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Risk Management in the Healthcare Facilities: Case Study

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Abstract

The COVID-19 pandemic has affected the whole world, and we can classify it as a significant disaster in modern history. However, not only a pandemic is the unique disaster that has hit the earth. Due to the increased attention to the pandemic, spent not much attention on the other disasters. There have been forest fires in Australia, floods in Indonesia, volcano eruption in the Philippines, and others in 2020. Several disasters are causing cascading effects that may affect different sectors. Fires or floods are just one of them. The cascade effect can endanger several elements of critical infrastructure, such as the energy sector and healthcare. In healthcare facilities, patients are dependent on electricity supplies. It is therefore essential that the proper functioning of healthcare facilities is maintained. The aim of the paper is to highlight the growing trend in the number of disasters around the world and draw attention to the preparedness of healthcare facilities to solve these disasters. Based on the analysis, we can take the information that there is a big difference in the preparedness of the healthcare facilities to solve a power outage.

Keywords: Risk management; healthcare facilities; power outage; cascade effect; disaster; COVID-19.

1. Introduction

The world is changing and is threatened by a series of disasters. These disasters are different in character and type. Disasters cannot be influenced; the aim is only to minimize the consequences. These disasters lead to a worsening of lives, health, property, the environment, and economic impacts. Society is traditionally dependent on a whole range of infrastructures. (Rehak et al., 2018) Infrastructures are also at risk. Climate change could be responsible for increasing disasters. Climate change is expected to increase the average summer temperatures. (Lebassi-Habtezion and Diffenbaugh, 2013; Tesselaar et al., 2020) Recently, extreme climate change has been occurring globally. (Kim et al., 2019) The complexity of situations and potential error connected to maxi-emergencies and disasters management are increasing in the last years. (Ferretti et al., 2016) Among the disasters where the incidence has increased, wind storms/snowstorms such as hurricanes and typhoons worldwide. (Kim et al., 2019, Zheng et al., 2020, Filipe et al., 2020) It has changed not only in the number of occurrences but also in terms of other seasons, strength, and other characteristics. With these changes, increased power outages may occur due to increased numbers of high-electricity-demand days in the summer and storm-related damage. In recent years, climate change and the associated longer and unpredictable weather events such as drought, hot waves, fires, heavy rain, floods, storms, hurricanes, landslides, etc., have affected several countries. (Luskova, 2018)

Windstorms are among the meteorological extremes that severely impact human society. The spectrum of wind damage is vast, appearing as direct harm to houses and other buildings. (Ulbrich et al., 2013, Brazdil et al., 2018) These situations could have a cascading impact on the infrastructures. It could threaten critical infrastructures – such as healthcare, economics, energy, and other sectors. (Rehak, 2020a; Government Regulation, 2010; Rehak et al., 2018; Council Directive, 2008)

Under current changing climatic conditions, natural hazards are expected to increase in frequency and intensity. (Batima et al., 2013) With time, some independent events can potentially increase negative consequences, whereas others can result in a cascade of failure (domino effect). (Bernatik et al., 2013) The following figure 1 shows the example of cascading effect by Rehak et al. (2018). As can be seen, there could be several threats such as anthropogenic or naturogenic threats that could impact the critical infrastructure system. As was said, there are several sectors of the critical infrastructure. This example is focused on the energy and transport sector. We can see that there are several effects such as direct, cascading, and synergic. Based on these effects on the critical infrastructure sectors, it could impact the state security, economy, and basic human needs. Critical infrastructure is composed of transportation, telecommunication, healthcare, and power supply essential for the functioning of modern society. (Hiete et al., 2011)

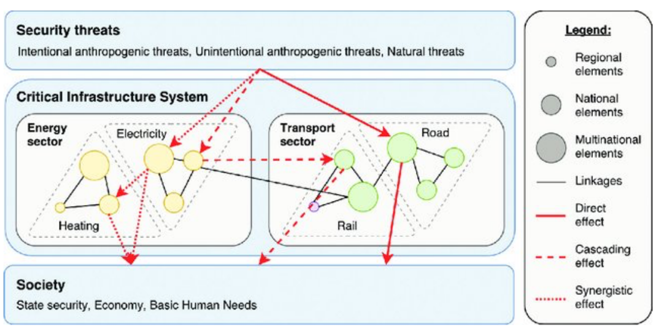

Figure 1. Cascading impact (Rehak et al., 2018)

This research is focused on the cascading effect on healthcare facilities. Electricity interdependence with and impact on the secondary sector is high. (Splichalova et al., 2020) Electric power critical infrastructure represents a highly complex network-based system that includes the generation, transmission, and disruption of electricity. (Rehak et al., 2020b) A guarantee of energy supply is required to ensure continuity of healthcare procedures. (Suszanowicz and Ratuszny, 2019) In conclusion, there is a need to point to the sustainability of the cities, which could reduce disaster damage to critical infrastructure and disruption of basic service, such as the supply of energy. (United Nations, 2015)

The aim of the paper is to highlight the growing trend in the number of disasters around the world and to draw attention to the preparedness of healthcare facilities to solve these disasters.

2. Methodology

The methodology is divided into few parts. Firstly, there will be presented scientific questions. Our goal was to predict natural disasters in the nearest period and our forecast of occurrence for a more extended period. The terms prediction and prognosis are frequently defined differently in the available literature, and their importance in individual scientific fields are typically mixed up. For this article, the prediction is determined as an estimate of the future values of the actual course.

The prognosis will be an estimate of further development of the observed phenomenon over a more extended period.

As already mentioned, the time series data of annual occurrences of natural disasters served as source data have done (Hendl, 2015). The most commonly used time series forecasting models were used to predict the time series. The following models were used: moving averages (2MA) and triple moving averages (3MA), weighted moving averages (2WMA) and triple moving averages (3WMA), exponential smoothing (ES), and the one was a linear regress model (LRM). The mean absolute percentage errors were determined by using metrics to compare forecasts. The linear regression model was unquestionably selected as the most suitable model, see Table 1.

Table 1. Forecasting models.

Forecasting models	2MA	3MA	2WMA	3WMA	ES	LRM
Mean absolute percentage errors [%]	10.22	10.05	10.01	9.33	10.19	6.96

Secondly, there will be presented research in healthcare facilities preparedness in times of power outage. The survey was done in spring 2021. There was addressed about 200 healthcare facilities in the Czech Republic. We take the feedback from the 29 of them. Based on this data, we assess the preparedness of these facilities.

Based on the above analysis, we have conducted an evaluation using the equation (1):

$$\mathrm{HAP} = \frac{R+H}{2.H}.100\% \tag{1}$$

HAP = heuristic analysis of preparedness.

R = sum of the results (acquired points).

H = number or evaluated heuristics.

Finally, there was used the basic methods such as literature review, analysis and comparation.

3. Results

The results are divided into two parts. Firstly, there will be solved the scientific question. Our goal was to predict the occurrence of natural disasters in the nearest time period and also our own forecast of occurrence for a longer time period.

The data set is also represented as curve shown in Figure 2. The whole curve represents the source data with intentionally color-coded period 2003-2019 (blue color). The course of the highlighted part of the curve shows considerable differences from the previous period. Moreover, the amount of data for the years 2003-2019 is certainly sufficient for forecasting. A selected part of the graph can be interlaced with a curve of some mathematical functions and thus predict the value of the phenomenon in the coming year 2020 without making a fatal error. The highest value of the coefficient of determination (R2) was identified in the linear regression model. Therefore, the curve points were fitted with a straight line. The period 1980-2002 was designated as insignificant and these values were not used in the analysis.

If the prediction should be sought from all available data given in the Figure 2, several important aspects would have to be taken into consideration. First, the values from 1980 to 2019 show exponential growth and the predicted value for 2020 would not differ much (including the coefficient of determination) from the linear regression described above. Secondly, it is necessary to point out that the calculation would be considerably more complicated than in the case of the mentioned linear regression. The third reason is also the age of the data. There is no need to use data that are more than 30 years old to predict the value in 2020. Values ten to fifteen years back are sufficient. There is not the cyclical component of the time series, so a selected part of the values is adequate for the analysis. The straight lines (linear functions) are more frequently used to describe the trend of time series, thus there is no needed to use curves of other mathematical functions. The facts described above demonstrate the demand to focus only on the selected parts of the source data.

All data are given in a single graph, see Fig. 2., to clearly show an overall picture of the occurrence of natural disasters for the whole monitored period 1980-2019.

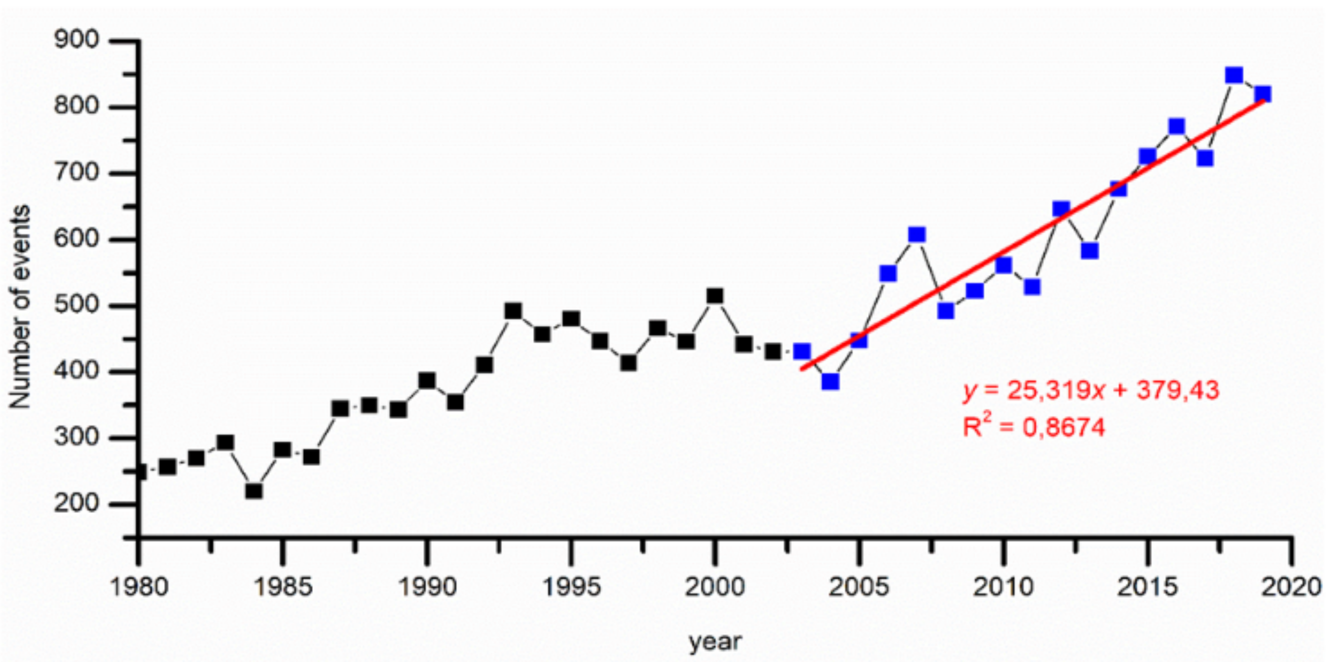

Figure 2. Number of relevant natural loss events worldwide 1980-2019. (Munich RE, 2019 + own edit).

The occurrence value (the mean interval value) for 2020 was determined on the basis of differences between the actual values from the provided data and the calculated functional values from the linear regression model. The functional formula of the linear regression model is shown in Figure 2. The extreme values of the deviation interval were determined by the mean and standard deviation of the calculated differences. Finally, by summing these extreme values with the mean value, the desired confidence interval was obtained.

The mean for the confidence interval was equal to 835, the true value of the occurrence of natural disasters can be expected in the interval from 787 to 884 in 2020 on the mean absolute percentage error 6.96 %. Therefore, it can be concluded that the incidence of natural disasters keeps the upward trend compared to previous values obtained for 2013-2019 period. An expected a gradual increase in natural disasters can be expected in the coming years. At the same time, it is directly possible to analyze the tightness of the relationship between the occurrence and the number of human deaths. It is obvious that with an increasing tendency of natural disasters, more people will certainly be affected. However, a deeper and more accurate analysis based on testing or correlation is not possible with respect to the data provided.

The second part of the results is to present the evaluation of the healthcare facilities preparedness. There was evaluated 29 healthcare facilities in the Czech Republic.

Table 2. Results of the healthcare facilities preparedness for the power outage.

Healht-care facilities	Number of ques-tions	Number of Answers	Number of points	Rating
1	12	12	9	87.5
2	12	12	5	70.8
3	12	11	10	95.5
4	12	10	7	85
5	12	12	6	75
6	12	12	6	75
7	12	12	9	87.5
8	12	11	7	81.8
9	12	11	-1	45.5
10	12	12	11	95.8
11	12	11	-2	40.9
12	12	12	11	95.8
13	12	11	5	72.7
14	12	12	12	100
15	12	12	9	87.5
16	12	12	8	83.3
17	12	12	11	95.8
18	12	12	6	75
19	12	12	10	91.7
20	12	12	11	95.8
21	12	11	11	100
22	12	12	7	79.2
23	12	12	10	91.7
24	12	12	10	91.7
25	12	10	5	75
26	12	12	10	91.7
27	12	12	11	95.8
28	12	11	6	77.3
29	12	12	10	91.7

Table 2 shows the preparedness of the healthcare facilities in the Czech Republic. As can be seen, there are considerable differences in the preparedness of the individual healthcare facilities. The lowest rating in the preparedness takes the healthcare facilities no. 11. There are prepared for the power outage only for 41 percent. On the other hand, healthcare facilities 14 and 21 are prepared for 100 percent. If we take an average of the preparedness of the evaluated healthcare facilities, we will get 83 percent preparedness in the Czech Republic based on the above method. The results are presented in the figure 3.

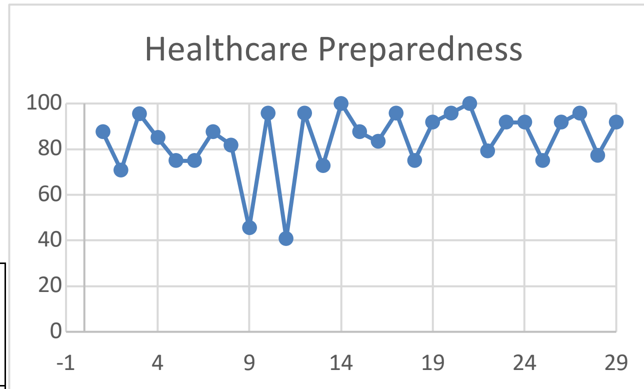

Figure 3. Healthcare preparedness

The analysis resulted in conclusions that allow us to identify the weaknesses of healthcare facilities. Based on the performed analysis, we concluded that 3/4 of the respondents answer the condition of using multiple power supplies in mutually independent networks. For these power supplies, it was also determined for which period the backup power supply should operate. Part of the solution was the evaluation of alternative sources of electricity. Most of the healthcare facilities have an emergency generator that suffices current capacity and quality requirements. Besides, these generators are regularly inspected and tested at total capacity. In a crisis, trouble-free commissioning of a spare power supply is ensured, both with the help of UPS and generator. The area of the emergency preparedness plans is one of the weaknesses of the preparedness of the healthcare facilities. It is an essential planning document in the field of emergency management. The plan aims to ensure emergency management units and suppliers of emergency supplies, such as fuel. Here we have encountered a problem that stipulates that fuel suppliers for an alternative source of electricity are not sufficiently informed about emergency preparedness plans. Likewise, suppliers of operational needs are not informed about the emergency preparedness plan.

4. Conclusions

The paper aimed to highlight the growing trend in the number of disasters around the world and draw attention to the preparedness of the healthcare facilities to solve these disasters. As the limitation of this research could be to gain a small evaluation sample (14 percent). Based on this small sample, the evaluation could be distorted. The paper was divided into few parts. Firstly, a literature review pointed out the growing trend of disasters in the whole world. Based on this problem, we could point out the cascading effect of these situations. The disasters could cause the situations such as power outages. Power outage is one of the critical elements in healthcare facilities. The patients are dependent on the electricity supply. Based on the performed analysis, we take the evaluation of the healthcare facilities in the Czech Republic. The average preparedness of the healthcare facilities is 83 percent. The aim of the paper is to appeal to healthcare facilities to address the situation and increase the preparedness of these facilities. One of the problems in this situation is also proper management of crisis communication.

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