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The Evaluation System to Ensure the Transport of Emergency Supplies of Fuel to the Hospitals

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Abstract

Nowadays we can see an increase of emergency and crisis. One of these may be a power outage. However, this can also be a cascade effect because of the windshield. Hospitals are a critical infrastructure sector where it is essential to ensure a constant supply of electricity. At the time of the power outage aggregates are used for which it is necessary to provide the supply of fuel. Each hospital has different stocks of fuel and therefore needs emergency supplies of this raw material. For this purpose, an assessment system is proposed for hospitals, but also for regions, which would determine the current state of fuel availability in hospitals in the area.

The aim of this paper is to introduce an assessment system for providing emergency supplies of fuel deliveries to hospitals in the event of a power outage. The paper will address hospital capacities regarding fuel stocks in the event of an outage. In the next part, the analysis of selected hospitals and their subsequent comparison will be carried out. Furthermore, the area of emergency fuel supplies for hospitals will be addressed. At the end of the paper, an assessment system will be designed to ensure the delivery of emergency fuel supplies.

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Keywords: Evaluation system; emergency supply; hospitals; emergency management; critical infrastrcuture

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1. Introduction

We can see the increasing number of emergencies and crisis. These situations affect life, health, and property of the inhabitants. According to Cioca, a person lives in an environment that is constantly exposed to a variety of more or less dangerous situations that arise from many factors. Extreme natural phenomena such as storms, floods, droughts, landslides, earthquakes, and others, other than technological accidents (such as heavy pollution) and conflict situations, can directly affect the life of every person and society as a whole (Cioca, 2010). Natural disasters are among the most expensive, deadly and dreaded events of humankind (Blakie, 2005), which have a huge impact on the general public (Jie, 2001) and have the potential to kill thousands of people within minutes (Heindaranlu, 2015). Sena notes that natural disasters caused by extreme weather events have increased in recent years (Sena, 2014).

Next, these situations can affect the disruption of the state infrastructure. Systems that are called critical infrastructure can be considered. The critical infrastructure system must be viewed comprehensively (Rehak, 2016a). The critical infrastructure protection in the Czech Republic was implemented in the Crisis Management field (Rehak, 2016b). The critical infrastructure may be damaged, destroyed or disrupted by deliberate terrorist acts, natural disasters, negligence, accidents or computer hackery, criminal acts and bad faith motivated behavior (Green Paper, 2005).

The consequences of the action of these effects and threats cause disruptions or failures of operational parameters of the critical infrastructure elements (Rehak, 2016, a). Breaking the critical infrastructure system would have a serious impact on the state's security, maintaining the basic living needs of the population, people's health, or the state's economy (Rehak, 2016c)

Important factors forming the nature of impacts are their intensity and duration of action. The intensity of impacts depends not only on the failure range in the sector, which further acts on another sector of critical infrastructure but also on the level of their mutual linkages and dependencies (Rehak, 2016a). Next Rehak defines synergic action as the effect of the action is of a multiway nature (e.g., a combination of direct and indirect actions) and takes place simultaneously in real time (Arab, 2009). The “bottom-up” approach was applied for an early indication of the impacts. This approach and assessment system should be based on determining indicators of resilience disruption for interconnected sectors of critical infrastructure. The essence of this approach is a systematic approach consisting of a cross-sectoral assessment based on an investigation of mutual linkages between individual sectors of critical infrastructure. It reflects the propagation of cascade impacts and synergies in the critical infrastructure system. [6] The example could be seen in Fig. 1. The blackout impact of the natural disaster.

The Czech Republic defines the sectoral criteria for identifying the critical infrastructure element. Healthcare is also one of the critical sectors of critical infrastructure. It is essential that healthcare can perform its function, even in an emergency or crisis. The damage, disruption or failure of an important (critical) element has a more or less significant impact depending on the number and nature of linkages determining the degree of its influence, dependence or interdependence (Rehak, 2016a). In Slovakia, the problem of complex risk management in the field of critical traffic infrastructure is quite new. There is no singular methodological approach designed for objective identification of the elements of so-called critical infrastructures in defined areas so-called sectors (Leitner, 2015).

One of the problems of crisis preparedness of the hospitals are fuel emergency supplies. In the event of a crisis, a power outage may occur. It is caused by the mentioned cascading effect of the disruption of the critical infrastructure. One of the problems could cause spreading other issues.

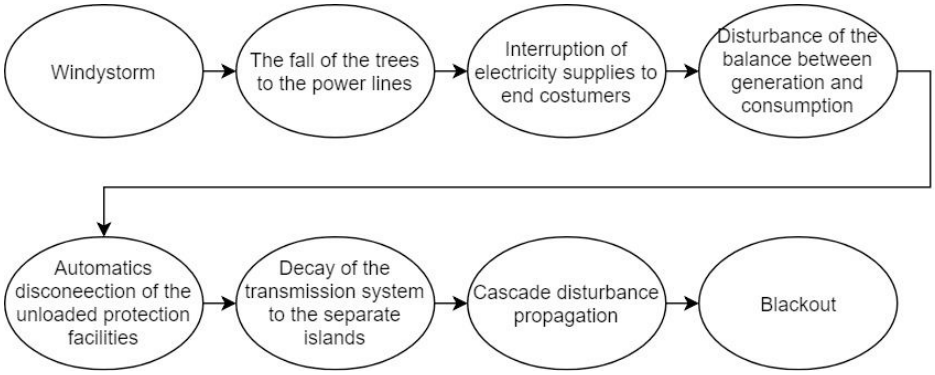

Fig. 1. The blackout impact of the natural disaster.

Hospitals are among the healthcare centers whose prompt and efficient services can play a significant role in decreasing disaster mortality rate (Brehovska, 2017). Healthcare facilities providing health care must be adequately staffed, materially and technically equipped for the type and scope of healthcare which they provide (Krajewski, 2005). One of the problems World Health Organization is effective disaster management necessitates having adequate disaster preparedness (World Health Organization, 2008). There is still no standard and valid tool for assessing hospitals (Jenkins, 2009).

The aim of this paper is to present the assessment system to ensure hospitals emergency fuel supplies delivery in times of power outage.

2. Methodology

Four methods of scientific work were used in this article. The method of analysis is used because it uses the principles of logic to achieve the set goal and provide the framework to explore the principles of crisis management and crisis preparedness of the healthcare facilities. The induction method was used, where this method serves to examine the fact of creating a hypothesis from the points obtained. Comparison method allows to evaluate and analyze processes and approaches in healthcare facilities in the Czech Republic. Finally, the heuristic analysis of preparedness was used.

A heuristic analysis of preparedness was developed for the assessment of healthcare facilities. This method is based on a quantitative assessment of the availability of emergency medical facilities. Based on this assessment, we will get an accurate idea of the weaknesses and strengths of the assessed healthcare facilities.

The assessment of the system used a set of assessment questions, which was divided into five categories. As mentioned above, we propose an assessment system for assessing healthcare facilities from an emergency supply point of view, focusing on emergency energy supplies. For this purpose, the results will be presented only emergency fuel supplies in the selected hospitals.

Emergency Energy Supply - this category assesses the preparedness of the healthcare facility for emergency energy supplies - the ownership of energy supply replacement units. However, these aggregates are fuel-dependent, and it is, therefore, necessary to assess fuel supply to the hospital. It deals with the area of contractual fueling, its gas station, etc.

Based on the above analysis, an evaluation was performed using the following formula:

$$HFP = ((R + H) / 2 \times H) \quad (1)$$

Where, HFP = healthcare facility preparedness, R = sum of results (obtained points), H = number of assessed heuristics. The assessment methodology consisted in assigning a response to each question answered in the form of valuation from a predefined set of values (0 = does not meet; 1 = meets; blank field if the problem is not relevant).

3. Results

In this paper of the work, five hospitals were assessed in the Czech Republic. The results could be seen in the Table 1 and Fig. 2. Fourteen regions are in the Czech Republic. Each evaluated hospital is from the various region. Next, there are divided into multiple types of hospitals - faculty hospital, region hospital, town hospital, private hospital.

The proposed method was used to assess the hospital. Firstly, there was assessed hospital from the Zlín region. It is a type of private hospital. This hospital takes 57.14% of the preparedness in the area of emergency energy supply. Secondly, there was assessed hospital from the Middle Czech region. It is a type of region hospital. This hospital takes 33.34% of the preparedness in the area of emergency energy supply. Thirdly, there was assessed hospital from the Southern Moravia region. It is a type of faculty hospital. This hospital takes 94.45% of the preparedness in the area of emergency energy supply. Fourthly, there was assessed hospital from the Hradec Králové region. It is a type of region hospital. This hospital takes 71.43% of the preparedness in the area of emergency energy supply. Finally, there was assessed hospital from Ústí nad Labem region. It is a type of town hospital. This hospital takes 64.29% of the preparedness in the area of emergency energy supply.

Table 1. Analysis of the hospital emergency energy supply.

Region	Type of the hospital	Emergency energy supply (%)
Zlín region	Private hospital	57.14
Middle Czech region	Regional hospital	33.34
South Moravia region	Faculty hospital	94.45
Hradec Králové region	Faculty hospital	71.43
Ústí nad Labem region	Town hospital	64.29

Table 1 shows the assessment of the selected hospital. There was assessed five hospitals from the different regions and different type of the hospital. As can be seen, the best-assessed hospital was hospital from the South Moravia region – faculty hospital. This hospital takes 94.45 percent. On the other hand, the worst assessed hospital was Middle Czech region – regional hospital. This hospital takes only 33.34 percent.

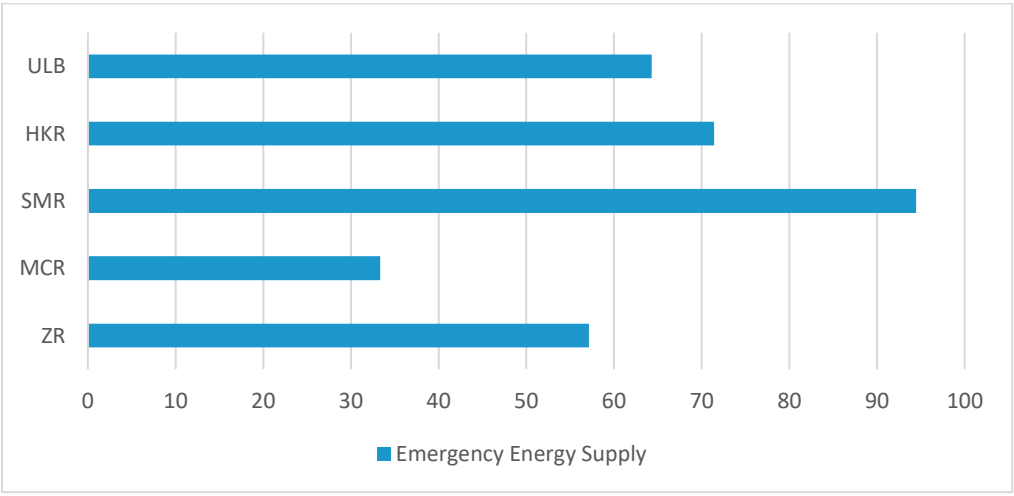

Fig. 2. Comparison analysis of the emergency energy supply.

Figure 2 shows the comparison of the assessed hospitals. From the assessment of the selected hospital is enormous differentiation. There is no valid law to determine the number of aggregates, fuel stocks to aggregates in hospitals in the Czech Republic. Based on this, each hospital is prepared otherwise for a power outage. It has earned an assessment of the selected hospitals.

4. Evaluation System to Ensure the Transport of Energy Supplies of Fuel to the Hospitals

The aim of the paper was to present the assessment system to ensure the hospital emergency fuel supplies deliveries. The propose of this system is a part of the dissertation which solves the propose of an algorithm for assessment of the hospitals. Now, we want to present a proposal of the starting point of the assessment system and final use for practice. Nowadays, there is no information support for this system.

Based on the results of the assessed hospitals, there is enormous differentiation from the selected hospitals. Some of the hospitals have fuel stocks for 12 hours, others for 36 hours. The goal of each state is to provide medical assistance, even in an emergency or crisis. The hospital owner may be a state, a county or a legal entity in the Czech Republic. It then has an impact on the financing of hospitals and their supplies.

Nevertheless, it is the objective of each region that hospitals, in the event of a crisis, provide health care to the affected population. In the event of a power outage, therefore, the region is also a target for hospitals to be supplied with fuel. Each region has its department of crisis management in the Czech Republic. This department also deals with the functioning of the hospitals in times of crisis. That is why the assessment system arises.

It is assumed that the use of this system will not only be within the hospital or more hospitals that cooperate, but also with the regional authority and, where appropriate, with the logistics suppliers of fuels. We will create a web portal that will illustrate hospitals in the region. Each hospital will fill in the data that is needed to calculate the length of hospital maintenance (or only selected rooms), and they will be stored in this portal. When a power failure occurs, the expected power failure interval will be entered. It will make it clear which hospitals can handle this emergency without having to deliver fuel. Otherwise, an external supplier or regional authority (depending on the duration of the power outage) will be sent to the fuel supplier.

All communication would then take the form of “data sentences” that would be documented. These “data sentences” would not only serve to send a request but subsequently to acknowledge the receipt of the application, to submit information about sent environments and quantity.

As a result, it will be both an assessment system, but also an information and communication system.
The following diagram describes the baseline of algorithm design for assessing crisis preparedness in hospitals with a focus on power supply failure (see Fig. 3).

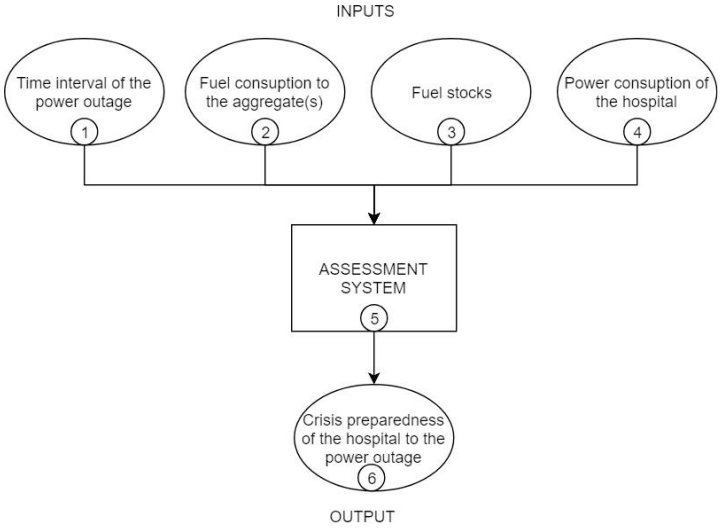

Fig. 3. Baseline of the algorithm.

The figure shows the baseline of an algorithm design as a part of the assessment system. As can be seen, there are four inputs, assessment system, and output. Firstly, there is the input – time interval of the power outage. This input is divided into five categories, based on the number of hours of outage. There is the example – shortage power outage (from six to twelve hours) and on the other hand extremely power outage (more than two days).

Secondly, there is the input – fuel consumption to the aggregates. This input will represent the fuel consumption of all units that are in the hospital for power supply at the time of power supply failure. This input will be expressed in liters per hour. This input will be taken as the fuel consumption in liters / kWh. There is necessarily distribution to diesel and gasoline aggregates.

Thirdly, there is the input – fuel stocks. This input will express fuel stocks that are intended to supply aggregates at a time of power failure. This entry will be shown in letters. Stocks of fuel are usually stored in barrels and tanks. Here, it is important to note that these are non-biofuel fuels can be stored for a long time.

Fourthly, there is the input – power consumption of the hospital. The power input of selected objects in the hospital - this input will represent the power consumption of selected buildings in the hospital, which are designed for an emergency power supply using aggregates at the time of failure of the power supply. This input will be expressed in kWh. The power supply of the hospital varies according to the season. Power consumption will be different in winter and summer season. It will also take into account whether the hospital is going to full traffic or crisis operations.

This information from the inputs goes to the assessment system. Finally, there is the output – crisis preparedness of the hospital to the power outage.

5. Discussion

The aim of this paper was the proposition of assessment system to ensure the hospital emergency fuel supplies deliveries in times of power outage. The crisis threatens the lives, health, and property of citizens. They also endanger the critical infrastructure of the state. The goal of each state is to maintain its security and to provide assistance to its citizens. Hospitals must also blow in times of crisis. Some power crises may occur in some emergencies. It poses a huge problem for hospitals. Their duty is to restore power sources using aggregates and other sources immediately. It is essential for these alternative power sources to be supplied with fuel. It can be a significant problem at the time of a power outage. In this case, it is necessary to introduce an assessment system that would assess the need to provide emergency fuel supplies deliveries to hospitals.

A heuristic analysis of preparedness was selected for the assessment of the hospital emergency energy supply. From the analysis, we can say, that there is enormous differentiation in this area. Some of the hospitals are prepared for long-term power outage and other not.

Secondly, there was the proposal of the starting point of the assessment system and final use for practice. There is a problem with the emergency energy supply in case of power outage. There is no unique way of the amount by the external supplier. It will create a web portal that will illustrate hospitals in the region. This portal will make it clear which hospitals can handle this emergency without having to deliver fuel. Otherwise, an external supplier or regional authority (depending on the duration of the power outage) will be sent to the fuel supplier.

6. Conclusion

The paper aimed to introduce the assessment system to ensure the transport of emergency supplies of fuel to the hospitals. Nowadays, an increase in crises is observed which results in a power outage. Hospitals should provide immediate supplies of spare power. Based on the analysis performed at five hospitals in the Czech Republic, it can be stated that the emergency supply of energy was at a different level. Some hospitals have their supplies for several days of power outage.

On the other hand, some hospitals need supplies in a short time. The region aims to provide health care services (even if they are not the owner the hospital). Therefore, an assessment system was designed to ensure the hospital emergency fuel supplies deliveries. It is not only an assessment system but also information and communication system. The use of this system could be a new module within the Information, Communication and Warning System of the Zlín Region.

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