SUPPORTING INTEGRATED RISK MANAGEMENT PLANNING FOR THE UK FIRE AND RESCUE SERVICES: EVALUATION OF PREVENTION AND PROTECTION ACTIVITIES ON COMMERCIAL, PUBLIC AND HERITAGE BUILDINGS

Stefan Raue & Chris Johnson
Department of Computing Science, University of Glasgow, Scotland, UK.
{raues, johnson}@dcs.gla.ac.uk

Dino Bouchlaghem & Selda Konukcu
Department of Civil & Building Engineering, Loughborough University, UK
{n.m.bouchlaghem, s.konukcu}@lboro.ac.uk

ABSTRACT

The Fire and Rescue Services faced significant changes in their area of responsibility. Community safety needs to be assured, by carrying out careful planning for the growing number of threats arising from man-made or natural disasters. This paper describes progress made by a multi-disciplinary team with support from CLG and a range of stakeholders including individual FRS and members of the insurance industry as well as English Heritage. Whereas the project is focusing on the evaluation of prevention and protection activities on commercial, public and heritage buildings, this paper will give an insight to the major information sources and tools employed in planning process of the Fire and Rescue Services in the UK. In particular, we will describe work on information integration of existing systems and the possible benefits and hazards that might arise. Therefore, a prototype developed to support the evaluation of operational planning scenarios is presented. The project's aim is to support the FRS in decision making regarding: the value of prevention and protection measures in the built environment on the one hand and the allocation of resources for fire safety interventions on the other hand.

THE CHANGING FACE OF THE FIRE AND RESCUE SERVICES

Over the past decade the area of responsibility for the Fire and Rescue Services changed significantly. Man-made disasters such as the terrorist attacks in New York 2001 or London 2005 [1], as well as threats evoked by climate change, e.g. UK Flooding 2007 [2] result in an increasing number of threats. These 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 is important and needs to be planned efficiently and effectively to ensure minimal impact on society.

In order to align the public services, such as the Fire and Rescue Services, according to the new challenges, the government has made several changes in the law. The White paper "Our Fire and Rescue Service" published by the government in 2003 introduced reforms that refocused the role of the Fire and Rescue Service (FRS) on the prevention of fires and broadened its role in dealing with other growing threats resulting from climate change and man-made disasters. [3] 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. [4]

INTEGRATED RISK MANAGEMENT PLANNING

In order to increase the efficiency in FRS resource allocation and to improve community safety, the Integrated Risk Management Planning is aiming at: "reducing the incidence of fires; reducing loss of life in fires and accidents; reducing the number and severity of injuries; safeguarding the environment and protecting the national heritage; and providing communities with value for money".[3] The White paper thereby also makes clear that a strong foundation consisting of evidence from rigorous research needs to be in place in order to successfully refocus the Fire and Rescue Services. This research must thereby include review of technologies and underpinning science on fire prevention, detection and suppression.

Research in the context of fires and other emergencies was focusing on risk assessment and risk management. Thereby most of this work dealt with estimating the probability of risks and their impact quantified in terms of damage and loss by modelling fire growth and spread.[5,6] "None of the above 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. 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 process for planning Fire Service Emergency Cover (FSEC).[7] Part of this work resulted in the development of a toolkit to assess risk, plan response, and model the consequences of resource deployment. 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."[4] With the aim to support the FRS in creating evidence to improve the decision making, the available information sources and tools, already employed in the planning process of the fire brigades, needed to be identified.

INFORMATION AND TOOLS EMPLOYED IN THE PLANNING PROCESS

In order to measure performance, analyse trends and enable planning for the future, the Fire and Rescue Services are collecting information on the majority of the actions they carry out. Thereby, in theory, every fire incidents, road traffic collision or fire safety audit adds records to the resources that inform decision making of the services. In practice, however, this information is widely distributed across a large number of agencies and individual FRS. In consequence, we continue to rely greatly on the subjective skill, experience and expertise of senior fire and rescue service personnel. Hence, there is considerable scope for the provision of appropriate information management systems to support their everyday tasks in directing a modern FRS.

Fire Damage Reports and Incident Recording System

In order to pull together information that could be used by the CLG and the local fire brigades to support operational decisions making, policy development and promotion of public awareness, the Fire Damage Report Form (FDR1) was introduced in 1978.[8] The form came into place to collect information on each fire that was attended by a UK Fire Brigade. The fires reported were either property fires or those which involved casualties. Details from around 200.000 fires were collected annually resulting in a huge amount of information. The review of the processes employed to collect FDR1 data resulted in the deployment of the Incident Recording System (IRS), which each fire brigade had to use until April 2009 at the latest.[9] Introducing IRS changed the data collecting process to be completely paperless and thereby promoting a standardised way to record incident information.

This is resulting in the information being promptly available for CLG and the Fire and Rescue Services.[9] FDR1 and IRS brought together details on causes and consequences of fires over the past 20 years, which forms an enormous information source for both researchers and service providers. Within that project it is aimed to employ this data to further improve resource allocation strategies. Thereby, we are analysing the specific causes of fires especially those contributing to high risks to loss of life or property damage. Additionally we are looking at possible best practices in operational response to mitigate the impact of these risks in the best way possible. Information on current building standards and prevention actions carried out in a region contribute to a better understanding of the overall fire-related risks in a community.

Fire Safety Audit Form (CFOA) and Community Fire Risk Management Information System

While IRS and FDR1 are recording details on fires in terms of causes and consequences, the Fire Safety Audit Form is used to carry out fire risk assessments of individual properties in order to prevent fires from occurring. The Regulatory Reform (Fire Safety) Order 2005 proposed major changes for the services provided by the fire brigades. Compared to former legislation, the responsibility of assuring compliance with fire safety standards was transferred to the owners or operators of the non-domestic premises. The Fire and Rescue Services therefore took on a new role within their communities, by advising on questions of fire safety. For example, by conducting Fire Safety Audits the Fire and Rescue Services are able to assess the potential risk of a fire for individual buildings, resulting in a better insight of the risk of fire to an area and therefore to the public community. According to a risk ranking scheme, premises with the highest risk to societal losses, such as hospitals or care homes, are audited on a regular basis. Since the change in legislation, thousands of fire safety audits have been carried out, with Strathclyde Fire and Rescue Services auditing more than 20,000 buildings in their region in 2008.[10] This information source is continuously growing, allowing an contemporary insight in the fire safety standards of buildings and communities. It therefore represents a good source to be employed for future research and strategic planning. In order to support the Fire and Rescue Services in providing efficient services to their communities, it is planned to investigate and quantify the impact of prevention activities carried out in the past.

Fire Service Emergency Cover

The Fire Services Emergency Cover (FSEC) is a software based system that was issued to the fire services and authorities to assist on their way to increase community safety. Based on a geographical information system (GIS) this tool was primarily designed to enable a consistent approach to risk assessment in each community.[11] Thereby the software is capable of pulling information from various sources, such as FRD1, IRS or CFRMIS, together in order to calculate the risk for regions, districts or individual buildings. Amongst other things, demographic details from the census data, and the road traffic network, and fire station resource allocation are used to generate a bigger picture for the fire and rescue services. Results from previous analysis and experiments on the basis of past incidents are thereby used to create the underlying model, in order to predict: "the number of lives lost in dwellings fires, special services incidents and other buildings fires; the amount of property loss in other buildings fires; or the total cost of the resources allocated."[11]

Community and Local Governments deployed this system to all Fire and Rescue Services in England, Scotland and Wales. Users of the system are not limited to monitoring risk in their communities and save information to the system, as it can furthermore be employed to support the strategic planning in terms of resource allocation. Simulating various "what-if"-scenarios, e.g. by moving a fire station or changing the crewing in existing stations, the system is then capable of predicting the impact of each strategic change in relation to the consequences of fire and the cost of the service provision. Hence, fire authorities are able to carry out future planning to effectively protect communities from the effects of fire. Although FSEC represents an innovative and radical innovation in support of the IRMP and similar initiatives, there remain significant tasks to ensure an integrated approach for information management. The following section will discuss this topic in greater depth.

FROM INFORMATION ISLANDS TO HOLISTIC INFORMATION SOURCES

Multiple information sources can be employed to inform the decision makers while creating an Integrated Risk Management Plan. Collected information, e.g. through fire incident reporting or fire safety audits inform about ongoing changes and help to identify high risk areas, that need further consideration in the planning process. Applications such as FSEC are employed to simulate the outcome of a proposed future strategy by using "what-if"-scenarios, without the need to actually carry them out. The amount of information collected on a daily basis, by the FRS, as well as the need to analyse these data, gives rise to the demand of information systems, which are capable of storing, analysing and communicating details to enable informed decision making. With standardised data collection procedures, such as FDR1 and IRS, in place, these systems already provide an enormous value to the services. Creating enriched datasets, by merging existing information systems with those of other government agencies, such as the Meteorological Office or the police forces, enables decision makers to conduct planning activities, having an improved insight in their community.

Possible Benefits of Information Integration

Adjusting the services provision to the continuously changing area of responsibility, the Fire and Rescue Services now additionally need to be prepared for a variety of threats resulting either from man-made disasters or the effects of climate change. The independent report by Sir Michael Pitt, outlining investigation results of the UK Floods of 2007, described amongst other things how the lack of compatibility of systems prevented government agencies from sharing important data effectively, not enabling them to assess the emergency situation to the full extend and to plan the best possible actions.[2] The Central Government, for example, found it hard to estimate the number of people that had been affected by the floods. Eventually more than 30,000 houses were flooded, instead of 3,000 to 4,000 as initially anticipated by the Environmental Agency.[4]

Planning for and responding to major incidents, such as the UK Floods, involve multiple agencies dealing with the threats in order to mitigate the impact on public safety. Sharing information across agency boundaries is thereby vital for assessing situations and planning and allocating resources to carry out appropriate responses. Multi agency planning is also carried out on regional level in the UK, e.g. to support contingency planning by developing Community and National Risk Registers.[12]

Sharing and merging information within organisations also proofs to be beneficial. Even though FSEC already helps to support Integrated Risk Management Planning, the information held in the system is limited to the area of response of each Fire and Rescue Service. Not being able to gain insight in the data of neighbouring authorities, effects the planning for cross-border actions or the assessment of risk in border regions, as e.g. no information on building standards or demographic information are held in the own system. Integrating the information from each system, in order to gain a more detailed view on these areas, would allow decision makers to receive more precise information and enable better planning. It could even contribute to establish a national FSEC, to assess risk on a national level and allow respective planning activities, e.g. for national civil contingency actions.

Not only that the bigger, merged data sets would allow additional analysis, as more relevant data is available. Fire authorities would also be able to share best practises and knowledge on risks evolving from special threats, such as arson. Over the past years several different systems have come into place with the aim to record incidents, document specific buildings or support planning. For example, the National Heritage Data Base provides information on Heritage Buildings all over Scotland and the UK. Currently it is a stand-alone application. With the detailed information hold on that system it could be used to inform Fire Fighters in an event of a heritage building fire, to identify most valuable items, important building specifics to support operational planning. Generally, the integration of information from multiple systems could help to aggregate the information that has been collected over the past years. As a result the larger and more meaningful datasets would allow even more sophisticated analysis in order to create evidence to be used in future planning processes.

Possible Challenges and Hazards arising from Information Integration

Despite the benefits outlined above, there are several challenges that need to be overcome or at least to be considered in order to establish planning systems that make efficient use of the resources available. One challenge is arising from the various information systems being employed for planning purposes within the services across the UK. Each system is thereby likely to introduce new data formats, interfaces, standards or system-specific vocabulary. As an example, codes that are used to identify certain building types and categories are not the same in the Incident Recording System and the Fire Services Emergency Cover Toolkit. This makes it almost impossible to merge information without transforming the data first into a uniformed, standardised format. According to interviews conducted with three different Fire and Rescue Services in England and Scotland much more software tools are in place to enable planning. It was experienced that combining information from different systems introduces costly transformation processes, which need to be validated very carefully in order to prevent the inclusion of errors in the merged data sets. These need to form a consistent and reliable foundation for future planning applications and upcoming research. Introducing new systems as a replacement of previous standards, e.g. the substitution of FDR1 in favour of the Incident Recording System, results in even more transformation processes that need to be carried out and validated in the future.

Merging information using planning applications, such as FSEC, provides great value to decision makers. Thereby, future strategies derived from the decision making process could have a serious impact on community safety. Hence, it needs to be assured that underlying information is correct and reliable and that the functionality of the planning systems is validated in order not to rely on predictions from faulty software components. Additionally, issues related to maintainability of systems are raised as the inclusion of multiple information sources could result in an increased complexity and a lack of transparency.

The combination of various information systems is an important topic, especially in the field of emergency response and planning, where different agencies are involved. The benefits are promising in order to improve the mitigation, preparedness, response or recovery to a number of heterogeneous scenarios. Focusing on the safety implications that might arise from safety-critical enterprise information systems, research has previously been carried out analysing possible hazards in detail. It was thereby suggested to introduce a code of practice for government information sharing, especially in order to ensure integrity of the data and mitigate the impact of possible hazards, e.g. by focusing on transparency of data and the applicability of the systems involved.[4]

CASE STUDY: OPERATIONAL PLANNING SCENARIO EVALUATION

The previous sections outlined the potential benefits as well as the challenges and hazards that might arise from combining information from different sources in primary or secondary emergency planning systems. As an example of a possible planning application this section describes a prototype developed to conduct operational planning evaluations for the Fire and Rescue Services with the focus on cost and benefit of each strategy.

More than fifty percent of the fire-related incidents attended in 2008 turned out to be false alarms. As a result the resources of Fire and Rescue Services are mobilised to an area, where no help is needed.[13] Despite the fact that each mobilisation accounts to additional costs of the brigade, e.g. fuel, the resources are bound to an incident and therefore not available in an event of a actual fire, road traffic accidents, major incident, etc. This implies that false alarm could have a serious impact on the causes of a real incident and therefore for the public safety. The cost related to the mobilisation and the resulting delayed response times of the FRS resources is estimated to be around £1 billion.[13]

Simulating response strategies for false alarms allows the decision makers involved in operational planning to assess strategies and chose the most appropriate one for the future. The prototype is employing information from FSEC and FDR1 data as information sources to gather knowledge on

resources available and previous fires or false alarms in certain areas. By configuring the number of appliances sent to an area or building, the tool then calculates the additional cost of mobilisation. It is planned to introduce loss predictions on buildings and lives calculated by FSEC in order to allow analysing the cost and benefit aspects of each simulated strategy in even more detail.

Several different schemes are in place to indentify premises and areas in communities that are responsible for large numbers of false alarms. The findings are then used to either carry out prevention activities, e.g. fire safety audits of the buildings to investigate the sources of false alarms or awareness trainings for communities or to adjust the response strategies of the services. In combination with tools such as the prototype described, the Fire and Rescue Service are able to adjust their resources allocation in terms of prevention and protection in order to provide the best service possible.

THE FUTURE OF THE FIRE AND RESCUE SERVICES AND FUTURE WORK

With the changing face of the Fire and Rescue Services and the new areas of application, effective planning has to consider a growing amount of information. In order to enable an informed decision making process, existing information sources should be employed in the planning process effectively. Thereby the quality of the data, on which the FRSs are relying, plays a vital role. Supporting the Fire and Rescue Services on the way to improved information systems, the future research within that project looks at the applicability of additional information sources, e.g. on heritage buildings, to be integrated in operational and strategic planning systems. Additionally, the projects aims to improve systems for efficient and effective resource allocation, e.g. for major events such as the common wealth games 2014, as they are having a major impact on the risk in areas and the resources needed to ensure safer communities.

ACKNOWLEDGEMENTS

REFERENCES

[1] Intelligence and Security Committee, Murphy P. 2006. *Report into the London Terrorist Attacks on 7 July 2005*. London (UK): The Stationery Office Limited.

[2] Cabinet Office. 2008. The Pitt Review: Lessons learned from the 2007 floods. [Online] (Updated: 28.10.2008) Available at: http://archive.cabinetoffice.gov.uk/pittreview/ thepittreview.html. [Accessed: 01.04.2010].

[3] Communities and Local Government. 2003. *Our Fire and Rescue Service, White Paper*. [Online] Available at: http://www.communities.gov.uk/fire/firesafety/ourfire/ [Accessed: 06.02.2010].

[4] Johnson, C.W. 2010. On the Safety Implications for e-Governance: Assessing the Hazards of Enterprise Information Architectures in Safety-Critical Applications.

[5] Ramachandran, G. 1988. Probabilistic Approach to Fire Risk Evaluation. *Fire Technology*, 24 (3), pp. 204-226.

[6] Wright M., and Waite P. *National Risk Assessment of High Occupancy Buildings*, ENTEC report.

[7] Community and Local Government. 2008. *Fire Service Emergency Cover: Description of the Risk Assessment Process for other Buildings*. London (UK): The Stationery Office Limited.

[8] Fire Safety Statitics.2009. *Notes for Guidance*. [Online] Available at: http://www.firesafe.org.uk/html/miscellaneous/fsstats.htm [Accessed: 13.03.2010].

[9] Communities and Local Government. 2008. *FRS Incident Recording System.*[Online] Available at: http://www.communities.gov.uk/documents/fire/pdf/frsc22008.pdf [Accessed: 31.01.2010].

[10] Strathclyde FRS. 2007. *Performance Report 2004-2007 and IRMP 2007-2010*. [Online] Available at: http://www.strathclydefire.org/pdfs/ppr/ IRMP2007-2010.pdf [Accessed: 23.02.2010].

[11] Department of Communities and Local Government. 2008. *Fire Service Emergency Cover Toolkit: Executive Summary*. West Yorkshire (UK): CLG Publications.

[12] Cabinet Office. 2010. *National Risk Register of Civil Emergencies*. [Online] Available at: http://www.cabinetoffice.gov.uk/reports/national_risk_register.aspx [Accessed: 13.01.2010].

[13] The Chief Fire Officers Association. 2008. *CFOA Policy for the Reduction of False Alarms & Unwanted Fire Signals*. [Online] Available at: http://www.rbfrs.co.uk/pdfs/cfoa-policy-rofaaufs.pdf [Accessed: 24.02.2010].