.*

If a nation's fire units need more training, demonstration and practice elements or need to keep the costs lower, they do not have to travel to one central facility. Due to the fact that individual training elements can operate for days or weeks in each location, for example installed in the fire brigades to be trained, several mobile training units can be served with one tractor or other carrier vehicles, ensuring flexibility in terms of needs and lower purchasing and operating costs.

I presented already existing and proven good examples to both solutions. The following two pictures illustrate separately moveable and installable training tracks.

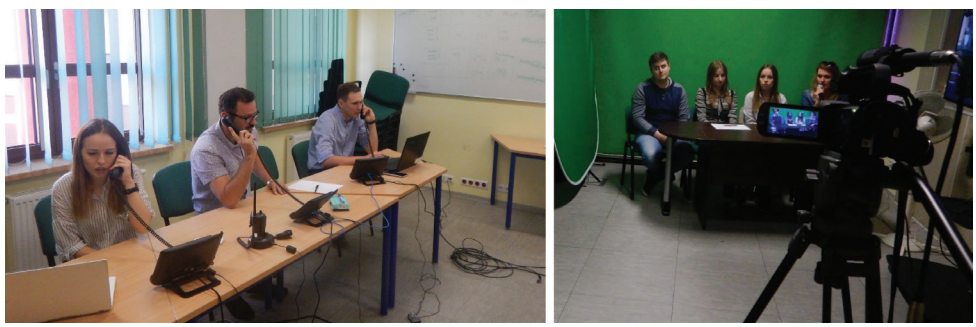
*Picture 23–24: Different towable fire training tracks at the Fire Training Academy in Washington, D.C., United States*

*Source: Photo taken by the author, 2017.*

A mobile exercise tool simulating the internal physical tension of fallen trees is already in use in Germany, about which another paper was published by Kersák and Pántya in 2021.

The importance of retaining knowledge and skills emerges after basic and later higher education. The author published more papers about the usefulness of further training in conditions that are as close to reality as possible, but at the same time, in safe and controllable ways. Higher education in firefighting in Poland also uses good solutions in this field that are useful at international level.

The first area is the various service and duty activities not performed directly at the incident area, but with great responsibility, short preparation time, external monitoring and high stress. Examples are dispatch units, operations management, but also the Press at the scene and disaster communication. Typically designed for this aim, there are teaching, training and further training practice rooms in Warsaw, Poland at the Main School of Fire Service, which have been used for years. The following pictures illustrate that telephone and on-call environments have been set up for students, where firefighters with several years on active duty are also trained to handle mass emergency calls. The author was personally involved in conducting a training for this purpose.



*Picture 25–26: Dispatch training rooms during an exercise and a video studio to practice the tv performance for the students in Warsaw, Poland*

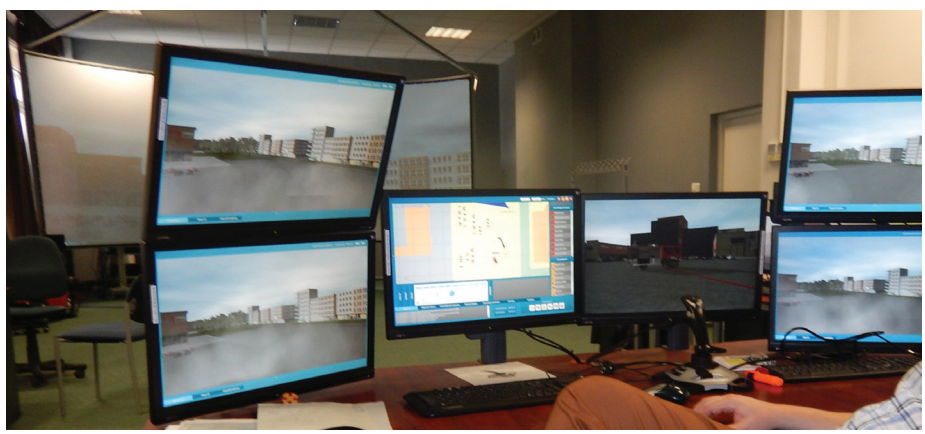
*Source: Photo taken by the author, 2017.*

The second area also worth considering is the training and further training method developed in Poland for firefighters, incident commanders, fire chiefs and other related command positions (e.g. background commander, security officer, etc.). Different types of computer-simulated incident environments, training in this form have been available for many years. It is important to introduce this Polish example because of the complexity of the way and infrastructure of training, and its significant efficiency. Its design is a system that works in a large room, so it can be built and operated at a relatively higher cost. The events displayed on the extra-large screen seen in the back of the following picture show the trainings in almost life-size. During the drill, the fire chief under training, the number one leader of the given and simulated incident can take a seat in front of the screen. At the tables on the left side of the picture additional commanders who play important roles in the given incident scene can sit and participate in the command activity together at the same time.

*Picture 27: Training hall for incident commanders in Warsaw, Poland*

*Source: Photo taken by the author, 2017.*

In the foreground of Picture 28, the operator's workbench is shown, where different floor plans, time periods and weather conditions, fire and rescue types can be set, and continuously modified and the simulated incident itself can be performed over time.

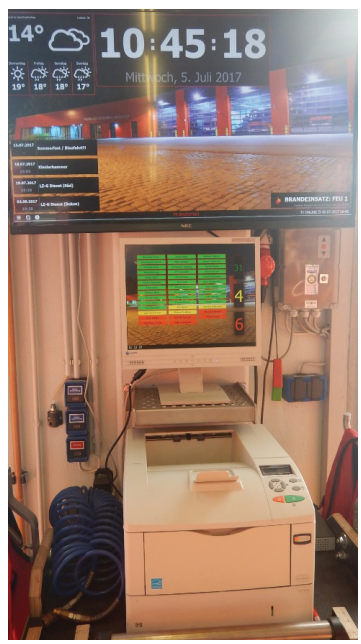


*Picture 28: The operator's desk in the training hall*

*Source: Photo taken by the author, 2017.*

Taking all this into account, it can be seen that special training of the crew command team, even with several participants, can be solved at a high level, and at any time of the year.

After reviewing current good practices in training and further training methods, the author draws the attention to the solutions that can be considered in the field of intervention firefighting. Support for voluntary fire, civil protection and disaster management organisations is paramount in all countries, as complementing and assisting professional forces with voluntary support significantly expand capabilities and reduce workload. Several articles have already dealt with the ways of IT support for voluntary organisations. The following picture shows the complete facility management software of a volunteer fire department created and operated by its own volunteer staff. For a similar purpose, the development of different activities of voluntary organisations on unified IT interfaces can also be useful in the life of the given unit and it does not divert its own resources and costs from the scarce resources.




*Picture 29: Complex alarm system for a voluntary fire station without personal attendance in Lübeck, Germany*

*Source: Photo taken by the author, 2017.*

In case of fire brigade on-site interventions, the applied firefighting equipment has a significant difference in efficiency. It has been seen for years that battery-powered solutions are available for small machines in addition to petrol power supplies (for example: rescue – tension cutters, various cutting tools). They have the advantage of a higher degree of mobility, in addition, their performance reaches or exceeds that of traditional units. Nowadays, it can be seen that in more and more countries, the proportion of battery-powered small machines on fire engines is increasing so much that they are

almost displacing petrol engine powered designs. The pictures below show the various equipment with interchangeable common system batteries in the cargo compartment of a German fire engine.


*Picture 30–31: Battery powered rescue tools with their spare batteries in the charger stations in fire engines in Berlin, Germany*

*Source: Photo taken by the author, 2019.*

Differences can also be found between different firefighting tactics, including the used firefighting equipment and methods. In German practice, the following pictures also illustrate pre-assembled quick hoses (typically type "C" nozzle with flat hoses), which are an alternative to rigid hose quick-acting systems.


*Picture 32–33: Prepared "fast attack" lines, hoses in a fire engine, and a solution with a tilted shelf for the easier accessibility Berlin, Germany*

*Source: Photo taken by the author, 2019.*

As shown in the picture on the top right (tilting shelves, Picture 33) or on the bottom left (folding steps with little space to reach the wheelhouses above the wheel, Picture 34), the design of the fire trucks themselves, and the ergonomic needs can directly contribute to faster and safer equipment handling and retrieval and for general maintenance activities. The several capabilities of the fire command vehicle shown below on the right can be used while standing next to the vehicle, it can be faster, more transparent and manageable for others during different kinds of incidents.


*Picture 34–35: Using all spaces in a fire truck to install mobile steps in Berlin, Germany and outside control, display possibilities in a fire incident commander vehicle in Washington, D.C., United States*

*Source: Photo taken by the author, 2019 and 2017.*

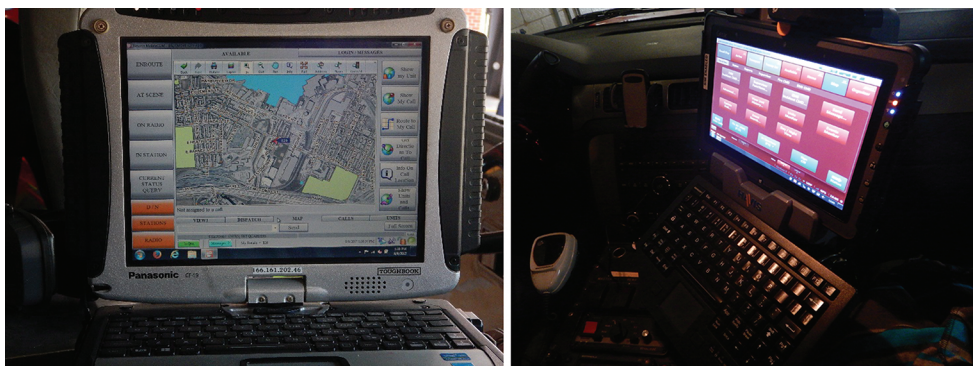
Given the incident challenges of the fire department and the limited transport capacity of fire trucks, it is important to keep multifunction equipment ready, but also to have access to special hand tools. Hand tools, mainly from Anglo–Saxon countries, that have been used successfully, easily and quickly in many situations, such as Halligan bars instead of or in addition to Ferno Norden's Force Rescue Tool, have already appeared in several countries (for example in Poland or Hungary).

The various tools that can be found in the workshop of an average family house become necessary for general firefighting, but even more so for technical rescue tasks. The good solutions shown in the pictures below are the compact, space-saving tool cases, the contents of which are well-suited to their tasks, in addition, whose continuous availability in the fire engine's storerooms is ensured.

*Picture 36–37: Compact, well-equipped tool cases with space-saving in a fire engine in Berlin, Germany*

*Source: Photo taken by the author, 2019.*

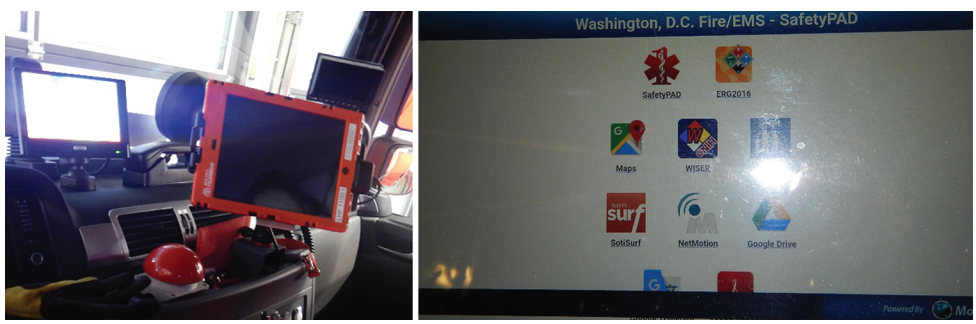
IT tools can provide useful background support for decision-makers, firefighters performing various organisational and management activities, but also for firefighters performing more specialised tasks. Good examples of such solutions are on-board computer terminals, whose software has been developed and kept up to date. These provide a detailed map database of fire alerts with background information (for example hydrants, floor plans, expected occupants, etc.) or hazardous materials or basic information on incident activities at the touch of a button (e.g. fast reports of arrival, general events, etc.). The pictures below show the solutions of several fire brigades in several countries, with different designs and data content, but serving the same purpose.




*Picture 38–39: Special laptop and mobile terminal installed in fire trucks in Baltimore and Washington, D.C., United States*

*Source: Photo taken by the author, 2017.*

Compared to the built-in on-board computers, it is a significant leap in usability if the IT unit (laptop, tablet) is mobile and can be removed from the fire truck (from its dock), thus helping the fire chief's work in various conditions. In these cases, protection against dust and water, good readability in sunlight, protection against damages are important. The solutions presented in the following examples (Picture 40–41) satisfy these conditions.




*Picture 40–41: Special mobile tablets in fire trucks Berlin, Germany and Washington, D.C., United States*

*Source: Photo taken by the author, 2019 and 2017.*

## Discussion

Based on the objectives set out in this paper, additional research areas can be identified that can be considered worthwhile, taking into account existing examples and experiences.

The author considers it worthwhile to research the effect of motivation and the degree of attachment to the organisation on the effectiveness of the interventions performed by firefighters. One of the elements of this may be the presence of recent or past firefighting equipment found in the fire brigades of several countries in common rooms and offices, which can strengthen integration and attachment to the organisation, so an internal motivating force can appear during different firefighting activities, professional tasks performed at a national level. It is more of a social science issue rather than technical, engineering, though.

A good direction is increasing the usability of firefighting vehicles to design more solutions for discharging extinguishing water at multiple points from fire trucks to additional fire engines. Based on developments in recent years, there are several examples of water conveyance in the United States and in Hungary. In addition to the ergonomic improvements in fire engines described in this paper, this can have direct on-site benefits in terms of intervention capabilities.

For reasons of length and due to the limited knowledge, research on alternative propulsion firefighting equipment will only be raised and discussed at a later stage. Here the air system of fire trucks can appear as an energy and power source by designing different connecting surfaces, and the usability of air-operated tools and small machines may be the question: is it worth modifying the current solutions, what are the benefits, advantages or disadvantages?

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