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QUANTITATIVE FIRE RISK ASSESSMENT FOR AN OFFICE BUILDING

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1. INTRODUCTION

Once, with the inclusion in the European Union, Romania had to adapt and implement a series of design regulations and new standards. The Eurocodes, for the buildings and the construction products design, are currently in use. Nonetheless, some other European regulations [1] have only been translated and kept idle due to the lack of legal infrastructure that may prove it applicable. Although, there are several methodologies for assessing the fire risk, there are not enforced any specific requirements concerning the methods and technics to be used for the risk analysis, nor for the verification. Moreover, the third-party peer review for the fire risk analysis is not deem necessary or required by any of the regulations.
One commonly used approach for assessing the fire risk, in Romania is the cumbersome method used in Switzerland and France [2], which is highly prescriptive and it is based on several coefficients which have been derived on certain assumptions that may not be actual nowadays and are not generally valid.
In general, a fire risk assessment is required for complex buildings of special importance as hospitals, hotels, shops and malls, offices, museums, industrial buildings etc. The occurrence of a fire in such buildings will result in many life losses or considerable material losses. Most of these buildings are unique and form very complex systems which need to be assessed in a holistic manner, therefore a probabilistic risk assessment approach would be more appropriate instead of the implicit fire risk analysis.
In practice, especially when it comes to businesses and organizations, there is a permanent need of a decision-making process and the decisions have to be made, despite the lack of knowledge or data. Bayesian statistics may offer useful interpretation of the uncertainty and it proves to be useful in such situations, when the number of identical structures is very limited and the operation and loading conditions are different for each kind of structure [3].
The present paper is a study case of Bayes theorem practical application in order to estimate what is the probability that and electrical faulty appliance may be the cause of a fire in an office building in Romania.

2. MODEL FRAMEWORK

For the decision-making process, it is important to have reliable data as a starting point of a risk analysis. In order to review the most common causes for fires in Romania, one forthcoming way is to use the statistics [4] available on the General Inspectorate for Emergencies Situations website. In 2018, according to the forementioned study, a total number of 28468 fire have been reported in the whole country. Electrical faults, short-circuits or defect electrical appliances accounted for the initiation of almost a third of the total number of fires, as it can be seen in the chart, below.

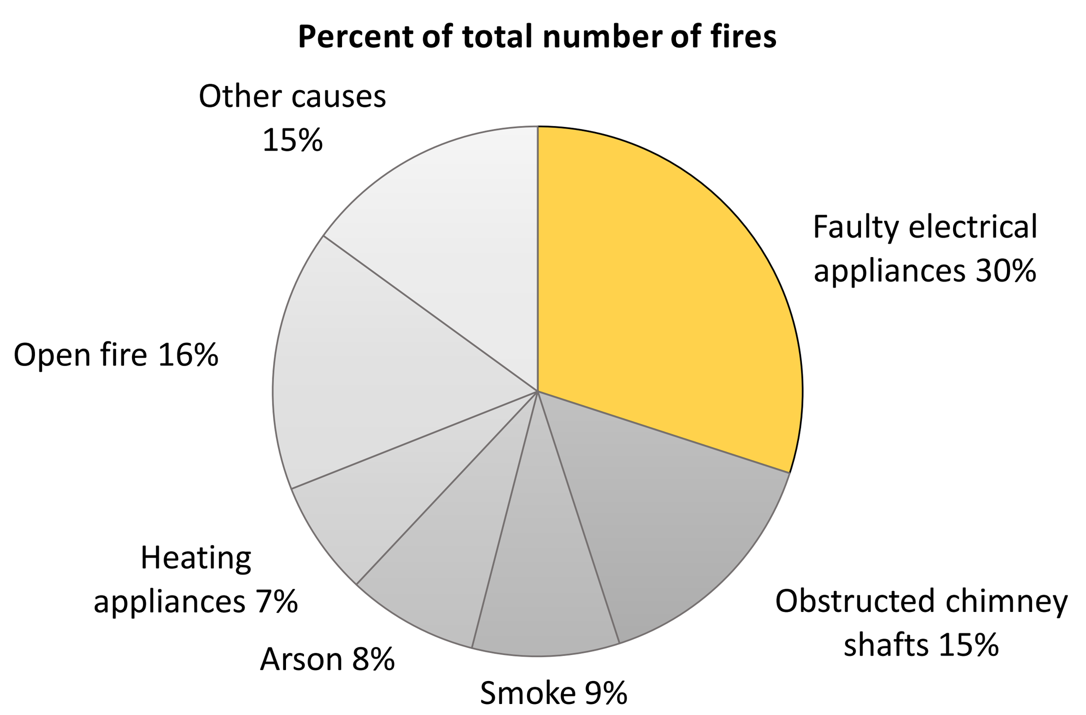

Figure 1 The fire sources distribution in 2018 [4]

Another useful website for statistical resources is that owned by the National Institute for Statistics [5]. Analyzing the data found in a study [6] about the building stock breakdown published by Buildings Performance institute Europe (BPIE), one can track down the percentage of the office buildings in Romania, shown in Figure 2.

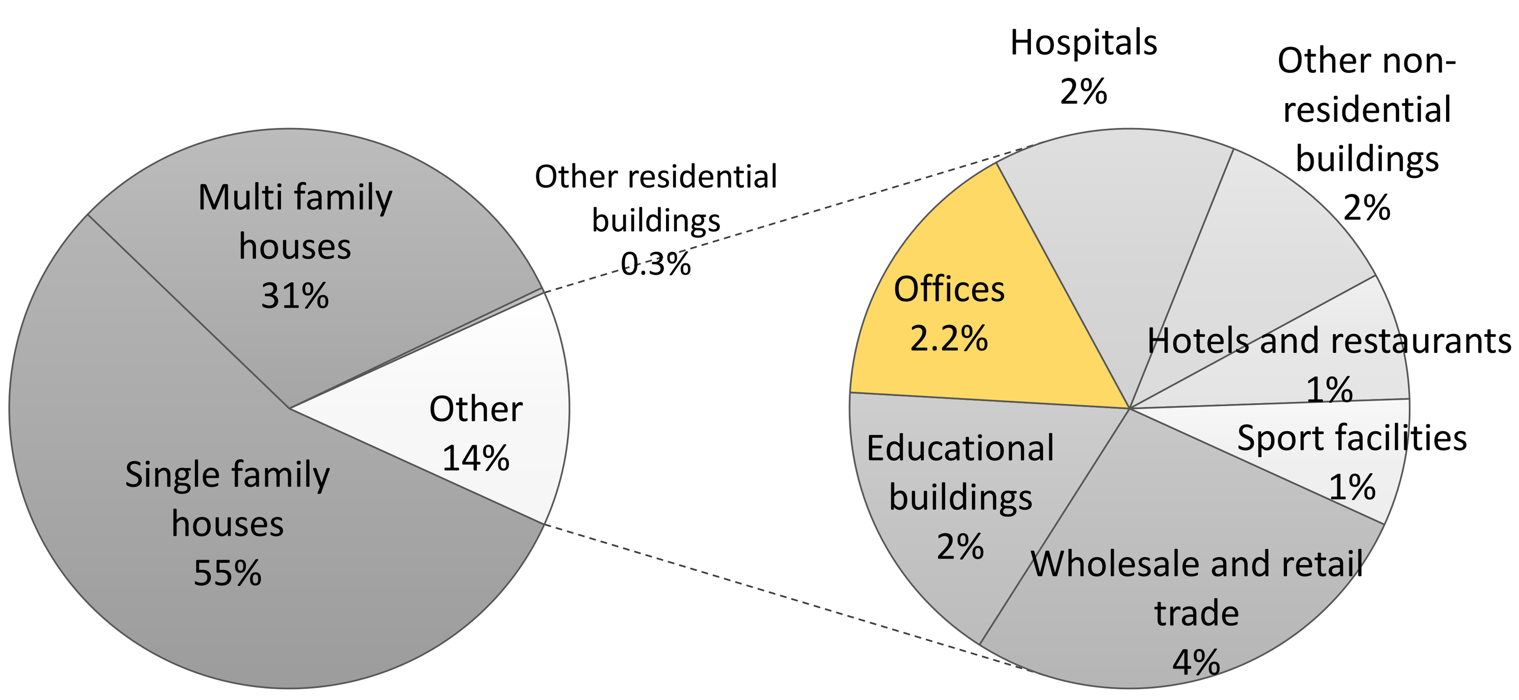

Figure 2 The breakdown of the building stock by building type

When there are two independent events, as a fire occurring into an office building, O, and an electrical fault, E, the probability of both events happening in the same time given that the latter event has occurred is given by the proportion of P(OE) to all of P(E). Similarly, the probability of both events happening, giving that the former event, O, has occurred is given by the proportion of P(EO) to the whole P(O), shown graphically in Figure 3.

Where:
P(E) is the prior probability that the fire occur due to electrical fault = the cause,
P(O) is the probability to have a fire in an office building = the event,
P(E|O) is the probability that a fire occurred due to an electrical fault, given that it started in an office building,
P(O|E) is the probability that the fire occurred inside an office building, given that it has been an electrical fault.

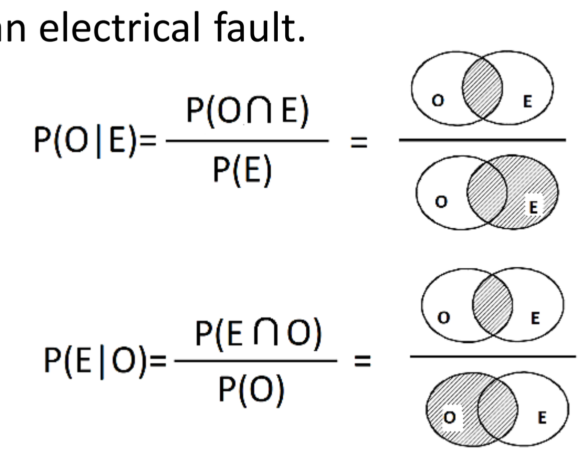

Figure 3 Conditional probabilities

$$P(\text{Cause}|\text{Event}) = \frac{P(\text{Cause}) \cdot P(\text{Event}|\text{Cause})}{P(\text{Event})}$$

$$\Downarrow$$

$$P(E|O) = \frac{P(E) \cdot P(O|E)}{P(E)}$$

Figure 4 Bayes law for two events

Conditional probabilities are the basis for updating the probability estimates based on new information, evidence or knowledge and experience. Bayes law describes the probability of an event based on the prior knowledge i.e. that 30% of the fires occur due to electrical faults, P(E). If the conditional probability P(O|E) is known, or can be estimated, Bayes law can be used to determine the reverse probability P(E|O).

3. PROBABILISTIC RISK ASSESSMENT

The total probability to have a fire in an office building, P(O), can be expressed as the overall chance of the event O happening, i.e. a weighted combination of its probability, given that the event E occurs and the probability of O, given that the event non-E happens. [7]

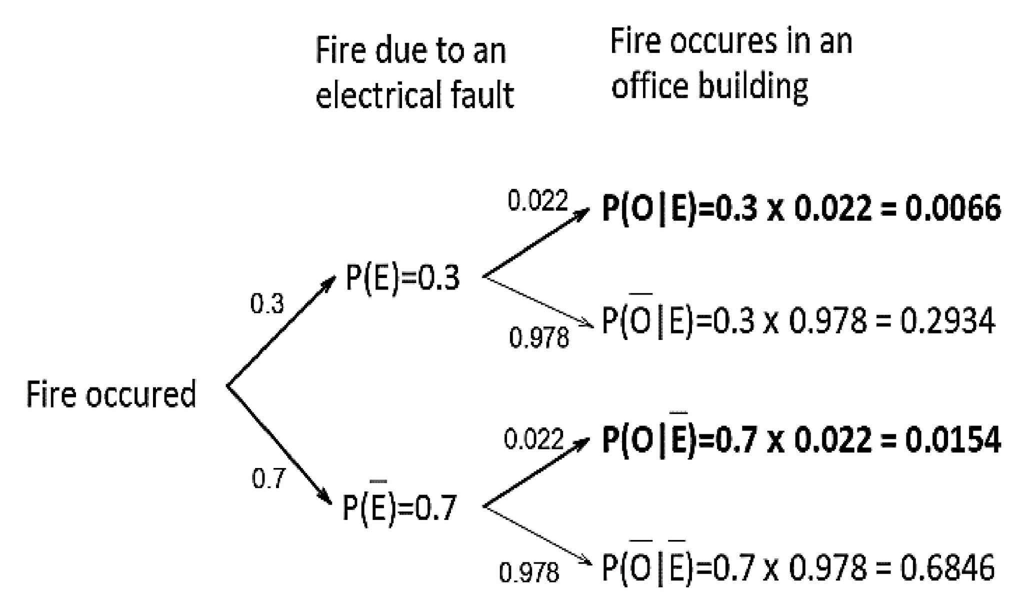

Figure 5 Event tree for the fire occurrence

The total probability to have a fire in an office building, P(O), calculated from the event tree shown in Figure 5, is replaced in Bayes law resulting a probability that the fire has started from an electrical fault, given that there is an office building, P(E|O) equal to 0.155.

4. RESULTS AND DISCUSSION

Assessing the initial probabilities, it is often a difficult task, given that statistical data are scarce and not always available. Bayes law is a powerful tool which enable updating the prior belief as the new information is revealed. In this study, the prior probability of having a fire due to electrical faults, based on statistical data, was initially 0,3. After taking into account the proportion of the office buildings to the total amount of the existing buildings in Romania, the same probability has been calculated as 0.155, decreased by a half.
The more accurate are the statistical data, the better results can be obtained. This method is very useful to apply within the whole decision making process involved in the risk management, providing a dynamic tool for the risk assessment.

5. CONCLUSION

The conditional probability is useful to estimate the probability of an event (the fire starting into an office building) given that one of its possible causes (electrical faulty appliances) has occurred and the Bayes law is useful to find the probability that one of the possible causes of an event, given that the event has happen.

References:

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