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Economic cost of fire: Exploring UK fire incident data to develop a design tool

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ABSTRACT

Statistical analysis of previous fire incidents in the UK has been carried out with the intent of providing an evidence base in the creation of a decision support system tool for UK fire engineering consultants to aid in the design of cost effective fire engineered structures. Analysis of the fire incident data has shown that the data collected until 2008 in the UK is very binary in nature and this has made it difficult to create an accurately predicting damage model. Even though statistical modelling of the data proved to be inaccurate, cost comparisons of other data sets (loss adjustors costs and UK building costs) was carried out and discussed, allowing the cost of fires to be calculated using over time should the data provided by the new Fire and Rescue Service data collection methods allow for collection of data in a non binary form.
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1. Introduction

Fires in buildings have occurred for many years leading to disastrous effects. The UK Government and building regulators have tried for years to prevent fire deaths through the implementation of building regulations such as Approved Document B (ADB) and pro-active fire safety initiatives, such as the “Fire Kills” campaign, run by the Department for Communities and Local Government [1]. These efforts have had a measurable amount of success, certainly in UK where fire deaths have fallen over the period from 1998 to 2008 [2] and shown in Fig. 1.

This decline in fire deaths is an achievement. However, whilst fire deaths have declined, over the same period of time, fire costs have slowly been rising [4] and this has caused concern amongst the insurance industry and others in the Architecture, Engineering & Construction (AEC) industry. Though the costs of fire are relatively small in comparison to the GDP of a country – in 2008, the cost of fire to the UK economy was £8.3 billion [2] compared to it's GDP of £1446 billion [5] (less than 1 percent of the UK GDP), it is still a cost that can be potentially be reduced through the use of fire engineering and prevention of fire.

Cost reductions are believed to come through the addition of extra protection in buildings and the use of fire engineering. The move from prescriptive building codes and therefore over engineered buildings has allowed the use of fire engineering to offer a more cost effective method of building design. In fact, Torero states:

> “Fundamentally, cost reduction is the only value we have to make our engineering better. If we don't embrace the idea of cost reduction, then what are doing? Lets just go back to prescription and over prescribe everything and ignore the whole thing.” [6]

This quote implies that fire engineering still needs to embrace cost reductions to improve its offering to the wider building community.

Fire engineering offers a number of benefits to that of meeting the Building Regulations [7] by following the guidance in Approved Document B [8]. Approved Document B is designed to produce safe buildings for the occupants, with a minimum amount of work. However, the solutions contained within can be restrictive to architects and other building services. Fire engineering offers the benefits of increases in travel distances, removal of staircases and other aspects that allow architects and building owners to maximise the use of the available space and therefore either save money in terms of construction costs or to gain more money in terms of usable (and therefore rent/sell-able) area.

This work intends to create a design tool methodology that will enable fire engineers to consider the cost reductions they can design into the building from the design stage, through the use of statistical analysis of previous fire incidents. Buildings built to Approved Document B do not offer much in regards to cost

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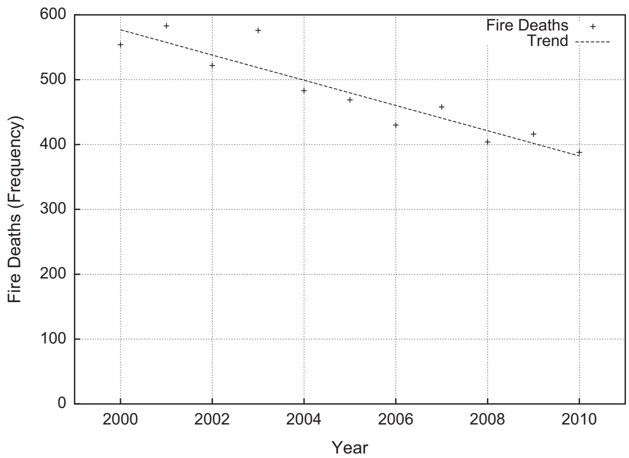

Fig. 1. Graph of UK fire deaths from 2001 to 2011. *Taken from* [3].

savings, though by following the guidance of British Standard 9999 [9] or 7974 [10].

This work only covers non residential buildings within the UK as these were considered to be the properties at risk of greater monetary loss and properties likely to undergo fire engineering work. It should be noted that residential properties can also have fire engineering, non prescriptive solutions, however this was not covered in this research.

2. Previous work

2.1. Cost work

Pursuing cost reductions through fire engineering and statistical use has previously been attempted. It has been considered for many years that additional fire protection may offer cost benefits in the event of a fire. In the UK, the earliest attempt to quantify the costs of fire and make recommendations to reduce the financial impact was completed by Burry. His paper in 1972 focused on the costs of automatic fire detection (AFD) in buildings and how the use of alarm system could reduce the costs to the building due to the “primary objective of any fire alarm is to help in reduction of fire losses, be that life or property” [11]. A separate paper by Rasbash [12] detailed that installation of an AFD system might save £0.03 per m^2. This was further built upon by Luck [13] who stated that early warning of a fire was important and when this was not possible (usually during night time hours) there was a higher frequency of fires, however, it was difficult to estimate the cost benefits of installing an AFD system.

Later work by Rutstein and Cooke [14] investigated the costs of alarm systems and sprinklers. This work focused on the costs to the UK economy as a whole, rather than to the building owners and therefore the insurance provider. It recommended that costs to the UK economy could be reduced through the use of sprinklers (estimates of 70–90 percent damage reduction were made) and through AFD (estimates of a 50 percent reduction in fire damage were made in industrial premises, with other premises offering different values). These estimates were for the UK economy as a whole but it was also made clear that installing a sprinkler system could financially benefit a firm using them, though installing additional fire detectors offered relatively little financial benefit. It also considered that installing additional structural fire protection could reduce fire losses by up to 50 percent but calculating the costs of installing this extra protection was not considered in the study.

The work by Rutstein and Cooke detailed the costs to the UK economy – other research has focused on other aspects of costs to different stakeholders in a property. Work by Marchant and Henesy [15] investigated the costs to business and the cost of business interruptions of fires. This work detailed the problems faced and the costs involved with returning a business to pre-fire incident output and attempted to calculate the costs to the business in lost custom. The research concluded that no uniform pattern had been observed and that the acceptable level of loss was difficult to estimate, either in terms of money or personal injury, though ignorance of industrial management was highlighted in each case study that was investigated.

Work by Ramachandran has investigated the probabilities of fires using fire statistics, made clear in his 1980 paper “Statistical Methods in Risk Evaluation” [16] and then throughout his career. In this paper, he states that statistical analysis of fire incidents could use multiple regression analysis to take into account all relevant contributions to the dependent variable, in this instance, damage. In 1998, he published a book entitled “The Economics Of Fire Protection” [17] which detailed the statistical analysis steps to conduct a risk assessment of a property and calculate the costs of these steps.

Research carried out by Lin et al. in Taiwan investigated the fire losses to Taiwanese residential building structures by using a stepwise regression model [18]. This work utilised interviews and questionnaires to derive the factors affecting the fire incidents. 918 records were considered in all and these values gave an explanatory fire loss model for Taiwanese residential buildings, identifying and quantifying the values that affected fires. The study makes clear it's main limitation that it uses a social science approach to calculate these values and do not use an engineering or statistical evidential base for these values. However, it identifies the main factors affecting the fire damage as

1. Fire occurrence time.
2. Degree of fire severity.
3. Degree of difficulty of fire escape.
4. Time taken for the Fire and Rescue Service (FRS) to control the fire.
5. The dispatched FRS forces.
6. Partition structure.
7. Situations of escape routes.
8. Accessibility and conditions of fire-fighting.

2.2. UK fire incident statistics analysis

Previous work in UK to make use of the UK FRS fire incident statistics database (FDR 1 data) includes work by Fraser-Mitchell [19]. This research used data from the FDR 1 database to establish the probabilities of fires starting in the UK schools so that a cost benefit tool could be constructed, allowing building designers to decide if sprinklers were worth installing in schools. The data from the FDR 1 dataset in this work was only focussed on the number of fire incidents in schools to calculate the probabilities of fire starting in a school occupancy and did not analyse the rest of the database.

A similar analysis was undertaken by Bureau Veritas [20] to provide technical insight into the environment and community impacts of fire with sprinklers and no sprinklers in single story commercial and industrial premises in UK. Select fire incident data from the FDR 1 database was used within this analysis but again, the whole database was not analysed for statistical use.

The biggest use of the FDR 1 data was in the construction of the Fire Service Emergency Cover (FSEC) toolkit, a toolkit for the UK FRS to help plan operational locations and organisation of fire

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