A HOLISTIC APPROACH TO FIRE RISK MANAGEMENT FOR BUILDINGS IN THE UK

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ABSTRACT

There has been a great deal of research on risk assessment and risk management within the context of fire and other emergencies. Most of this work focused on estimating the probability of risks and their impact quantified in terms of damage and loss by modelling fire growth and spread. However, the integration of the performance and effectiveness of prevention and protection measures used in buildings while developing risk management plans to allocate fire and rescue resources is still a developing area. Some recent efforts within the Department of Communities and Local Government (CLG), the Home Office, and the Office of the Deputy Prime Minister investigated risk assessment as part of the development of a Fire Service Emergency Cover. Part of this work resulted in the development of a toolkit (FSEC) to assess risk, plan response, and model the consequences of resource deployment. However, there is still a need for a holistic approach that integrates prevention and protection activities and considers, fire related incident data held in the UK, recent fire risk assessment methods and tools, and the prevention and protection methods. This paper presents the current status of Integrated Risk Management Planning (IRMP) processes and procedures. The main elements of IRMP are described together with the fire risk assessment methods and tools used by the Fire and Rescue Services (FRSs). It also describes the various types of data recorded and kept by the CLG and FRSs and their relation to current and potential fire risk management activities for buildings. Finally, the potential steps that have to be taken for the improvement of the integrated fire risk management planning are presented.

INTRODUCTION

Risks that affect the built environment and threaten human life are becoming major societal issues in the 21st century. Managing these risks and responding to emergencies such as fires, floods, and terrorist attacks is important and needs to be planned efficiently and effectively to ensure minimal impact on society. There has been a great deal of research on risk management within the context of fire and other emergencies, most of this work focused on estimating the probability of risks and their impact quantified in terms of damage and loss by modelling fire growth and spread[1,2]. However none of these work considered the integration of the performance and effectiveness of prevention and protection measures used in buildings while developing risk management plans to allocate fire and rescue resources. These fire prevention and protection measures include such features as structural fire resistance, means of escape, sprinkler systems, automatic detectors and alarms, fire doors, ventilation systems etc. There is a need for an evidence based work to assess the performance of this fire prevention and protection measures for a comprehensive risk management planning. To have such a comprehensive risk management planning there is an urgent need for a focus on the available fire data in the UK, risk assessment methods and tools used by the FRSs.

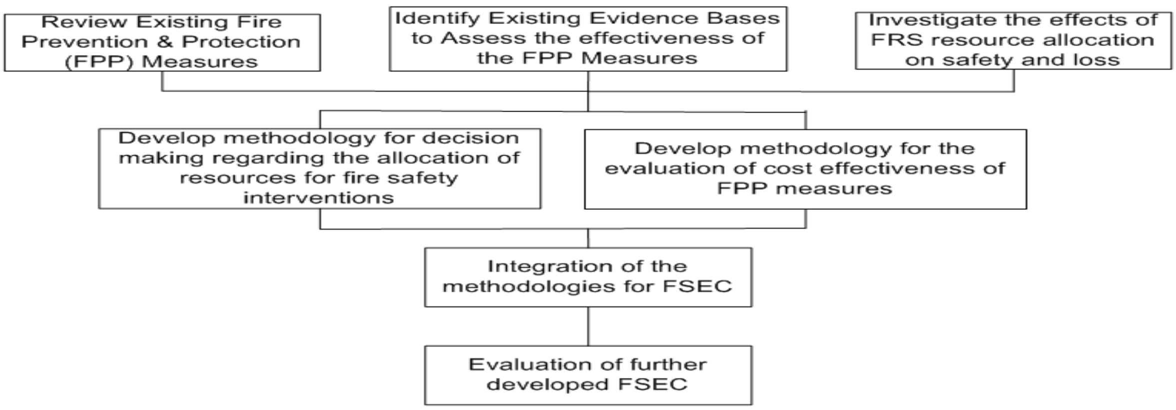
The government's White paper "Our Fire and Rescue Service" published in 2003 introduced reforms that refocused the role of the FRSs on the prevention of fires and broadened its role in dealing with other growing threats resulting from climate change and man-made disasters. As a result, a new statutory framework is now in existence that places a responsibility on the FRS to produce Integrated Risk Management Plans (IRMPs) to plan for, and respond to, a range of emergencies. This new statutory framework has a fire protection management strategy and a risk-based inspection programme to enforce the provisions of the new Fire Safety Order. The Chief Fire Officers' Association (CFOA) in partnership with the department of Communities and Local Government (CLG) developed a new inspection programme and procedures for FRSs[3]. These procedures are planned to enable the delivery of a risk-based inspection programme aligned with the Government's IRMP Guidance Notes. The White paper also highlighted that new processes for the FRS must be based on evidence from rigorous research in the science on fire prevention, detection and suppression.

Recent efforts driven by the government resulted in the development of a toolkit (FSEC) to assess risk, plan response, and model the consequences of resource deployment[4]. However the new requirements of IRMPs that need a holistic and integrated approach and focus on prevention are introducing further research challenges, these can be summarised as follows:

- lack of evidence based methods for the assessment of the effectiveness of prevention and protection measures used in buildings
- lack of evidence based methods for evaluating the effectiveness of auditing prevention and protection measures
- difficulties in assessing and predicting property, heritage, and human loss
- the need for decision making tools for the cost effective allocation of prevention and protection resources
- the need for decision making tools on prevention/protection measures used in the built environment.

In this research, a holistic approach to fire risk management is being developed, and the main objectives are presented in Figure .1

Figure 1 Main objectives of the research



FIRE RISK MANAGEMENT

Background

A systematic engineering approach has been developed for fire safety design over the last few decades. This derived from a better scientific understanding of the fundamental aspects of fire initiation, growth and spread in buildings, the performance of materials, structures and the behaviour of people during fires [5]. Research on fire safety engineering within the built environment highly contributed to this knowledge and understanding since it covers a wide range of areas that include decision support related to a facility's lifecycle, regarding the type of detection and protection systems used their performance, effectiveness and cost benefits. In particular the fire engineering approach provides opportunities for reducing the overall cost of providing fire safety and protection measures in buildings and introduces greater flexibility in design. This leads to a fundamental change in the methods that are used to design buildings for fire safety and protection. Designers need to explicitly consider various fire scenarios, responses of the different building fire safety and protection systems, and human behaviour [5]. As a result, a comprehensive fire risk assessment with a holistic approach to the assessment of fire safety and protection systems is required to increase level the of fire safety in buildings.

One of the earliest improvements to fire risk assessment methods have been suggested by Ramachandran [6] who reviewed mathematical techniques and concluded that deterministic models would provide better tools for predicting the fire damage. Other research focused on methods used for fire safety design in buildings that aid designers chose appropriate safety measures and check compliance with regulations and codes. One such approach commonly used in this area is the probabilistic risk assessment method outlined in BS 7974 [7] for fire safety engineering design, also used by Ramachandran [8] for the evaluation fire risk and the effectiveness of fire safety measures. Benichou et al [9] adopted a similar method to develop a tool to evaluate fire protection systems, and assess the impact of selected fire scenarios on life, property, and business interruption. In existing buildings, the performance and effectiveness of systems for fire detection and protection, and the behaviour of people in a fire constitute the main types of uncertainties that affect risk. For the first type, ranking techniques have been widely applied to evaluate the relative weighting of fire safety features [10, 11, 12]. These techniques use heuristic models based on the subjective evaluation of safety measures from professional judgment. Moreover, The Fire Research and Development Group of the Home Office conducted a study that aimed at evaluating possible risk assessment methods which enables a better allocation of resources against risk as well as supporting decisions on the balance between protection and response [13]. Cost benefit evaluation studies have been conducted on individual fire safety measures [14, 15] however these are still limited to the extent that the data are available. All the efforts above focused on important parts of fire risk management, however, none of them present a holistic approach to fire safety and protection in buildings.

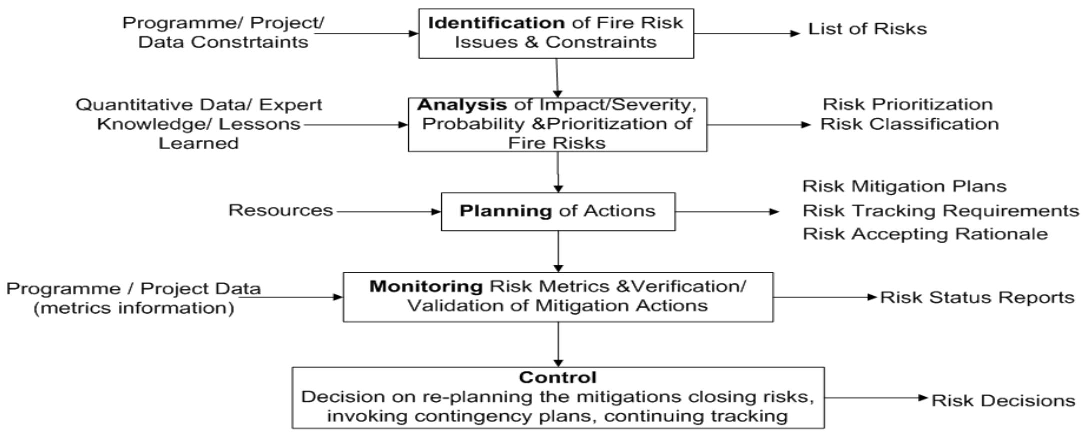
Fire Risk Management Process

Fire risk management is the organized systematic decision-making process that efficiently identifies fire risks, assesses or analyses risks, and effectively produce mitigation plans to reduce or eliminate these risks and to achieve an acceptable level of fire safety. The main aim of fire risk management process is to reduce the likelihood and the severity of fire incidents and thus improve fire safety in the community. Figure 2 illustrates the fire risk management process. This starts with the identification of the risk and continues with the analysis on the frequency and consequences. Risk identification and the analysis process forms the risk assessment part of the fire risk management. Fire risk assessment ensures that fire safety procedures, fire prevention measures, and fire protection (plans, systems and equipment) are all in place and working adequately. Risk assessment should identify any issues that need attention and aims to [16]:

- identify the fire hazards,
- reduce the risk of those hazards causing harm to as low as reasonably practicable
- decide what physical fire precautions and management arrangements are necessary to ensure the safety of people.

Once the risks are identified and ranked, a decision is made to determine whether the risk level is acceptable. If it is not, then a mitigation plan put in place to decrease the probability of occurrence and/or severity of the consequences. The mitigation plan should consider the resources available and identifies the most cost effective solution. These mitigation actions should be monitored to ensure the effectiveness of the developed plan. Finally, the risk management process starts from the beginning again to determine if the level of the risk is acceptable after all mitigation plans are applied. The process iterates until the risk level is judged as being acceptable.

Figure 2 General Approach to Fire Risk Management (Adapted from PD7974 [7])



In fire risk management, improvements can be achieved by using probabilistic risk analysis methods to establish subsequent events and develop evidence based risk mitigation plans. A deterministic fire engineering analysis assumes that the fire occurs and continues to grow, so do not take in to account the subsequent events after the fire starts and do not consider the likelihood of occurrence and consequences [7] However probabilistic risk analysis approach will consider the likelihood and consequences of fire risks and would take this further by considering the uncertainties and adding in the additional factor of probability to the assessment. Risk assessment models are needed to identify those combinations of building subsystems which provide a level of safety in a cost effective manner. Deterministic fire engineering design methods can not be used for that purpose, because it is necessary to estimate both the likelihood of fires and their consequences, and then combine the results in order to evaluate the likely cost and likely safety level [5]. This research is making use of incident data kept in the UK to develop an evidence based methodology for IRMP.

The above fire risk management considerations are used in this research during the investigation of the IRMP activities in the UK. In the light of this knowledge, risk assessment and risk planning tools and actions are reviewed and analysed to understand current practice in fire risk management in the UK.

INTEGRATED RISK MANAGEMENT PLANNING

Since April 2003, every fire and rescue authority (FRA) is required to produce a local IRMP that sets out the authority’s strategy, in collaboration with other agencies [17]. The aim of IRMPs is to improve community safety and make a more effective use of FRS resources by [18]:

- reducing number and severity of fires, road traffic accidents and other emergency incidents occurring in the area for which it is responsible;
- reducing the severity of injuries in fires, road traffic accidents and other emergency incidents;
- reducing the commercial, economic and social impact of fires and other emergency incidents;
- safeguarding the environment and heritage; and providing value for money.

Guidelines are available from the CLG to support the FRSs in developing their IRMPs. The IRMP prepared by each FRS is expected to be a strategic forward looking plan incorporating some elements from business and change management plans [17]. Each FRA must produce and maintain an IRMP which reflects local need and which sets out plans to tackle both existing and potential risks to communities effectively [19].

IRMP has five major elements which cover important activities which include fire safety audits, fire risk assessment and planning, fire prevention activities, fire incident reporting and IRMP returns. These activities are briefly explained in the following sections.

Fire Safety Audits

Fire Safety Audits form an important part of the IRMP process. FRSs deliver their enforcement duties through locally determined, risk-based programmes of audit (or inspection) visits to non-domestic premises. FRSs are required to prioritize audits (inspections) and enforcement action according to the level of risk within individual types of premises [20].

In 2008, CFOA provided fire and rescue services (FRSs) with a revised data collection form and guidance for the management of the inspection process. The revised CFOA Fire Safety Guidance Notes and Audit Form is intended to help FRSs assess the extent of compliance with the Fire Safety Order and thus inform the need for, and level of, enforcement action in a consistent manner [21].

To determine the level of risk in the premises in question, a fire safety audit is carried out, which will, on completion apply a risk rating. The risk to individual persons will be of concern to inspectors carrying out the audit; however it will be the potential for the loss of life or serious injury that will have a major influence on the level of risk. The life risk score is based on the following measures which are weighted according to the predefined scale in the fire safety audit form:

- Fire Safety Management
- History of Fires
- Unwanted Fire Signals
- Known Fire Setting Activity in the area
- Features which may assist fire spread
- Fire loading which may assist fire spread
- Access for fire fighting
- Water Supplies
- Total number of premises at the peak time
- Building size
- Description of occupants
- Fire Warning system
- Extract or Positive pressure smoke control system availability
- Operational Sprinkler System Availability (installed maintained and working in order or not?)

The findings of the audit process and any risk rating applied to a premise are stored within the fire safety database of each FRS [20].

Fire Incident Recording System

Data collection is an important part of any risk assessment process. A comprehensive incident reporting system aims to provide a reasonable amount and spread of data to be stored and used to predict risks before they result in an accident [22]. Therefore the fire incident recording system plays an important role in the IRMP process.

A reportable fire is defined as an event of uncontrolled burning involving flames, heat, and smoke attended by a UK fire brigade. Primary fires are generally more serious and are those that occur in one or more of the following locations: buildings, vehicles, trailers or other methods of transport, plant, machinery etc. Secondary fires are generally small fires which start in and are confined to outdoor locations. Fires in secondary locations which involve causalities or rescues or which are attended by 5 or more appliances are reported in the same way as primary fires. In each FRS, from 1978 to 2009 primary fire data were collected using FDR1 forms. Starting from 1979, the fire statistical data collected was computerised in electronic format by the Home office. In 1994, the FDR1 form was revised involving many changes in the structure of fire data collected by brigades.

Information on primary fires recorded by the brigades on FDR1 forms is converted by the CLG into data items which make up an annual database of fire statistics (data exists in electronic format from 1981 onwards). These data items are then converted into analytic variables using statistical analysis package. Using FDR1 forms, the following data was collected:

- Brigade information: Brigade Incident number, Brigade Area, etc.
- Incident Information: the location of fire, time and day of call to brigade, type of call, risk to life (risk category), name of the occupier,
- Location of Fire: Type of property, Occupancy of building, Place where fire started.
- Extinction of Fire: method of fire fighting.
- Supposed cause, damage and other fire details: most likely cause, source of ignition, spread of fire
- Life Risk: Fatalities, other casualties and rescues
- More Detailed description of fire/further information.

In April 2009, a new fire data collection system called IRS (Incident Reporting System) was introduced and the FDR1 forms were discontinued. The IRS is a web-based electronic data collecting system that includes a core set of forms to ensure data on all incidents attended by FRS personnel are collected in a consistent manner [23].

IRS includes the data collected in previous FDR1 forms but also collects additional data in the following areas:

- More information on vehicles is collected
- Information on equipment used is collected
- Information on type of incident 'at time of call', as distinct from 'at attendance' is collected.
- Ethnic origin of casualties is collected
- Information on building evacuations is collected
- Construction features in building fires
- Fire safety inspection info
- Fire service building facility info

Fire Risk Assessment & Response Planning

Fire risk assessment and resource planning form the backbone of the IRMP process. FRSs have to specifically set out how the risk is assessed and how the resources are allocated. Each FRS has to define the tools to be used for risk assessment and resource planning in their IRMP reports. They can use GIS based software to manage their geographically dispersed resources responding to geographically dispersed risks. This software can include real time and historic data incidents, resource data, demographic data, home safety checks etc. as well as its road network and mapping. For fire risk assessment and response planning, each FRS in England, Scotland and Wales have also been provided with a FSEC (Fire Safety Emergency Cover) toolkit which is based on a methodology developed by statisticians at CLG, and independent risk consultant. FSEC is a tool which utilises GIS technology and a GIS based user interface, and is fundamentally a statistical model that predicts losses and includes cost benefit analysis. In FSEC, GIS is used as a framework for providing inputs and understanding outputs [24].

In summary, FSEC includes three main components: risk assessment, response planning, modelling and analysis, and four different modules: dwellings, other buildings, special services and major incidents. Because the main focus of this research is on commercial, public and heritage buildings, it is concerned with the FSEC Other Buildings module.

The FSEC Toolkit assesses the life (societal) and property risk in buildings using the average national fire frequencies per building for each type of occupancy (based on FDR1 data), the number of such buildings within an area and the site assessments [25]. The fundamental component of the other buildings risk assessment is the site assessments. In order to keep the amount of data that needs to be collected locally to a minimum the FSEC Toolkit supplied to each FRS already contains default site assessments for certain occupancy types. These default site assessments are expected to be revised after each fire safety audit. In FSEC the following fire safety measures are scored and the relative a risk score is calculated:

- Fire Safety Management
- Total number of premises at the peak time
- Building size
- Description of occupants
- Fire Warning system
- Extract or Positive pressure smoke control system availability
- Operational Sprinkler System Availability (installed maintained and working in order or not?)

As it is seen although the majority of the fire safety measures are similar to the ones used in the Fire safety audit forms; the history of fires, unwanted fire signals, known fire setting activity in the area, features which may assist fire spread, fire loading which may assist fire spread, access for fire fighting, and water supplies are not taken into account in the FSEC risk assessment.

The FSEC Toolkit also contains a statistical model of the impact of response times on the number of deaths per fire in the case of societal risk incidents and the amount of property loss in the case of property risk fires. So, once the Planning Scenarios (location of the fire station, the number of the fire engines, the crew arrangements (whole time or retained for each area) are defined and resources are allocated, the tool can also predict the number of deaths and loss of property for any one fire cover proposal.

Fire Prevention

The Fire Prevention part of IRMP includes Community Fire Safety (CFS) campaigns and initiatives, carried out by community fire safety staff, other FRS operational staff and partner organisations. This includes fire safety publicity events, fire safety talks, and home fire safety assessments/visits. Information on CFS work is used to monitor progress with the statutory duty in the Services Act 2004 for Fire and Rescue Authorities (FRAs) to promote CFS [26].

IRMP Returns

Communities and Local Government (CLG) collects annual statistical data returns from the Fire and Rescue Services (FRS) to inform central government policy and to support governance. This data covers HR, operations, fire safety, community fire safety and financial data, and are collectively called Integrated Risk Management Planning (IRMP) returns. Currently IRMP returns are only collected from the England and Wales FRSs. Information collected on the IRMP returns are briefly presented in the following sections [26].

- Fire Safety Enforcement (Number of hours spent on audits and enforcement activities, number of prosecutions and convictions)
- Fire Prevention (Campaigns, fire safety publicity events and talks, fire safety assessments/visits)
- Human Resources – Health and Safety and Equality and Diversity (Several staffing issues within each FRS, such as applications, appointments, absences, promotion, career progression, health and safety issues, disability, gender, religion, sexuality and ethnicity.)
- Operational Activity (number and type of fire stations, vehicles; calls handled by fire control; special service incidents attended)
- Financial Returns (The payment of invoices for commercial goods and services; percentage of invoices for commercial goods and services)

The data from these returns are used in the Fire Service Emergency Cover model and also as feedback to support Parliamentary Questions about local resources, in particular fire stations.

METHODOLOGY OF THE PRELIMINARY FIELD WORK

In the initial stages of this research, visits to three different FRS regions were conducted to capture current practice in fire risk management activities in the UK. During these visits, semi-structured interviews were used to develop an understanding of the IRMP related activities and the tools used by the FRSs. For this preliminary field work, three FRSs were selected: FRS1 in South West England, FRS 2 in the East Midlands, and FRS3 in Scotland. In the following sections, the outcome of this preliminary field work is presented.

Integrated Risk Management Planning

In all of the FRS regions, IRMP is conducted as part of their corporate or business plan. However, even though the guidance notes for the IRMPs are easy to understand and well written, they are found not to directly relate to the content and extent of the plans. Furthermore, it was felt that the new guidance lacks clarity compared with the older guidance documents.

There have been major changes in the way FRSs plan for service provision, especially after introducing IRMPs. The level of planning moved from a perspective, dominated by operational issues, to strategic aiming at “community safety”. This is leading to attitude changes within the brigades at all levels introducing some tensions related to budget allocations for community safety and operational costs. It was argued that it is difficult to quantify the direct benefits of prevention measures put in place.

There are differences in the way IRMPs are perceived by the CLG and the different FRS regions. While CLG is looking for a broadly defined future plan for the FRS, FRSs include detailed operational planning and specific operational scenarios. FRSs want to retain some autonomy and therefore accept the trade-off between the CLG giving clear instructions and being too prescriptive. Moreover, planning for neighbouring authorities can be complicated especially when borders overlap and therefore risk areas.

Overall, although FRSs enjoy the freedom of generating their IRMPs independently, there is some lack of clarity in the IRMP process; hence there is a need for “Best Practice Guidelines”.

Fire Safety Audits

There are some differences in the way fire safety audit forms are being used; in FRS1 and FRS2 the latest version of CFOA Fire Safety Audit forms were used, while FRS3 used the Scottish Fire Safety Audit Forms. The main difference is, the risk rating part at the end of the audit form is omitted in the Scottish Fire Safety Audit Form. Instead, in FRS3, the relative risk rating for a building is calculated by uploading the audit results to FSEC.

In FRS1, the selection of the buildings for a fire safety audit is based on local intelligence, complaints, and experience. However, it is aligned with the number of fires for each property type and the potential loss of life and damage for that type of building obtained from FDR1. This information is provided by CLG to each FRS in the FSEC Relative Risk Level Matrix published in 2008. FRS2 and FRS3 also use this matrix to select premises, however local intelligence and experience also plays an important role in this selection process.

FRS3 developed their own system to keep track of all Fire Safety Audit related actions. The system is called Fire Safety Enforcement Information System (FSEIS) and keeps information on all audits from year 2006 onward. The system is used to generate key performance indicators (KPI) for audits and local risk ratings for several building categories. FRS1 and FRS2 use Community Fire Risk Management Information System (CFRMIS) to store the fire safety audit data. This system records all the fire safety information from the audits and produces a risk rating for a specific building; the risk rating calculation is based on the latest CFOA Fire Safety Audit Form. This system is being used by 28 FRSs in the UK at the moment. In FRS1 the site assessment data collected during the audits are not used to revise the default values in FSEC's other buildings module; however in FRS2 and FRS3 the default values are updated according to the new assessments.

In FRS1 and FRS2 the fire safety officers are provided with tablet PCs to collect the fire safety audit data, however in the FRS1 the tablet PCs are mainly used after collecting the data in a paper format during the visit, this is because the fire safety officers do not find the tablet PCs easy to use during the audit process.

Incident Recording System

There are no significant differences between the FRD1 collection of information and the new IRS, the majority of FRSs have previously used computer-based data collection and storage. However some issues related to the new data collection process were reported by the FRSs:

In the new system, fire fighters are equipped with a notebook that contains predefined sets of questions for certain incident types, in order to investigate the incident in the best possible way. However, the computer-based system is not used until the Fire Fighters return from the incident site to the station with the aim of filling in the computer-based form within 48 hours after the incident in order to provide information on near real-time statistics. The level of detail in the information is very dependent on the level of knowledge and expertise of the Fire Fighter collecting data. In recent years, there have been improvements in the system used to collect the data to speed up the documentation and increase the data quality and reliability by making data input easier.

The Information Recording System issued by CLG is getting better, but there is still some confusion when using the forms mainly due to the terminology used. The terminology is impacting the consistency of the information held which has a significant impact on fire incident data analysis.

The main factor impacting data quality is that the number of choices for certain entries is too large (e.g. type of building). In contrast to that, some categories for the entries are too poorly defined. In FRS2, it was mentioned that in March 2009 when IRS was first introduced; approximately 80% of the forms were filled in incorrectly. It was reported that CLG plan to integrate a consistency check in their IRS forms in future versions. However FRS2 already has this in place.

There was no real training on the new IRS system. In FRS2, only one person per Fire Station was trained, he then passed on the knowledge as well as he could. As the system is changing, it is also hard to create consistent knowledge and documentation on how to use the forms.

In FRS2, it was mentioned that due to the requirement to complete the form within 48 hours, some information revealed by future investigations of the incident cannot be included in form. There is a need to introduce options such as: "Under Investigation" or "To be revised later", as this is not possible Fire Fighters tend to ignore any additional entries in order to be compliant with the 48 hours rule.

Fire Risk Assessment and Resource Planning

FRS1 and FRS2 use GIS based systems while FRS3 use FSEC for risk assessment and resource planning. Both FRS1 and FRS2 mentioned that their GIS system is user friendly for front-end and backend users where new data can easily be added. Both FRS regions also added that being able to configure the system according to their individual needs is an additional benefit when compared with FSEC. FRS2 reported that one of the main benefits of FSEC compared to their GIS software (CadCorp) was the resource allocation functionality. Conducting "What-If scenarios" to identify future planning strategies are found useful.

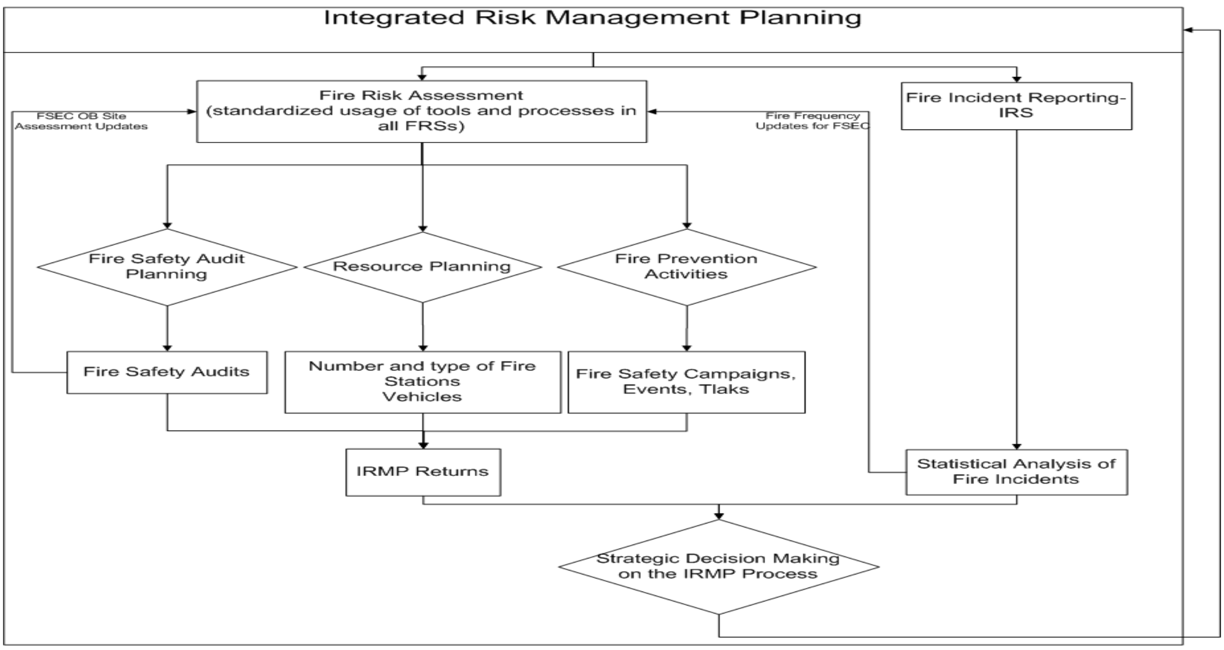
The main reason given by FRS1 and FRS2 for not using FSEC efficiently is the complexity of the tool. None of the GIS-Group members in both regions had an official FSEC training. The system was obtained some years ago and is now in the process of being updated using new data, in order to make use of the extra functionality offered. In FRS3, although FSEC has been used for risk assessment and resource planning for many years, the same criticisms were made. One of the staff in FRS3 who attended the initial training mentioned that although this course was a good theoretical introduction to the tool, the practical training was very limited, so they had limited knowledge about the tool from the outset. It was also added that the training is no longer provided free which creates added financial pressures in all FRSs especially in today's financial climate. The fast employee turnover in FRSs has quite an adverse affect on the loss of FSEC knowledge and expertise. In all of the FRSs visited as part of this research, FSEC is found to be very slow and lacks flexibility in configuration. They also mentioned that FSEC guidelines and documentation do not provide the right level of detail to enable an effective use of the system.

Despite all criticisms, FSEC is found to be helpful in terms of resource allocation and cost-benefit analysis of planned strategies. That is the main motivation behind plans to update FSEC for use by all FRSs.

IDEAL IRMP FRAMEWORK

The framework presented in Figure 3 describes the high level IRMP activities at both national and FRS levels and the relationships between them. The framework is based on the literature and field survey conducted as part of this research. It shows that the results of the Fire Risk Assessment process in each FRS region are used for the decision making process on Fire Safety Audits (selection of premises); resource and response planning (location, type of stations, vehicles); and fire prevention activities (campaigns, awareness talks and events). The site assessment data collected through Fire Safety Audits are used to revise the FSEC site assessment default values to increase the accuracy of the tool in the long term. The information on the IRMP actions taken by FRSs is based on these decisions which are reported to CLG on a national basis as IRMP Returns. At the same time the fire incident data is collected through the new IRS system, and the fire frequencies according to the fire safety measures are statistically analysed by CLG. This is then used as input in FSEC for risk assessment. The IRMP Returns and the statistical analysis are used to revise the IRMP strategy and the guidelines on a national basis by CLG.

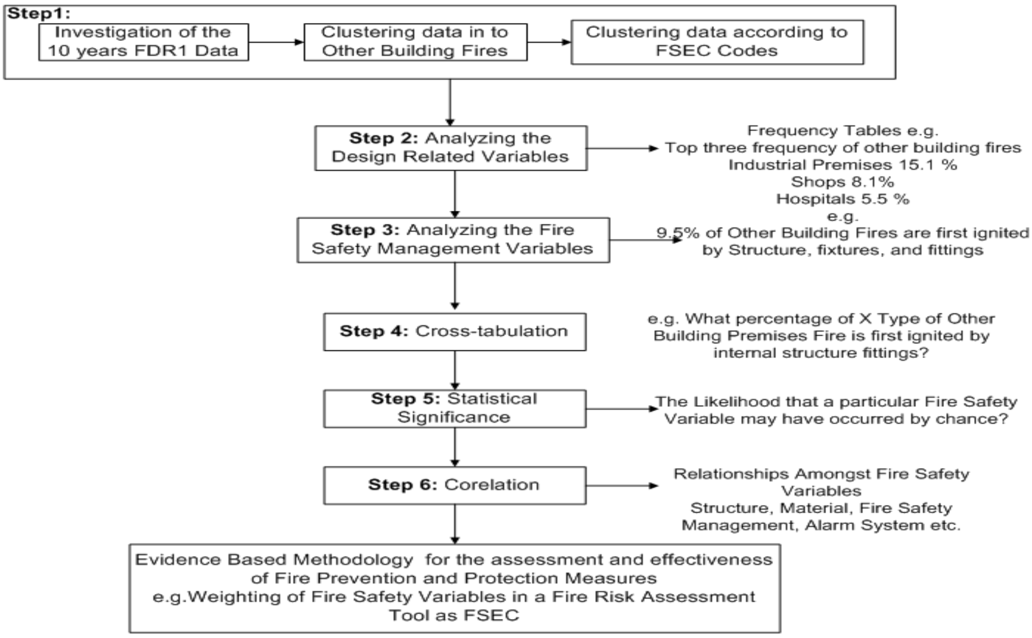
Fig 3. IRMP Process-An ideal Case



FUTURE RESEARCH

The next step in this research is to investigate the FDR1 and IRS data in detail to understand the affect of fire safety measures on fire frequencies; property and life loss for the "other building" type as defined in FSEC. FDR1 and IRS data are both good sources that provide more understanding on the fire safety measures to validate the current risk assessment methods used in FRSs and improve the tools by enabling FRS planners to make evidence based decisions. In Figure 4 the data analysis methodology is presented.

Figure 4 Data Analysis Methodology



For the analysis, the last 10 years FDR1 data was used. The first step was clustering the data; the other buildings data was selected from the whole FDR1 data set and clustered according to the building codes used in FSEC. Then, the FDR1 other buildings data set is reviewed and the fire safety measures which effect design and fire safety management in buildings are selected. The frequency of each other building fires and the frequencies against each fire safety measure is calculated. This will be progressed by checking the correlation between the fire safety measures to build evidence on the relationships between the fire safety variables. The relationship between the fire safety variables will be used in the development of fire risk assessment methods. This will be used for the development of decision making methodology regarding the allocation of resources for fire safety interventions. Based on this methodology the national fire risk assessment tool, FSEC will be further developed.

CONCLUSION

In this paper, the issues with the UK fire risk management at both national and FRS levels are discussed. The fire risk management process is illustrated and an analysis of current practice in Integrated Risk Management Planning is presented. The major elements of the IRMP and the fire risk assessment methods and tools used by the FRSs are discussed. The main outcomes of the preliminary field research are presented. According to the results, FRSs are seeking better defined IRMP and Best Practice guidelines to ensure the accuracy of the plans that they prepare. It is observed that there are a variety of tools used in the IRMP process for fire safety audits, risk assessment, and response planning. FSEC, being a nationally tool provided to all FRSs, is not widely used in the IRMP process. The reasons of this are described as lack of knowledge of the FSEC functionalities, complexity of the tool and its low processing speed. The lack of comprehensive training and the lack of detailed guidelines had an adverse effect on the usage of FSEC. This paper also reported on issues associated with the fire incident data kept by the FRSs and CLG. Finally the next steps of this research are described, these include FDR1 and IRS data analysis to validate current risk assessment methods used; and that the development of new evidence based methods for risk assessment and resource planning.

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