A statistics based fire risk assessment methodology to support decisions in building life-cycle management

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Keywords: Fire Risk Assessment, Building Life-cycle management, Fire Statistics, Decision Supporting processes.

Background and objective

The digitalization process is changing the Architecture, Engineering and Construction (AEC) industry through the introduction of new methodologies such as the Building Life-cycle Management (BLM). This methodology aims to improve the information exchange among stakeholders by providing an integrated IT environment to manage the building life-cycle **Virheellinen lähde on määritetty.**. The current state of the art, however, focuses on deploying BLM for applications limited to the optimization of building design and construction phases. As a repository of information and a communication facilitator, the BLM digital model can support decisions in risk management, but this potential is still untapped. Fire Risk Assessment (FRA) plays an important role in performance-based fire design as it affects decisions regarding building and occupant safety.

This work attempts to integrate a statistics-based FRA methodology into the BLM environment, in order to provide fire engineers and decision makers with a semi-automatic tool for the quantitative estimation of fire risk during the whole building life-cycle.

Method

The proposed methodology aims at a rapid calculation of the impact of building renovation on the fire risk level, since the required data is stored and linked to the BLM model and probabilities related to the fire scenarios are structured in a standardized database. The method accounts for changes in building floor area, use of spaces and addition/removal of automatic protection systems.

We propose the use of a standard event tree to evaluate fire consequences in terms of economical and human losses for each space category of the building. This allows us to assess the influence of fire risk on the different parts of the building. The outcome of the event trees for different space categories are risk indices which can be combined to obtain the building risk indices and visualized as risk matrices. Risk matrices are an intuitive and easy tool to communicate the FRA results to all the stakeholders involved in the decision process. The initial model of the event tree was constructed based on the information from scientific literature and national statistical databases. The available information was used to structure the logical

sequence of the event tree and to quantify the probabilities and consequences of various scenarios.

Results and discussion

As a case study, the FRA methodology is applied to a hotel located in Italy. Due to the lack of Italian statistical data, UK **Virheellinen lähde on määritetty.** and Finnish statistics **Virheellinen lähde on määritetty.** are used as a reference for the estimation of the probabilities of scenarios.

Figure 1 shows a comparison of normalized results for fire start locations obtained by eliminating the fires in uncategorized spaces in the Italian **Virheellinen lähde on määritetty.** and UK statistics **Virheellinen lähde on määritetty.**. The percentage of uncategorized fires were 43,4% and 9,2% in the Italian and UK statistics respectively. Variation in percentage of fires was less than 20% for bedrooms reception areas, laundry and store rooms. For external spaces, kitchen and garages the variation in percentage of fires exceeds 50%.

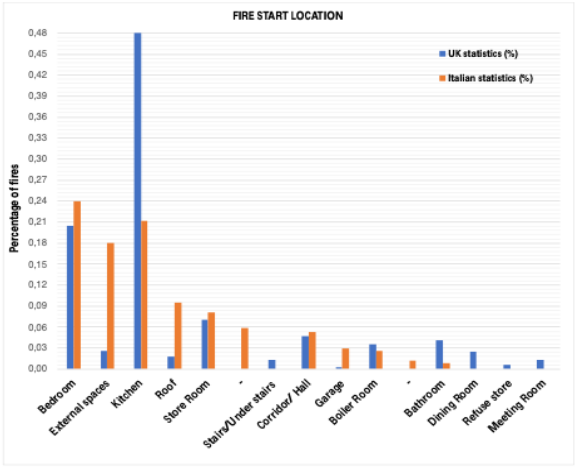

Figure 1. Comparison between Italian and UK statistics fire start locations

As the risk assessment is carried out for each space category, the impact of economical (Figure 2) and human (Figure 3) fire losses of building space categories is evaluated. The distribution of the risk among space categories is less uniform for the economical index since the estimation of total economical loss strictly depends on the average floor area of the fire start location. The highest values for both economical risk index (63%) and human risk index (36%) is reported for bedrooms. The second highest incidence of human risk (17%) is observed in the kitchen where 48% of fires start (Figure 1).