

Impact case study template (REF3b)

Title of case study: Fire Prevention and Community Safety

1. Summary of the impact

This case study concerns research in the fields of fire prevention and community safety. A novel causal factor model of accidental dwelling fire risk was developed and incorporated into a geographical information system for fire prevention management, which has been used by Merseyside Fire and Rescue Service (MF&RS) to support delivery of fire prevention activities within the region since 2010.

In addition, a novel customer segmentation approach was developed to provide an enhanced understanding of at-risk social groups in terms of combined fire risk, health risk, social care risk, and crime risk. This formed the basis for further analysis of causal factors within the same geographical area, enabling the deployment of yet more accurate targeting of fire prevention resources.

The impact of the research has been the adoption of the approach as a form of best practice to improve targeting of fire prevention activities, which is a contributing factor to the observed reduction in fire incidence. This was associated with a reduction in accidental dwelling fires by approximately 12% (163 incidents) observed across Merseyside between 2009/10 and 2012/13.

2. Underpinning research

The research methodology was to build multivariate linear regression models to detect socio-economic associations that were then combined with expert knowledge to identify causal factors linked to increased incidence of unintentional dwelling fires. Further insights into the composition of vulnerable groups and individuals within the community were modelled with cluster analysis. This led to the development of a community safety model incorporating combined fire, health, social care and crime risks.

The research focused on computational statistical models for accidental dwelling fire risk and customer segmentation. This validated a methodology for building risk models that are practically useful for identifying at-risk individuals and social groups in terms of fire prevention [1], [5], and the implementation of such models within geographical information systems [2], [3], [4], [5]. Initially MF&RS provided contestable research funds to investigate accidental dwelling fire anomalies (2007 – 2008) (grant awarded to M. Francis, H. Francis and M. Taylor) [6]. A Knowledge Transfer Partnership funded by the UK Technology Strategy Board and MF&RS (2009 – 2010) (grant awarded to M. Francis, H. Francis and M. Taylor) [7] developed a novel causal factor model of accidental dwelling fire risk that was incorporated into a geographical information system for fire prevention management. Previous research in this area had concentrated on descriptive analysis of historical fire incidents and associations with generic measures such as indices of multiple deprivations.

The novelty of the research was to combine data from a wide variety of sources to develop a more accurate predictive model that could be used at small-area level [1]. Moreover, the model also had to be sufficiently interpretable to be explained in detail to non-expert users and for validation of the tool as a decision support system.

The computational tool has been used by MF&RS to support delivery of fire prevention activities in the region since the end of the KTP [1], [2], [3], [4] in 2010. The statistical model devised was embedded into a novel geographical information system that provided spatial fire risk analysis using different social characteristics associated with fire risk [2], [3], [4].

The development of a novel multiple linear regression model for accidental dwelling fire incidence from population measures at the best achievable spatial granularity was undertaken jointly by P. Lisboa, M. Taylor and H. Francis in the School of Computing and Mathematical Sciences between 2007 and 2010. The research involved MF&RS working in partnership with local council departments and Merseyside Police, first to identify appropriate population measures to form the main covariates for the computational data analysis.

Supporting information was also obtained from the UK Department for Work and Pensions and the UK Office for National Statistics. The novel small-area prediction model for accidental dwelling fire risk was validated and shown to provide a more detailed fire risk assessment from fire causal factors than existing models used by other fire and rescue services [1], [2], [4]. This model also involved the use of a novel geographical information system to provide a spatial layered risk model [2], [3], [4] to support fire prevention management. The research also produced a novel approach to the testing of geographical information systems [3].

The research into accidental dwelling fire risk was extended to incorporate associated risk factors within health care, social care and crime using the previous analysis of fire risk as a basis for further analysis of causal factors. This led to the development of a novel customer segmentation model by P. Lisboa, M. Taylor and I. Jarman between 2010 and 2013 to provide novel analyses of at-risk social groups in terms of combined fire risk, health risk, social care risk and crime risk [5]. The theoretical challenge of the research was to identify those social groups and individuals that were considered at risk by a number of public sector agencies, resulting in a set of community profiles. The novelty of the research was a customer segmentation approach that identified combined fire, health, social care and crime risks to produce a set of community profiles. The research was funded by the UK Department for Communities and Local Government (2010 – 2012) (grant awarded to P. Lisboa, M. Taylor, and I. Jarman) [8] and MF&RS (2012 – 2013) (grant awarded to P. Lisboa, M. Taylor, and I. Jarman) [9]. The grants involved MF&RS, Wirral Council, Wirral NHS PCT and Merseyside Police as project partners. The research provided novel and original customer insight allowing the partner agencies to work collaboratively by signposting individuals and households to relevant partner agencies [5] as part of a multi-agency preventative approach. Overall the staff involved in the project were Professor P. Lisboa, Senior Lecturers M. Taylor and H. Frances, and Senior Researcher I. Jarman.

3. References to the research

Peer-reviewed outputs

- [1] Taylor MJ, Higgins E, Lisboa PJG, Kwasnica V (2012) "An Exploration of Causal Factors in Unintentional Dwelling Fires", *Risk Management*, vol. 14(2), 109-125, DOI 10.1057/rm.2011.9.
- [2] Taylor MJ, Higgins E, Francis M, Lisboa PJG (2011) "Managing Unintentional Dwelling Fire Risk", *Journal of Risk Research*, vol. 14(10), 1207-1218, DOI 10.1080/13669877.2011.587884.
- [3] Taylor MJ, Higgins E, Lisboa PJG (2012) "Testing Geographical Information Systems: A Case Study in A Fire Prevention Support System", *Journal of Systems and Information Technology*, vol. 14(3), 184-199, DOI 10.1108/13287261211255310.
- [4] Higgins E, Taylor M, Francis H (2012) "A Systemic Approach to Fire Prevention Support", *Systemic Practice and Action Research*, vol. 25(5), 393-406, DOI 10.1007/s11213-012-9229-9.
- [5] Higgins E, Taylor M, Jones M, Lisboa PJG "Understanding Community Fire Risk – A Spatial Model for Targeting Fire Prevention Activities", *Fire Safety Journal*, <http://dx.doi.org/10.1016/j.firesaf.2013.02.006>.

Note that the best three publications are [5], [1] and [2].

Grants awarded

- [6] Merseyside Fire and Rescue Service contestable research funding for Analysis of anomalous unintentional dwelling fires (2007-2008), Strategic Planning Department, MF&RS Headquarters, Bridle Road, Bootle, Merseyside, L30 4YD, Tel: 0151 296 4000. Grant awarded to M. Francis, H. Francis and M. Taylor, Grant Value £16,000.
- [7] Knowledge Transfer Partnership KTP007286 (2009-2010), Knowledge Transfer Partnerships, Technology Strategy Board, North Star House, North Star Avenue, Swindon, SN2 1UE. Tel: 0300 321 4357, Email: KTP_Academics@tsb.gov.uk. Grant awarded to M. Francis, H. Francis and M. Taylor, Grant value £83,000.

- [8] UK Department of Communities and Local Government (2010 - 2012), Customer led transformation programme. Grant awarded to P. Lisboa, M. Taylor and I. Jarman, Grant value £77,716. http://www.local.gov.uk/c/document_library/get_file?uuid=670e4b6c-876a-40f9-a69a-ca918b667030&groupId=10180.
- [9] Merseyside Fire and Rescue Service contestable research funding for Customer Insight Project (2012-2013), Strategic Planning Department, MF&RS Headquarters, Bridle Road, Bootle, Merseyside, L30 4YD, Tel: 0151 296 4000. Grant awarded P. Lisboa, M. Taylor and I. Jarman, Grant value £44,000.

4. Details of the impact

In 2008 the economic cost of fire across the UK was estimated at £8.3 billion. As well as the economic cost, there is also the injury and loss of life resulting from fire incidences. Between 2009/10 and 2012/13, there was a reduction in accidental dwelling fires by approximately 12% (163 incidents) across Merseyside [A], [B], [D]. This reduction in accidental dwelling fires is associated with improved delivery of fire prevention activities resulting from the research. Based upon the knowledge gained from causal factor analysis, the enhanced community safety model enabled more accurate identification of vulnerable groups and individuals within the community, for example those likely to have elderly falls. The community safety model supports preventative measures that can save considerable funds in the medium term for the different agencies involved. For example, care for elderly individuals who may suffer from excess cold costs £3.2m per local authority, whereas remedial work is estimated to cost less than £1m, resulting in a significant saving if the vulnerable people can be identified through the customer insight approach.

Fire Prevention:

A KTP in partnership with MF&RS developed a novel causal factor model of accidental dwelling fire risk and incorporated it into a geographical information system for fire prevention management. This has been used by MF&RS to support the delivery of fire prevention within Merseyside since the end of the KTP. The implementation of the enhanced risk identification system was a major development for MF&RS, which is now able to more effectively identify groups of individuals at increased risk of experiencing an accidental dwelling fire. This allows greater understanding of why groups of individuals are at risk for better tailoring and targeting of services to the community. The adoption in 2010 of the approach as best practice for improved delivery of fire prevention activities is associated with an observed reduction in accidental dwelling fires between 2009/10 and 2012/13.

Furthermore, the geographical information system and the learning gained from the KTP contributed to the Community Safety strategy at MF&RS [A]. The financial impact of our research on MF&RS was measured by the reduced cost of responding to accidental dwelling fires. Response to fire is estimated at £3,100 per incident, therefore reducing the number of incidents amounted to an estimated saving of over £500,000 over the period 2009/10 to 2012/13 [D].

MF&RS has been a pioneer of preventative initiatives in the community, reducing accidental dwelling fires and driving down related deaths in Merseyside over several years. The sophisticated geographical information system developed through the KTP assisted with further reductions by better targeting fire prevention activities using a spatial analysis of known accidental dwelling fire risk factors. As this methodology is based on risk factors that are also of relevance to other partners, it has enhanced collaboration with other public service agencies, as listed in Section 2, for more accurate targeting of preventative measures to the most vulnerable communities. This will have significant economic value in the region but most importantly will reduce human suffering. The system has the potential to be adopted by Fire & Rescue Services across the UK and possibly beyond [B].

Community Safety:

We extended our fire safety approach to other aspects of assessing risk to the community through a customer insight project funded by the UK Department of Communities and Local Government and MF&RS. This extended the analysis of fire risk to incorporate associated

health, social care and crime risks that used the previous analysis of fire risk as a basis for further analysis of causal factors. The research provided an objective means to identify households most at risk in the community in order to support more targeted use of fire prevention resources [5]. The approach has been disseminated as a model good practice approach by the UK Department of Communities and Local Government [C]. This supports the joined-up public sector provision approach advocated by the UK Government [C].

The results of a pilot of customer insight found that over 70% of residents identified by the approach and visited during the customer insight pilot had some factors present that could result in them becoming at risk from fire. In addition, 50% of residents visited were signposted or referred onto another agency because additional risks or needs were identified [C]. This evidences the value of more accurate targeting of fire prevention activities as part of a multi-agency preventative approach, by allowing officers to signpost or refer onto other agencies if additional risks are identified. This methodology has the potential to significantly reduce costs for MF&RS and its partners. For example, due to more accurate identification of vulnerable individuals through the customer insight project, elderly falls and problems related to excess cold will be reduced. An elderly person falling at home will cost the NHS approximately £2,500, whereas preventative remedial work carried out at the home of an elderly person would result in a potential avoided cost of approximately £2,000 per person (there are approximately 5000 elderly falls in Merseyside each year). Another currently important concern is that of problems relating to excess cold, which cost £3.2m per local authority, whereas remedial work is estimated to cost less than £1m, giving a significant saving if the vulnerable people can be identified through the customer insight approach.

The community of Merseyside has benefited from more co-ordinated community safety which supports elderly, disabled and other at-risk individuals to live independently via co-ordinated support from the fire and rescue service, national health service, local council and police service. The Community Profiles developed by the research are used by the six MF&RS Service District Prevention Teams and the Home Safety Coordinator at headquarters when developing new fire safety campaigns. The Vulnerable Person Index (VPI) developed by the research is used by Operational Crews at the sixteen fire stations in Wirral and Liverpool on a daily basis. This index enables Operational Crews to better target Home Fire Safety Checks based on known risk factors, for example a person known to adult social care, over 65, living alone etc. The Community Profiles have also allowed for a greater understanding of communities. For example, an analysis of kitchen fires identified that over 80% occurred in three out of the ten Community Profile groups. This enabled greater targeting of safer cooking messages towards those most at risk. The VPI has enhanced the identification of vulnerable individuals. Typically, some of these vulnerable individuals may not have been identified using previous methodologies as they live within 'low risk' areas. Utilising this methodology has resulted in a 5% increase in Home Fire Safety Check visits within areas previously defined as 'low risk'. In addition, over 70% of these individuals were found to have some fire risks present that could lead to death or injury.

5. Sources to corroborate the impact

[A] Knowledge Transfer Partnership KTP007286 Final report, Knowledge Transfer Partnerships, Technology Strategy Board, North Star House, North Star Avenue, Swindon, SN2 1UE. Tel: 0300 321 4357, Email: KTP_Academics@tsb.gov.uk.

[B] KTP Advisor for Knowledge Transfer Partnership KTP007286, Knowledge Transfer Partnerships, Technology Strategy Board, North Star House, North Star Avenue, Swindon, SN2 1UE.

[C] UK Department of Communities and Local Government, Customer Led Transformation Programme Case study: Merseyside Fire and Rescue Service 41/58 http://www.local.gov.uk/c/document_library/get_file?uuid=670e4b6c-876a-40f9-a69a-ca918b667030&groupId=10180.

[D] Business Intelligence Manager, Merseyside Fire and Rescue Service, MF&RS Headquarters, Bridle Road, Bootle, Merseyside L30 4YD.