

14th International scientific conference on sustainable, modern and safe transport

## Logistics in the Process of Evacuation of the Population in the Finding of a Booby-Trapped Explosive System

Martin Dzermansky<sup>a\*</sup>, Tomas Krejci<sup>a</sup>, Jitka Trneckova<sup>a</sup>, Zdenek Kalvach<sup>a</sup>, Marketa Habrova<sup>a</sup>, Nikola Cajkova<sup>a</sup>

<sup>a</sup> Tomas Bata University in Zlin, Faculty of Applied Informatic, Nad stranemi 4511, Czech Republic

---

### Abstract

Every day, emergencies endanger people who are at risk of injury and, in worse cases, death. It is even worse when another person is responsible for the loss of human life. In recent years, we have encountered attacks on places where a large number of people gather, such as concerts, shopping malls, or even Christmas markets. This work focuses on logistics in the process of evacuating the population when finding a booby-trapped explosive system that aims to injure as many people as possible. For better orientation, a model situation is created in the Zlin Malenovice Shopping Center, during which the routes of the IRS to the place of intervention and their dislocation are also outlined.

The work aims to point out the model situation of the attack in the Shopping Center Zlín Malenovice and the logistics of the IRS.

© 2021 The Authors. Published by ELSEVIER B.V.

This is an open access article under the CC BY-NC-ND license (<https://creativecommons.org/licenses/by-nc-nd/4.0>)

Peer-review under responsibility of the scientific committee of the TRANSCOM 2021: 14th International scientific conference on sustainable, modern and safe transport

*Keywords:* Logistics; evacuation; integrated rescue system; booby-trapped explosive system

---

### 1. Introduction

Logistics is an industry that deals with management methods and analytical techniques in the field of transport and logistics. It is the management of transport and storage activities of the organization, which includes the management of material, information, and financial flows, so that, if possible, the customer's requirements are met. The goal of

---

\* Corresponding author. Tel.: +420775514761.

E-mail address: [m\\_dzermansky@utb.cz](mailto:m_dzermansky@utb.cz)

logistics is to ensure that the right customer receives at the right time, in the right place and the right quantity, and above all the right goods and also quality.

Nowadays, people face more and more attacks, which aim to injure as many people as possible, cause panic, and cause chaos. Shopping centers, public gatherings, sports, and cultural events or other places where is a high concentration of people and where these places are not sufficiently secured are becoming frequent targets.

In such attacks, people need to be able to evacuate from a place as quickly as possible. The material and logistical equipment of the IRS, which can transport the endangered population from a place of danger, can also be used for this purpose.

The IRS plays an important role in rescue and liquidation work in dealing with emergencies. Depending on the nature of the emergency, it intervenes according to the type of activities that define the individual tasks of the components of the IRS system and their coordinated action.

## **2. Logistics and terrorist attacks**

Logistics is an industry that deals with management methods and analytical techniques in the field of transport and logistics. It is the management of transport and storage activities of the organization, which includes the management of material, information, and financial flows, so that, if possible, the customer's requirements are met. The goal of logistics is to ensure that the right customer receives at the right time, in the right place and the right quantity, and above all the right goods and also quality. Logistics (c2011-2016)

Terrorist attacks are characterized by their difficult predictability. The attackers choose their targets to destabilize them by causing fear. Their aim is not only to cause damage to the life and health of a larger number of people or property at the time of the attack but also to cripple the feeling of security in society. Successful management of such a situation is also preceded by the readiness of the components of the IRS to respond operationally to events. The presented article deals with an example of a model situation, which describes the method of logistical security within a terrorist attack. Centro Zlin is chosen as the reference object, it is a shopping center in Zlin - Malenovice. Kalvach, (2016); Rehak et al. (2018.)

An example is a terrorist attack in a shopping center. A serious incident with tragic consequences took place in a luxury shopping center called Westgate in Nairobi. The event took place between 21 and 24 September 2013, when at least 72 people lost their lives and more than 200 were injured. The shopping center had more than 80 shops and several luxury restaurants. The place was generally perceived as safe, with weekend attendance reaching up to 10,000 shoppers. The attackers belonged to an Islamic militant group called Al-Shabaab, part of al-Qaeda. The attack was carried out by at least 4 terrorists, who purposefully searched for and killed visitors to the center, regardless of age. If anyone was able to prove he was a Muslim, he was released. Grenades and assault rifles were used for the attack itself. In addition to the police, the army also took part in the intervention. The security forces managed to get the situation under control after four days. An anonymous threatening bomb (2020)

## **3. Shopping Center Zlin Malenovice**

Shopping Center Zlin Malenovice is located in the city district Zlin - Malenovice. This is a peripheral part that is not part of typical urban development. On the north side, the shopping center is separated from the industrial area of roads No. 49, Class 3 May. The rest is an undeveloped area. The shopping center has more than 90 shops and restaurants, there are over 1,200 parking spaces.

The model situation assumes the finding of a booby-trapped explosive system - semtex in a plastic bag with a total weight of 5 kg. This finding is reported to the emergency line by members of commercial security, who found the bag at one of the benches located inside the shopping center. Shopping Centre Zlin – Malenovice (2020)

## **4. Material Security of the Integrated Rescue System**

The IRS is defined in Act No. 239/2000 Coll., On the IRS as a coordinated procedure of its components in the preparation for emergencies and the performance of rescue and liquidation work. The IRS, hereinafter referred to as IRS can be divided into basic and other components. Šenovský, et al. (2007)

The basic components of the IRS are:

- Fire and Rescue Service of the Czech Republic.
- Fire protection units included in the area coverage of the region by fire protection units.
- Emergency medical service providers.
- Police of the Czech Republic.

Other components of the IRS are:

- Dedicated forces and resources of the armed forces.
- Other rescue corps.
- Public health authorities.
- Professional emergency and other services.
- Civil protection equipment.
- Nonprofit organizations.

The IRS was created as a need for coordination between individual units, which are now governed in the event of emergencies by typical activities, which state their tasks in the intervention. Today, we encounter many types of emergencies that need to be addressed. Within logistics, one can encounter the emergence of negative factors that threaten not only people's lives and health but also their property. When dealing with emergencies, it is also necessary to take into account the logistical support of the IRS.

Logistics provides a set of measures, services, materials, persons, funds, and relationships that create a precondition for timely, effective, and efficient activities of IRS units in solving their tasks and in preparing for emergencies and rescue and liquidation work.

One of the most important aspects is material security, without which it would be very difficult to deal with emergencies. Each of the IRS units has specific material security, which it also handles during emergency response. Law. Czech Republic. § 17 Act No. 239/2000 (2000).

#### 4.1. *Emergency Medical Service*

- The medical rescue service hereinafter referred to as the emergency medical service, is a part of the system of medical services provided on the territory of the Czech Republic. One of the most basic tasks is the provision of pre-hospital emergency care. The emergency medical service is based on Act No. 374/2011 Coll., On the emergency medical service. Obligations and requirements for equipment are imposed by Decree No. 296/2012 Coll., Which mentions the requirements for the equipment of the provider of medical transport services, providers of medical rescue services, and providers of transport of patients in urgent care through transport and requirements for these means of transport. Selected equipment of vehicles for patient transport can include: Stretcher equipped with a restraint system for children and adults, transport tarpaulin, automatic external defibrillator, hand-held breathing apparatus, oxygen cylinder with 2L content, disinfectants, disposable, and sterile surgical gloves, vehicle radio, and others. Šenovský, et al. (2007)

#### 4.2. *Fire brigade and fire protection units*

The fire and rescue service hereinafter referred to as the fire and rescue service, and fire protection units form part of the fire protection system in the Czech Republic. The Fire and Rescue Service was established by Act No. 238/2000 Coll., On the Fire and Rescue Service, which is currently defined as Act No. 320/2015 Coll. The fire brigade performs tasks in the area of fire protection, IRS, population protection, and crisis management. Šenovský, et al. (2007).

The material equipment of the fire brigade units represents:

- CAS 24-2500-250-M1T (PZL 102) – 1Z7 6958.
- AZ 37-M1Z (PZL 103) – 5Z0 8238.
- AP 42-S1V (PZL 104) – ZLA 04-40.
- CAS 30-9000-540-S3VH (PZL 107) – 3Z5 7567.
- TACH\_S1 (PZL 109) - ZLK 44-44.
- PKN-S3Z (PZL 116) - 4Z9 9156.
- KHA 32-2000-2500-3000-S3R (PZL 117) - ZL 34-03.

- UA-UL1 (PZL 128) - 3Z6 6569.
- BUS-S1Z (PZL 128) - 4Z9 1789.
- OA-UL1 - 2Z8 9220. (Technical equipment at the Zlin station, 2020)

#### 4.3. Police of the Czech Republic

The Police of the Czech Republic is a unified security force, which was established by a law of the Czech National Council and its main task is to protect the security of persons, property, public order, and the prevention of crime. The Police of the Czech Republic is based on Act No. 273/2008 Coll., On the Police of the Czech Republic.

The logistical support of the police of the Czech Republic in crisis management can be compared to any other logistical branch of human activity. To deal with extraordinary events and crises, the police of the Czech Republic use the same technical means as in their normal activities. These activities consist mainly of providing conditions for rescue work, which in most cases are carried out by other specialized components of the IRS. Šenovský, et al. (2007).

### 5. Evacuation

As a result of the emergency, a full-building evacuation is announced. When evacuating people, the emphasis is placed on safety and timeliness. In the case of a shopping center, it is appropriate that the building, because of the increased concentration of people, be divided into sectors and appropriate escape routes, which will allow faster exit of endangered areas.

The direction of escape routes can be determined through safety markings, which must be visibly located. As a general rule, information signs in the direction of escape must be visible and recognizable for as long as is necessary to leave the object. Their use is conditioned by the requirement for easy identification, especially for cases of extraordinary events, when endangered persons are exposed to a risky situation and judgment is thus reduced as a result of panic. There is a possibility that visitors will not try to find the shortest possible route, but will want to use the route that they entered the object and which is known to them. Hradil et al. (2018)

Before the arrival of the IRS units, support for the present visitors can be provided by the staff of the security agency, as persons who have local knowledge and have been trained for evacuation management purposes. Another means of support are recorded messages, which are broadcast by radio in the event of an alarm. Induction loops should be used for the hard of hearing and hard of hearing. Kratochvílová et al. (2013).

The entrances for visitors' access to the building primarily serve as escape routes. The building also has other entrances that are not normally accessible, but in the event of an emergency, the emphasis is placed on their usability in terms of escape routes. Since the normal visitor is not aware of their existence, it is advisable to provide them with a light signal in addition to the security markings, which is subject to the announcement of an alarm and thus ensure their easier finding.

After leaving the building, visitors get to the open space. Persons who do not require further care are informed of the requirement to leave the scene immediately. Persons who require medical or psychological assistance are directed to the assembly point, which in this case is an operationally defined area at a safe distance with easy access. The rescue of persons who were not able to leave the premises of the affected building independently takes place under the auspices of the IRS units.

In the event of an emergency of a similar nature, possible complications must be taken into account. These include: reduced mobility of people, the need for special care for children and people with disabilities, limited entry options due to damage to the object after an explosion, a high number of injured people, time distress and panic, people trying to return to the building. CZECH. Government Decree No. 375/2017, (2017).

- TerEx SW from T-SOFT is used for the model situation. This model uses a booby-trapped explosive system, specifically semtex, which is stored in a plastic bag with a total weight of 5 kg. In the first image, you can observe information about the circles that define the types of tracks and their distance from the epicenter.

EXPLOSIVE - nástražný výbušný systém

Vstupní parametry	
Hmotnost nálože	5 kg
Typ výbuštiny v náloži	Semtex

Výsledek výpočtu	
Bezpečnostní vzdálenost pro nekruté osoby	481 m
Ohrožení osob uvnitř budov okenním sklem	66 m
Ohrožení osob mimo budovy závažným poraněním	32 m
Závažné poškození budov	20 m

EVAKUACE DO VZDÁLENOSTI **481 m**

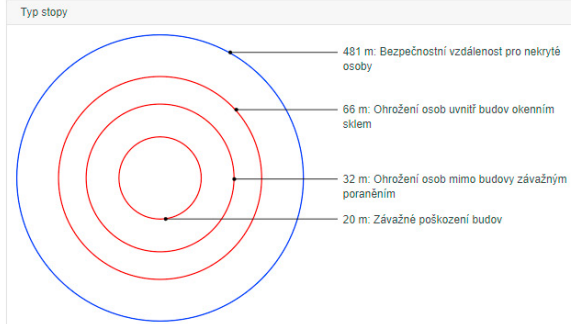


Fig. 1. Booby-trapped explosive system.

The second image shows a blue slice indicating the necessary evacuation. The calculation from the previous picture showed that when a booby-trapped explosive system - semtex weighing 5 kg, it would be necessary to evacuate a population of 481 m. In the range of 20 m, there would be serious damage to the building and 66 m endangering people inside buildings with window glass.

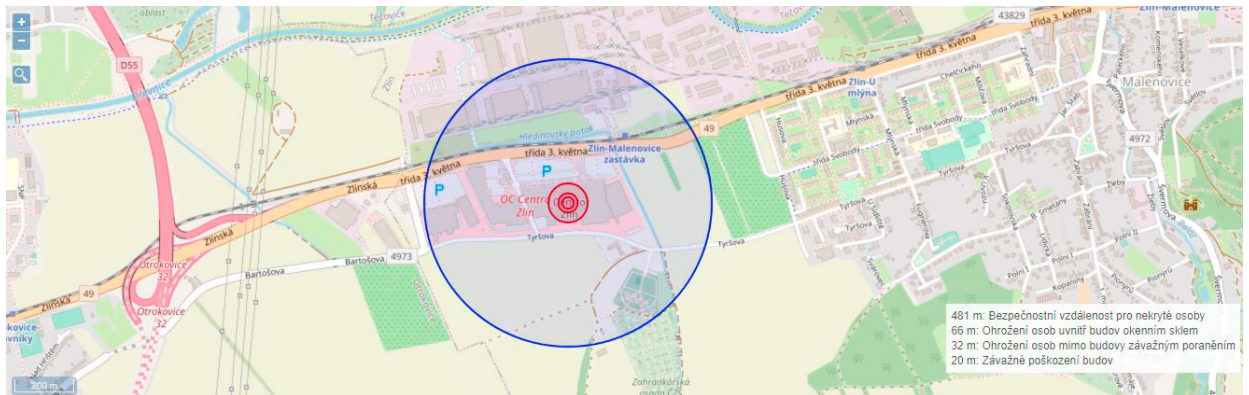


Fig. 2. Urgent evacuation.

The last image, which is output by SW TerEx, shows a graph indicating the shock wave overpressure. The graph is given in meters and, in addition to the shock wave overpressure, it also shows the information on serious damage to the building, danger to persons outside the building from serious injuries, and danger to persons inside the building through window glass.

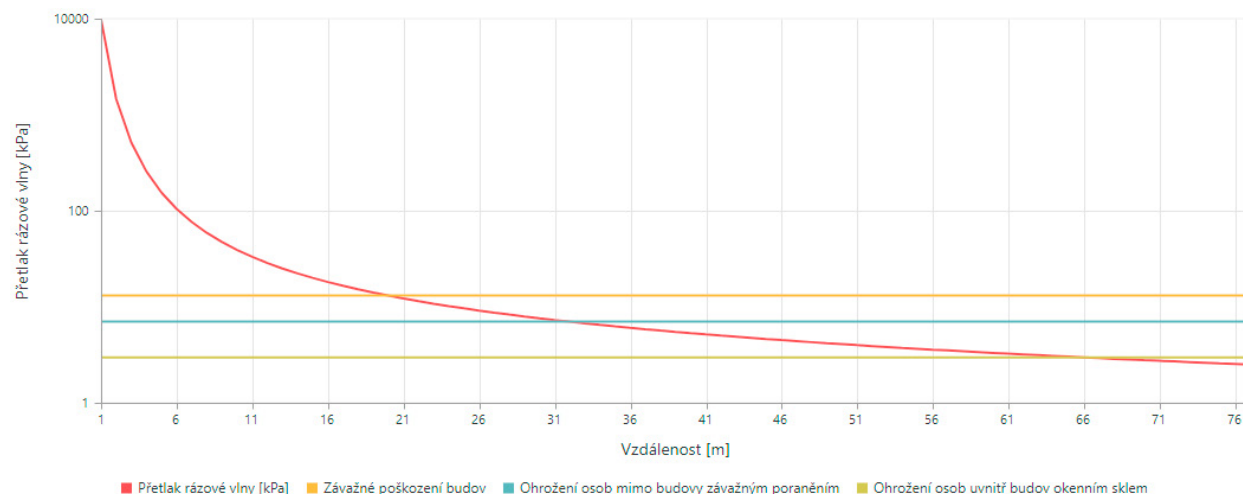


Fig. 3. Threat chart

In the event of this type of threat, it is necessary to immediately evacuate all visitors to the shopping center. It is necessary to cause as little panic as possible and to manage the evacuation by an authorized person. As a rule, this evacuation should be managed by the components of the IRS and follow the type activity, namely type activity No. 3 - Threat of booby-trapped system use or finding booby-trapped system, suspicious object, ammunition, explosives, and explosive objects.

According to this type of activity, the place of intervention should be divided and a place for the concentration of forces and resources, evacuees, storage of personal belongings and property of disabled persons with secured guarding, place for treatment of wounded, and place for the transmission of information to media.

Spontaneous evacuation can be considered for this event when most visitors to the shopping center would be able to evacuate themselves, as the shopping center is located on the outskirts of the city, where most visitors are transported by car. However, this evacuation would have to be controlled by the police to avoid a traffic collision, and other vehicles would have to be prevented from entering the affected area.

It is also necessary to have a defined route for the fastest possible arrival of the components of the IRS. In the attached map data created in the SW QGIS, these routes are shown, where the components could get to the place of notification of the booby-trapped explosive system as quickly as possible and start its destruction and evacuation.

The map marked as IRS in Zlin shows the location of the basic components of the IRS in the City of Zlin and Malenovice. These are three stations of the medical rescue service of the Zlin Region shown in yellow circles in the picture. Blue circles mark the places where various departments of the Police of the Czech Republic are located, and the last red circles show the stations of the Fire and Rescue Service of the Zlin Region. There are also marked routes by which the individual components of the IRS get the fastest to the place of intervention marked by a green polygon Bernatik, et al. (2013).

The picture below shows the stations of the fire and rescue service of the cities of Zlin and Malenovice and their route to the building, ie to the Malenovice shopping center. When the booby-trapped system is found, the IRS ensures the tasks of receiving notifications, conducting proceedings at the tactical level, communicates with other IRS units, secures the intervening forces of the Police of the Czech Republic, implements measures preventing the spread of the effects of an emergency and more.

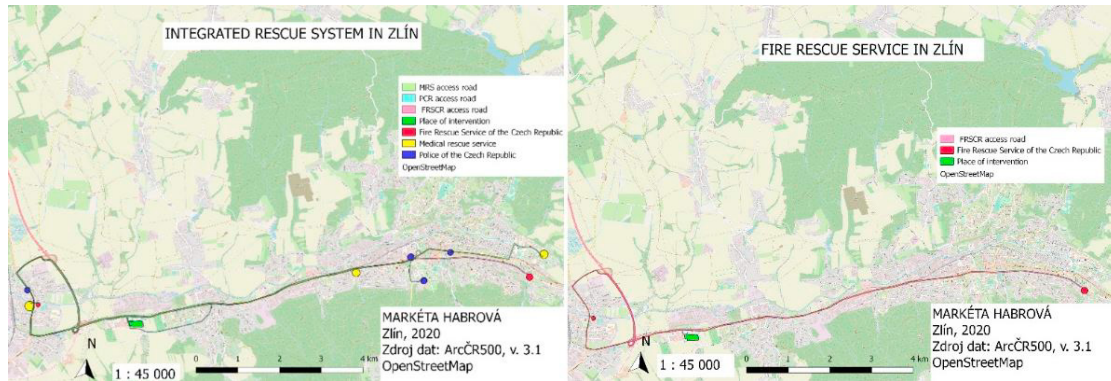


Fig. 4. IRS and Fire Rescue Service in Zlín

Figure 5 shows the dislocation of the medical rescue service, which is also involved in rescue work within the IRS. During this event, the ambulance service performs tasks primarily in the area of providing pre-hospital emergency care and transport of wounded persons to hospital facilities.

In the same figure is the deployment of the police of the Czech Republic and, as with other components of the IRS, their route to the Malenovice shopping center. When reporting a finding of a booby-trapped system, the police primarily protect the safety of persons and property, activities aimed at inspecting a suspicious object and disposing of the booby-trapped system, ensuring the protection of the population and closing the point of intervention, and restricting persons entering.

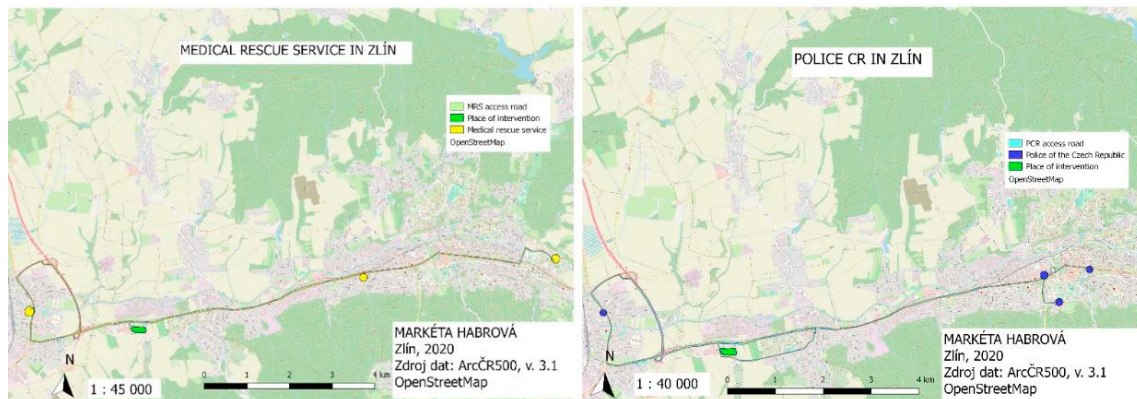


Fig. 5. Medical Rescue Service and Police CR in Zlín.

## 6. Methods

The modeling method which can be described as a simplified picture of reality was used in this work. This method was used to display the route and dislocation of the IRS of the city of Zlín and the adjacent part of Malenovice. This dislocation was visualized using the QGIS application.

The method was further used in the model situation of finding a booby-trapped explosive system, which was implemented in the TerEx program from the company T-SOFT. (Lorenc. M, 2013)

## 7. Conclusion

In the event of an emergency, there is a risk of personal injury or, in worse cases, death. To minimize the loss of life is need to be properly prepared for these emergencies. An important role in dealing with an emergency is its early detection, the transmission of information about imminent danger to defined locations, correct and rapid decision-making by security staff, coordination of all rescue activities, coordinated evacuation of people from the threat, organized intervention of IRS, and last but not least the endangered persons themselves.

The units of the IRS must be prepared for all possible variants and scenarios of emergencies. Pre-created type activities are used to practice these extraordinary events. IRS units are controlled by type activities, of which there are a total of 16. It describes their tasks and the procedure they follow in the event of an emergency.

Situation modeling is a good tool for displaying exercises that can not only check the individual components of the IRS but also streamline their rescue and liquidation work. A total of two programs were used in this work for these model situations. The first program was the QGIS tool, which displayed the routes of the IRS to the crash site and their dislocation. The second program was the TerEx tool, in which a booby-trapped explosive system was defined, namely semtex, which was stored in a plastic bag weighing 5 kg. The output is then a display of the necessary evacuation in the range from the accident site.

The work aimed to point out the model situation of the attack in the Shopping Center Zlín Malenovice, which occurred with the help of the mentioned tools and modeling methods. The second goal was also to point out the logistics of the IRS, where the logistics of the relevant IRS units and the display of their optimal route to the accident site were announced.

## Acknowledgments

This research was supported by the Internal Grant Agency of Tomas Bata University under project No. IGA/FAI/2021/003.

## References

- An anonymous threatening bomb in Kaufland stores pretended to be an Islamic terrorist. Tydenik policie [online]. Prague: Tydenik Policie, 2020, Available from: <https://tydenikpolicie.cz/anonym-vyhrozuji-bombou-v-prodejnach-kaufland-se-vydaval-za-islamskeho-teroristu/>.
- Bernatik, A., Senovsky, P., Senovsky, M., et al. 2013. Territorial Risk Analysis and Mapping. LP2013 – 14<sup>th</sup> Symposium on Loss Prevention and Safety Promotion in the Process Industries, Vols I and II Book Series: Chemical Engineering Transactions, Volume: 31, p. 79-84.
- CZECH. Government Decree No. 375/2017 of 13 November 2017 on the appearance, location and design of safety signs and markings and the introduction of signals. Available from: <https://www.zakonyprolidi.cz/en/2017-375?citace=1>.
- Emergency Medical Service Zlín Region. ZZS Zlín [online]. Zlín: ZZS Zlín, c2020. Available from: [http://www.zszs.zlin.cz/stranka\\_vypis.php?id=2&dd=o\\_nas](http://www.zszs.zlin.cz/stranka_vypis.php?id=2&dd=o_nas).
- Hradil, J.; Mika, J. O.; Musil, M.; Svoboda, B.; Rak, J. & Vičar, D. (2018). Základy ochrany obyvatelstva v České republice, ISBN 978-80-7454-774-4, Bezpečnost společnosti.
- Kalvach, Z. Basics of soft targets protection - guidelines (2nd version) [online]. 2. Prague: Soft Targets Protection Institute, z.ú., 2016. Available from: <https://www.mvcr.cz/cthh/soubor/basics-of-soft-target-protection-guidelines.aspx>.
- Kratochvílová, D.; Kratochvílová, D. & Folwarczny, L. (2013). Ochrana obyvatelstva, ISBN 978-80-7385-134-7, Sdružení požárního a bezpečnostního inženýrství.
- Law. Czech Republic. § 17 zákona č. 239/2000 Sb., o integrovaném záchranném systému a o změně některých zákonů. In: *Zákony pro lidi.cz* [online]. © AION CS 2010-2020 [cit. 15. 9. 2020]. Dostupné z: <https://www.zakonyprolidi.cz/cs/2000-239#p1>
- Logistics. Management mania [online]. Prague: Management mania, c2011-2016. Available from: <https://managementmania.com/cs/logistika-a-doprava>.
- Lorenc. M (2013). Final work – methodology, Available from: <https://lorenc.info/zaverecne-prace>.
- Rehak, D., Senovsky P., Hromada M., Lovecek, T. & Novotny, P. Cascading Impact Assessment in a Critical Infrastructure System. *International Journal of Critical Infrastructure Protection* [online]. 2018, vol. 22, s. 125-138. ISSN 1874-5482. Available from: <https://www.sciencedirect.com/science/article/pii/S1874548215300251>.
- Šenovský, M.; Adamec, V. & Hanuška, Z. (2007). Integrovaný záchranný systém, ISBN 978-80-7385-134-7, Sdružení požárního a bezpečnostního inženýrství.
- Shopping Centre Zlín - Malenovice. Centrozlin [online]. Zlín: centrozlin, c2020. Available from: <https://www.centrozlin.cz/>
- Technical equipment at the Zlín station. HZSCR [online]. Zlín: HZSCR, c2020. Available from: <https://www.hzscr.cz/clanek/technika-na-stanici-zlin.aspx>.