STUDY REPORT

SR 238 (2010)

Residential Design Fire Scenario Selection – Using NZ Fire Incidents

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Preface

This report was prepared during research into design fire scenarios for use in a probabilistic model as part of the Building Safety Design-Fire Tool for Use in a Risk-Informed Regulatory Environment research project. This report utilises the results summarised in the two reports: 'Residential New Zealand Fire Statistics: Part 1 Initial Analysis', *BRANZ Study Report* 222 (Robbins and Wade 2010a), and Part 2 'Two-Level Event Tree Analysis', *BRANZ Study Report 223* (Robbins and Wade 2010b).

Acknowledgments

This work was jointly funded by the Foundation for Research, Science and Technology from the Public Good Science Fund and BRANZ from the Building Research Levy. Fire statistics used in the analysis were provided by the New Zealand Fire Service.

Note

This report is intended for researchers, fire engineers and regulatory authorities.

Residential Design Fire Scenario Selection

BRANZ Study Report SR 238

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Reference

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Abstract

Sets of design fire scenarios are required as one of the inputs for the probabilistic model currently being developed.

Results and experience from analysis of New Zealand fire incident statistics were used in the identification of the most important design fire scenarios for residential occupancies in terms of life safety for apartments and all residential types of buildings.

A normalised weighting of design fire scenarios was developed that incorporates:

- the magnitude of the incidents (in terms of total numbers of incidents and casualties)
- the severity of the incidents (in terms of casualties per incident), and
- a measure of the confidence in the available statistics (in terms of the spread of data compared to assumed normal distributions for each of the scenarios considered).

Example distributions of fire design scenarios based on a normalised weighted combination of the importance values, based on percentages and ratios, for apartment fire statistics is in a form that can be used as an input for the probabilistic model currently in development as part of the larger project that this research was performed within.

The summary of the analysis presented here focuses on life safety of occupants. A similar approach may be used focusing on protection of property if, for example, extent of flame damage statistics were used instead of casualties. The approach presented here could also be applied to commercial occupancies.

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1. INTRODUCTION

The overall research project has a number of core elements as follows:

1. The development of a suitable fire properties database.
2. The characterisation of fire scenarios in residential and commercial occupancies.
3. The development of an item-to-item fire spread sub-model.
4. The development of a semi-automated mechanism for providing probabilistic design fire input (a so-called Design Fire Generator).
5. The development of probability distributions that reflect the reliability of building fire safety features.
6. The integration of these components into the final fire model with associated testing, validation and user documentation.

This report contributes to the second component listed above: the characterisation of fire scenarios in residential and commercial occupancies. This report summarises the event selection that is used in part towards the characterisation of residential fire scenarios.

1.1 Motivation

In 1991, New Zealand was one of the first countries to introduce a performance-based building regulatory system. In a situation where the New Zealand Building Code (NZBC) applies nationally and a small market size, the intervening period has provided the ability to review the effectiveness of the performance-based regulatory regime in a New Zealand context.

A lack of quantitative fire safety performance criteria and suitable verification methods remain the key obstacles for the full benefits of performance-based design being realised in the New Zealand built environment. This has resulted in the unsatisfactory situation of fire safety designers both proposing and applying their own criteria. In addition, with no standardisation, general fire safety engineering (FSE) design approaches are not consistent and sensitivity analyses are rarely performed.

Part of the infrastructure needed to support the next generation of risk-informed stochastic FSE regulation in New Zealand is suitable calculation tools. Therefore research was initiated to develop a new probabilistic model (based on the deterministic BRANZFIRE computer zone model) that generates outputs in the form of cumulative distribution functions that can be directly compared with probabilistic criteria for building fire safety performance.

1.2 Objectives

The objectives of this report are to:

1. Describe a method for selecting event scenarios for use in design fires using fire incident data.
2. Provide an example design fire scenario selection for residential buildings.

2. DEFINITIONS

The definitions used throughout this body of work are consistent with those found in ISO/TS 16733 (2006).

Fire scenario

A fire scenario is a qualitative description of the course of a fire with time, identifying key events that characterise the fire and differentiate it from other possible fires related to the building design and intended usage that will be the focus of the fire safety analysis.

Design fire scenario

A design fire scenario is a specific fire scenario on which a deterministic fire safety engineering analysis will be conducted, i.e. those determined to be the most important in relation to the specific building design and intended usage that is the focus of the fire safety analysis.

3. SUMMARY OF SCENARIO SELECTION METHOD

Characterisation of fire scenarios in residential occupancies for use as input to the probabilistic model was performed by:

- determining what input is required by the Design Fire Generator performing a detailed analysis of New Zealand fire incident statistics
- estimating the weightings of the fire scenarios using fire incident statistics in terms of fire event frequency and loss of life and injury for use in the Design Fire Generator
- accounting for the influence and limitations of statistical significance and use of records of past events as indications of future events.

Characterisation of fire scenarios in residential occupancies requires:

- choosing the intended level of user interaction/control
- determining what input is required for the Design Fire Generator for the fire scenarios
- performing a detailed analysis of New Zealand fire incident statistics
- estimating the weightings of the fire scenarios using fire incident statistics in terms of fire event frequency and loss of life and injury for use with the Design Fire Generator
- accounting for the influence and limitations of statistical significance and use of records of past events as indications of future events.

3.1 Level of user interaction

Ultimately it is intended that a user has complete control over the design fires scenarios to be used, since a researcher and a designer would potentially have very different

motivations for using a fire model and therefore possibly require a different set of scenarios.

The method outlined here is an example of using fire incident statistics to estimate the scenarios that would be of highest occurrence or highest cost of life, if the future were able to be predicted based on past events.

At this stage, it is recommended that if the combination of selections of fire events presented here is used, the level of user interaction is restricted to the values for weightings of a set of design fire scenarios.

It is intended that users would also be able to use the methodology demonstrated here to develop their own design fire scenario set for their own specialised purposes.

3.2 Input required for Design Fire Generator

The required input for the Design Fire Generator includes:

- description of scenarios – in terms of pointing to a design fire database
- weightings of scenarios

The selection of scenarios based on fire incident data is the focus of this report. The weightings of the scenarios selected in this manner is based on an effective 'cost', where the 'cost' is estimated based on statistics for numbers of events and civilian casualties. This is discussed in detail in Section 3.4.2.4.

Potential use of weightings beyond the selection of the most important scenarios to include in the suite of design fire scenarios is discussed at the end of Section 0.

3.3 Identifying scenarios to include in residential set

It is assumed that the scenarios that are the most important to consider can be, at least initially, identified from available incident statistics in conjunction with engineering judgement for the specific building design, functionality and usage, and the specific fire safety objective for the fire safety analysis.

For example, if the fire safety objective is stated as life safety of the occupants, then fire incident statistics for the most common and the most costly, in terms of civilian casualties, could be used. For other objectives, 'most costly' may refer to monetary loss for insurance purposes, area of building lost to flame, and smoke damage.

The fire safety objective for the demonstration of concept of a method for selection of design fire scenarios for this study is life safety of the occupants. Throughout the remainder of this document 'most common' refers to the number of fire incidents in residential buildings and 'most costly' is based on civilian fatalities and moderate and severe injuries in residential buildings.

The analysis of New Zealand residential fire incidents used for this research is summarised in previous *BRANZ Study Reports 222* and *223* (Robbins and Wade 2010a, 2010b).

The fire incident database category of 'room of fire origin' was used as a basis for describing possible scenarios, and then the scenarios were reduced to the most important based on the most common and most costly of the groups for the other three categories. In particular, the category combination of 'room of fire origin' and 'reported cause of ignition' was found to be the most useful in terms of this analysis.

The following is a summary of the current state of the New Zealand fire incident statistics utilised in this research.

3.3.1 Summary of the state of New Zealand statistics

An analysis of New Zealand fire incident statistics have been reported elsewhere (Robbins and Wade 2010a, 2010b). A summary of these results are included here to provide a context for the further analysis that was performed and to estimate the event selection for residential occupancies.

The residential fire statistics available for New Zealand are limited based on the small population of the country. For example, between 1995 and 2005 there was an average of approximately:

- 230 and 3500 fires/year in apartment and residential properties, respectively
- four and 24 civilian fatalities/year in apartment and residential properties, respectively, and
- 55 and 270 civilian (moderate to severe) injuries/year in apartment and residential properties, respectively.

Furthermore, historical trends are influenced by changes in fire incident recording processes of the New Zealand Fire Incident Reporting System. These include a major change in 1995 to the way casualties were recorded, and changes in the regulatory requirements, of which there was a significant change introduced in 1991, as briefly outlined above. To reduce these types of influences, the data available for the period from 1995 to 2005 was used in this analysis.

The available fire statistics were first analysed with specific objectives of:

- determining the appropriateness of the use of New Zealand fire statistics for all residential structures to represent fire statistics for apartments
- determining the appropriateness of the use of New Zealand residential fire statistics to determine a selection of fire events for apartments
- identifying the most common and the most costly fire events that occur in New Zealand residential structures.

In summary, there were four categories considered in the analysis: room of fire origin, equipment involved in ignition, first material ignited, and cause of fire. These categories were chosen based on the ease of potentially describing a design fire scenario and the details available in the fire statistics. Each category considered had up to 211 individual classes, where a class represents a specific standard description used in the recording of the fire statistics (e.g. kitchen, living room, etc, are classes of the category of room of fire origin). The situation of such a large number of results was improved by using groups of related individual classes. Similar classes were combined into a smaller number of clusters (or groups) that included a group for 'information not recorded' (to provide an indication of the level of detail recorded) and 'other' (to collate all the classes with small individual contributions to the information, based on the results of the analysis for all of the individual classes). The results were four categories:

- Room of fire origin, with 74 classes agglomerated into seven clusters
- Equipment involved in ignition, with 211 classes agglomerated into nine clusters
- First material ignited, with 80 classes agglomerated into seven clusters, and
- Cause of fire, with 67 classes agglomerated into nine clusters.

The selection of the clusters for each category considered was based on an initial analysis of all the available data. The details and results of the analysis used are summarised elsewhere (Robbins and Wade 2010a). An example of the total percentage of fire incidents in residential structures for the categories of room of fire origin and equipment involved in ignition is shown in Figure 1.

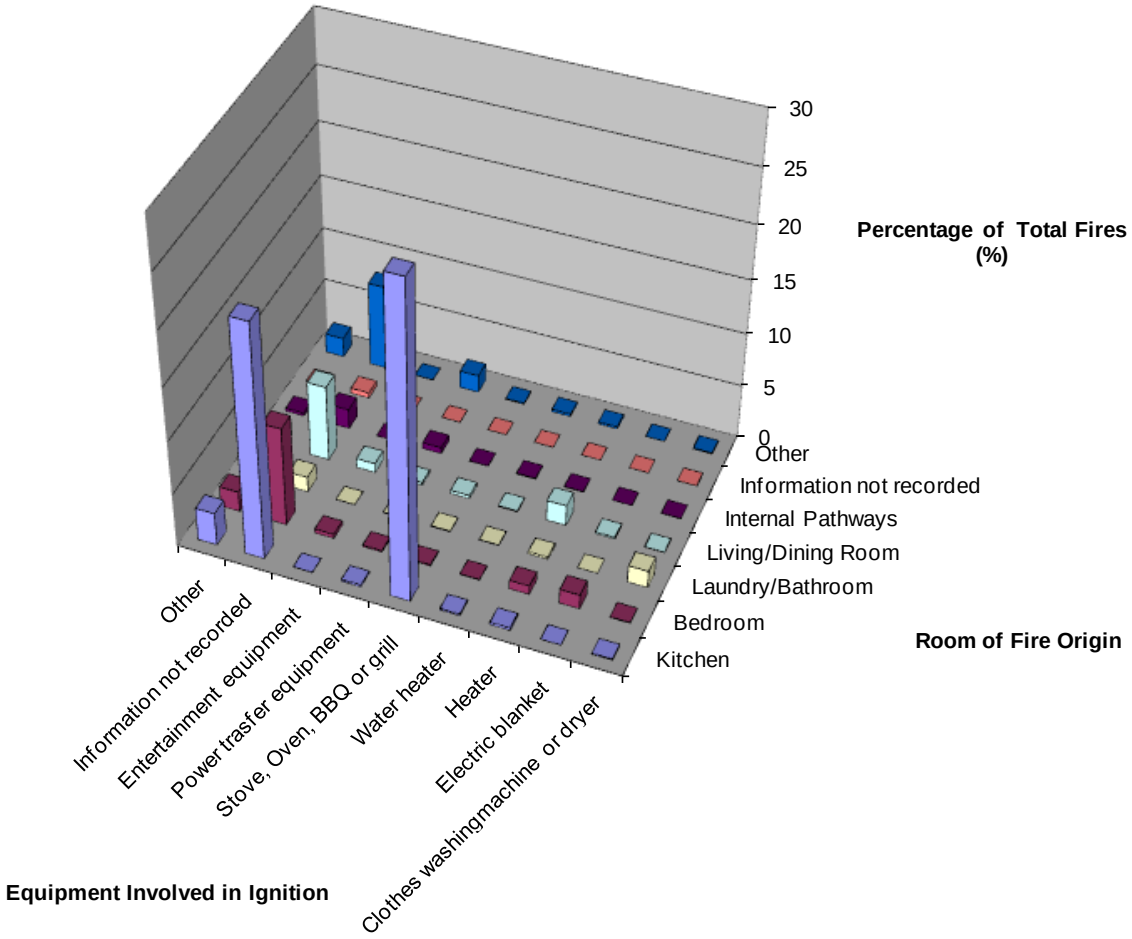


Figure 1: An example of the percentages of total fires that occurred in apartments for combinations of room of fire origin and equipment involved in ignition (1995–2005)

The appropriateness of using New Zealand fire statistics for all residential structures to represent fire statistics for apartments was estimated using linear correlations between the two data sets for the range of categories and classes and clusters within these. An example of the results of the linear correlations between apartment and all residential data sets for combinations of the room of fire origin and each of the other categories is shown in Figure 2. In summary, the linear correlation coefficient values indicated that residential results for numbers and percentages of fires and injuries are reasonably similar to the apartment data set and therefore can be used as in indication of the trends expected in apartment fire incidents. Care must be used when considering fatalities or ratios of casualties to fires for residential structures compared to apartments (Robbins and Wade 2010b).

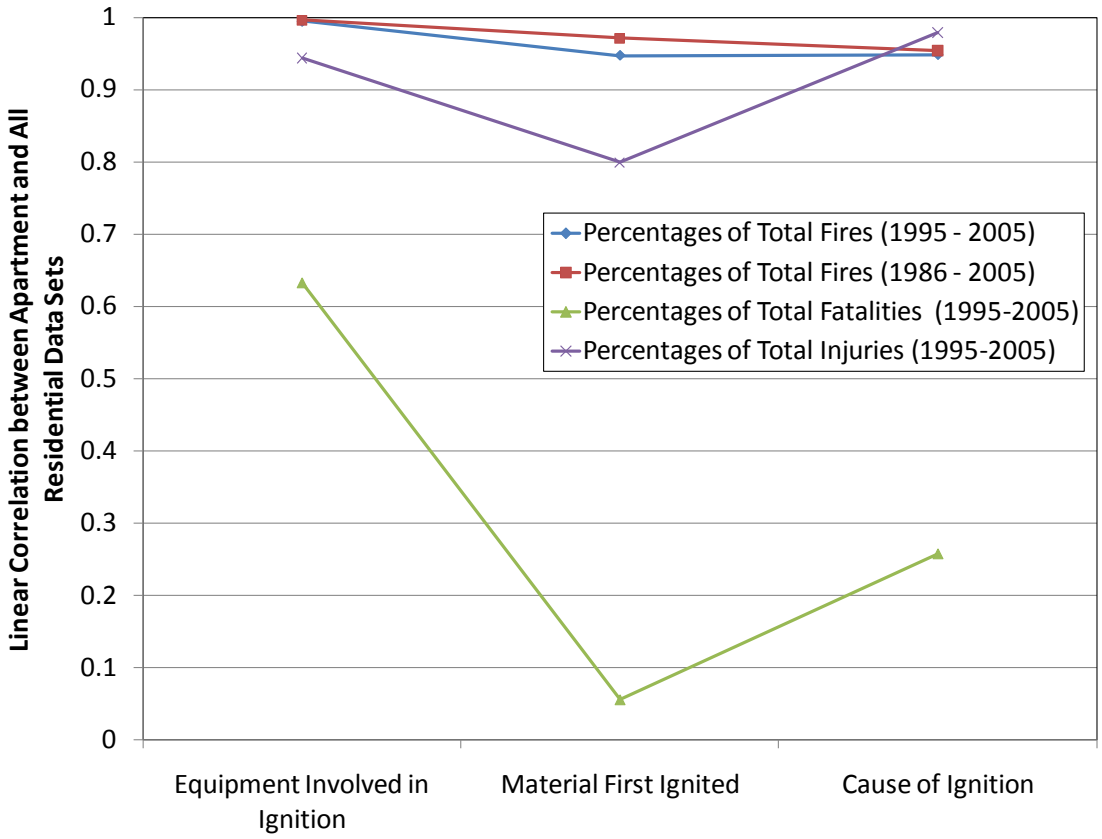


Figure 2: Linear correlation coefficients for apartment and all residential data sets for percentages of fires, fatalities and injuries

The appropriateness of using New Zealand residential fire statistics to identify a selection of fire events for apartments was determined by the probabilities of the yearly numbers of fires, fatalities and injuries of the data sets used being representative (within ±10%, ±20% or ±50%) of the reality of the situation in New Zealand, assuming this could be represented by a normal distribution. The assumption that these values can be described by a normal distribution is only for calculation purposes to provide a measure of influence of the sample size and spread. It is not expected that data would provide a normal distribution for statistics per year, since historical trends are expected to be influenced by changes in NZBC requirements, building practices and changes in occupant behaviour that are all changeable over time. However for short time periods, the assumption of a normal distribution may be reasonable if the results are used as indicative only. An example of the results for residential fire incidents for the categories of room of fire origin and equipment involved in ignition is shown in Figure 3. The results of this analysis are presented in full elsewhere (Robbins and Wade 2010a, 2010b).

The averages for fire events for the combined clustered categories are estimated to be mostly reasonably (i.e. >80%) representative, to within at least ±20%, of the reality of the situation in New Zealand (excluding clusters of 'no information recorded' and 'other'). For casualties the combined clustered categories are estimated to be mostly reasonably (i.e. >80%) representative, to within at least ±50%, of the reality of the situation in New Zealand. Therefore the results based on these statistics are recommended to be used only as a general indication.

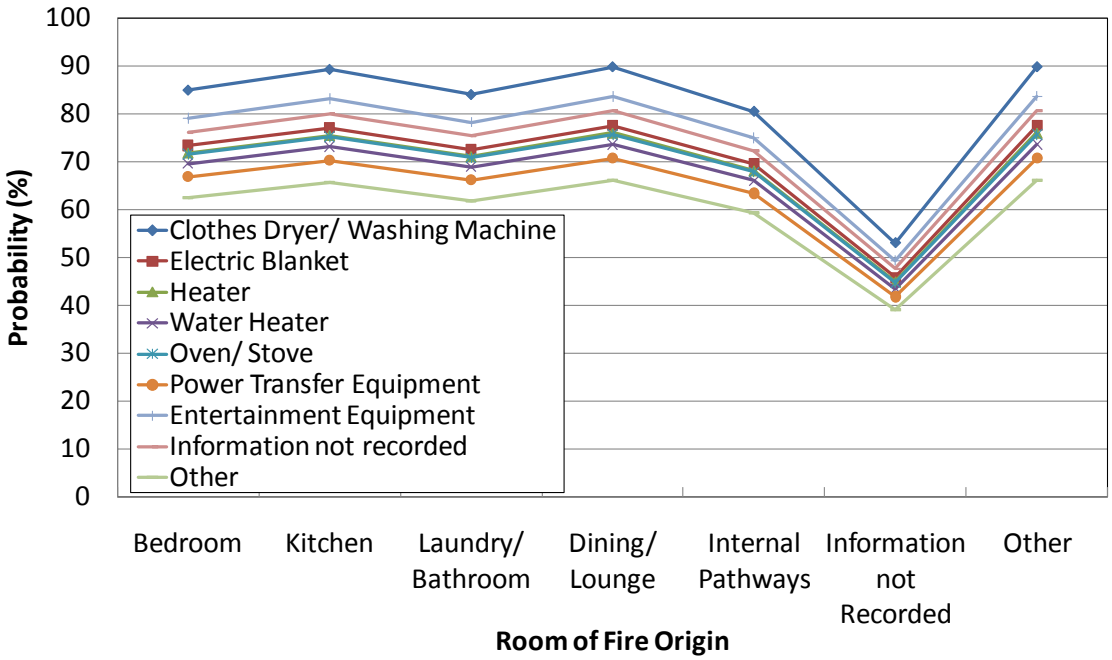


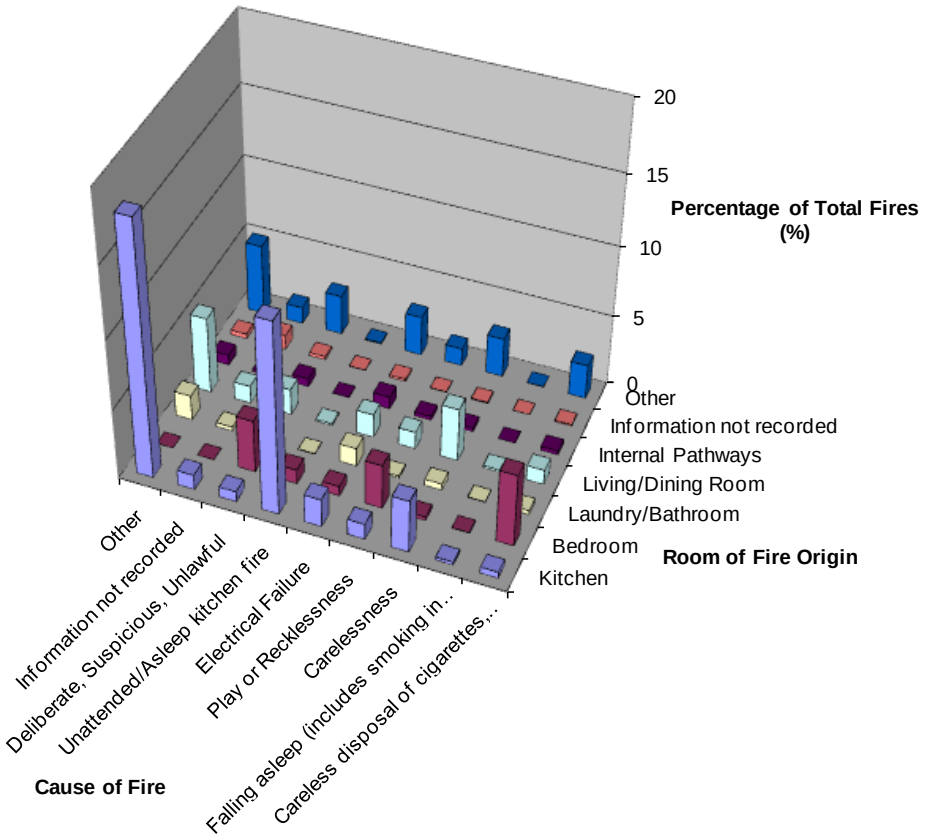
Figure 3: Probabilities of the data set for residential numbers of fire events for room of fire origin and equipment involved in ignition being representative (within ±20%) of the situation in New Zealand (assuming normal distributions)

The most common and the most costly fire events that occur in New Zealand residential structures were identified for each of the combinations of clusters of categories that were considered. An example of the results for the combination of room of fire origin and equipment involved in ignition for residential data is shown in Figure 4(a) (Robbins and Wade 2010b).

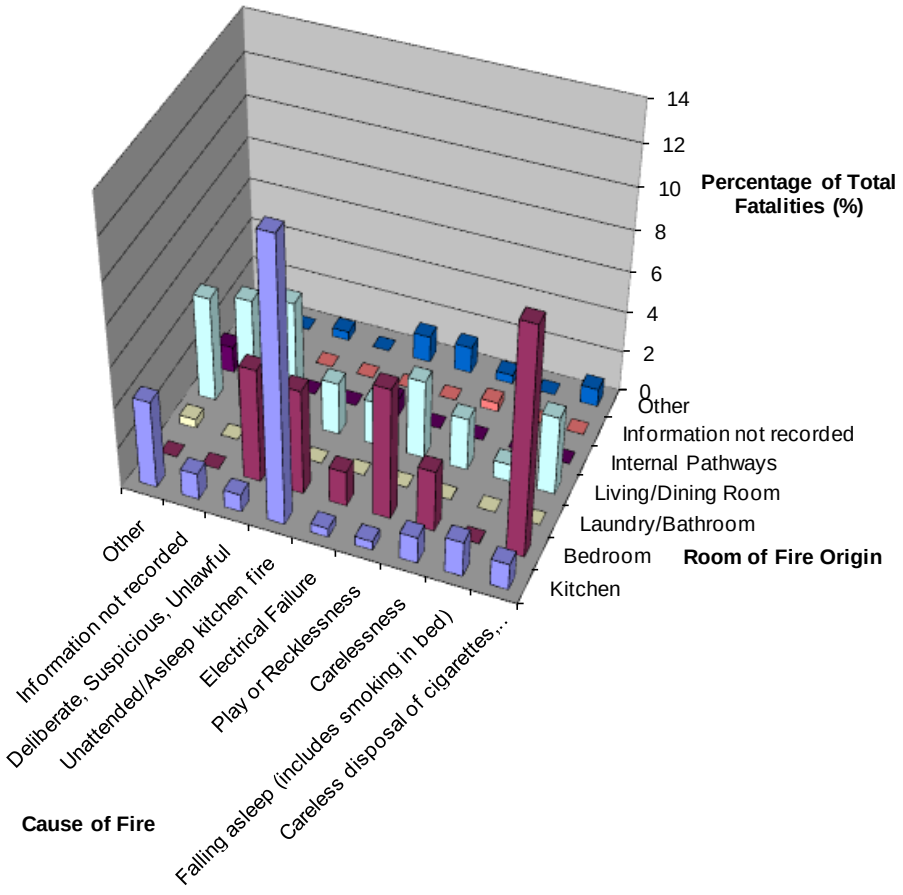
The results for the most costly fire incidents were determined in terms of percentages of casualties and ratios of numbers of casualties to fires for each cluster. Examples of the results for the combination of room of fire origin and cause of ignition for residential data sets are shown in Figures 4(b) and (c).

The measure of the most costly in terms of percentages of casualties provides an indication of the most common combinations that lead to casualties. However the measure of the most costly in terms of ratios of casualties to fires provides indications of the most lethal combinations, which may or may not be common. The measure using ratios of casualties to fires may highlight the danger of both common (e.g. kitchen cooking equipment or bedroom electric blanket) and uncommon situations (e.g. bedroom cooking equipment or bedroom water heater). Uncommon situations may indicate the unintended use or misuse of equipment that are unexpected combinations of room of fire origin and equipment involved in ignition, etc. They may also indicate rare accidental types of fire incident that tend to be dangerous for the occupants (e.g. fires that occurred in ‘internal pathways’ that includes means of escape where electrical failure of equipment or electric transfer equipment was involved in ignition).

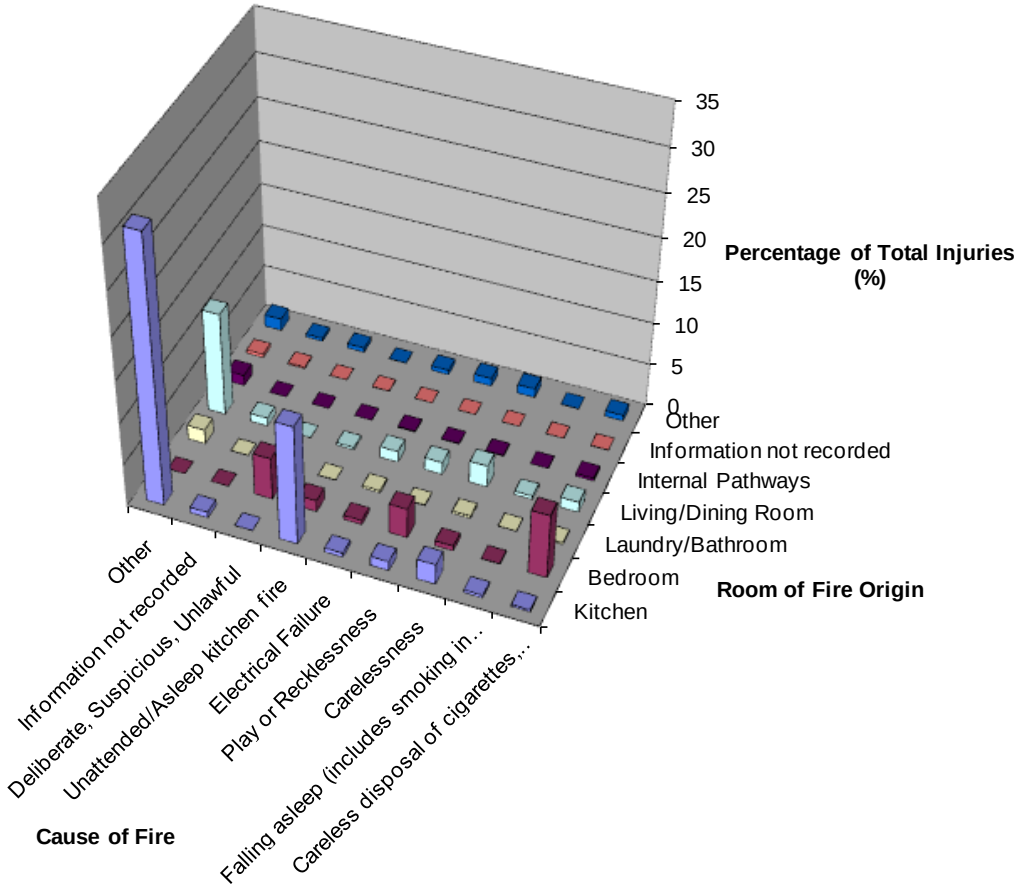
The results are recommended to be used as indicative only.


20
15
10
5
0
Percentage of Total Fires (%)
Other
Information not recorded
Internal Pathways
Living/Dining Room
Laundry/Bathroom
Bedroom
Kitchen
Room of Fire Origin
Other
Information not recorded
Deliberate, Suspicious, Unlawful
Unattended/Asleep kitchen fire
Electrical Failure
Play or Recklessness
Carelessness
Falling asleep (includes smoking in..
Careless disposal of cigarettes,..
Cause of Fire

(a)


14
12
10
8
6
4
2
0
Percentage of Total Fatalities (%)
Other
Information not recorded
Internal Pathways
Living/Dining Room
Laundry/Bathroom
Bedroom
Kitchen
Room of Fire Origin
Other
Information not recorded
Deliberate, Suspicious, Unlawful
Unattended/Asleep kitchen fire
Electrical Failure
Play or Recklessness
Carelessness
Falling asleep (includes smoking in bed)
Careless disposal of cigarettes,..
Cause of Fire

(b)



(c)

Figure 4: Percentage of total (a) fires, (b) fatalities and (c) injuries that occurred in residential structures for combinations of room of fire origin and cause of ignition (1995–2005)

3.4 Selecting the scenarios to consider

The number of possible fire scenarios needs to be reduced to a manageable number for use in the analysis as the design fire scenarios.

Clustering similar types of scenarios together is an initial way of reducing the number of possible fire scenarios for consideration. Prioritising this reduced number of possible fire scenarios assists in identifying the most important fire scenarios to be included in the analysis. These methods for reducing the possible fire scenario set to a manageable size for analysis are described here.

3.4.1 Clustering

The initial clustering of the classes within each category into groups of similar types reduced the number of possible scenarios for consideration. For example, for the category of 'room of fire origin' the classes including bathrooms and laundries were clustered to form one group that is referred to as a 'cluster'. Clusters were based around the most common and most costly individual classes. Selection of these clusters was based on the results and experience gained during the analysis of the entire data set available at the time.

Each category was also assigned one cluster called ‘other’. This cluster combines all the miscellaneous classes that did not have similarities with other classes enough to be combined into one of the descriptive clusters and were not sufficiently ‘common’ or ‘costly’ enough to be a cluster by themselves. Therefore the results for the ‘other’ cluster are not indicative of components of a possible scenario. Instead, results for the ‘other’ cluster provide an indication of what proportion of the fire incident parameters (e.g. fire incidents, civilian fatalities, etc) of interest is included or not in the analysis. Similarly, the ‘information not recorded’ cluster results provide an indication of the potential amount of data that was not collected for fire incidents attended by the fire service. This follows on to provide a general indication of how representative of the historical situation the results may be (i.e. considering that fire incidents are influenced by past building regulations, events, cultural trends, etc).

The initial clustering of individual fire incident data classes into groups significantly reduces the number of possible combinations of each category for consideration. However there are still a very large number of possible scenarios included. For example, considering the ‘room of fire origin’ category with five possible clusters of interest and the ‘cause of fire’ category with seven possible clusters of interest, this combination led to 35 possible scenarios for analysis.

3.4.2 Prioritising the set of possible scenarios

The set of possible fire scenarios needs to be prioritised so that the scenarios that are most important to the fire safety objectives are included for analysis. There are many ways of prioritising a set of scenarios (e.g. a risk-based approach using estimates for likelihood and consequence, etc). The method chosen for prioritising the set of possible fire scenarios will depend on the available relevant parameters and the statistical significance of the values.

The parameters used from the available incident statistics for this analysis is in terms of numbers of fire incidents and numbers of casualties. The three parameters used in this analysis are:

- percentage of fire incidents
- percentage of fatalities
- percentage of injuries (severe and moderate).

Other analyses may use additional or other parameters related to the specific fire safety objective of the analysis.

Considering life safety is the fire safety objective for this example, if a risk-based approach is initially taken, the likelihood of a fire could be related to the percentage of fire incidents and the consequence of the event could be related to the percentage of fatalities and injuries that have been recorded for that type of event.

However the statistical significance of New Zealand fire incident data, especially for fatalities and injuries, is not good. Considering the low statistical significance of New Zealand fire incident data for civilian fatalities, and to a lesser extent civilian injuries, the implications may be that recorded fire incidents that didn’t result in civilian casualties may not be representative of a reasonable expectation that there will be no civilian casualties from the next occurrence of this type of incident.

Therefore, another approach to prioritise the set of possible scenarios was taken that assumed that the occurrence of a fire incident posed a credible threat to life safety. That is, all recorded New Zealand fire incidents were considered to have a possible consequence in terms of life safety. Furthermore records of New Zealand fire incidents with civilian casualties were considered to have a higher probable consequence in

terms of life safety. Therefore the percentage of fire incidents and percentages of civilian casualties were effective measures of consequence, although they represent different levels of consequence.

A measure of the statistical significance of each parameter value was also included to provide a weighing of the confidence in the parameter value being representative of a larger population (i.e. larger data set, if it was available).

Therefore relative occurrence of the parameter, relative level of consequence of the parameter, and measure of confidence of the available data were combined to provide an indication of relative importance of each scenario. This is described here.

3.4.2.1 Relative occurrence

The relative occurrence of fire incidents and casualties was estimated using the percentage of total fire incidents, total fatalities and total injuries for each scenario.

In this analysis, the 'information not recorded' cluster for each category, where no detail was recorded, was removed and the fire incidents associated with this cluster were assumed to be proportional to the fire incidents where details were recorded. This was made on the assumption that incidents where no detail was recorded were relatively minor events that were caught early with limited damage and resulted in no casualties.

The cluster for 'other' was also removed, since it represents a number of dissimilar infrequent and low consequent possible scenarios within the statistics analysed.

3.4.2.2 Level of consequence

The relative level of life-safety consequences for the records of fire incident compared to records of civilian casualties was expected to be low. That is, the occurrence of a fatality is associated with much greater consequences than the occurrence of a fire incident.

Therefore the level of life-safety consequence for the occurrence of a fire incident was chosen to be 1. The level of life-safety consequence for the occurrence of a civilian fatality was chosen to be 6. For the occurrence of a civilian injury, the level of consequence was chosen to be 2.

The influence of the values chosen for these relative levels of life-safety consequence was investigated. A summary is included in Appendix D.

3.4.2.3 Measure of confidence

An estimate of the statistical significance of each parameter value was made by assuming a normal distribution could be used to describe each parameter value. Then the probability of the parameter value being within a certain percentage of the actual mean can be calculated.

The size of the New Zealand fire incident data set is such that it is only reasonable to expect to be able to estimate to within at least ±20% of the mean for the percentage of fire incidents and at least ±50% of the mean for the percentage of civilian casualties.

A brief description of the calculation of the probability of each parameter value being within a prescribed percentage of the mean of a data set that is assumed to be a normal distribution, and example values used in this study, are included in Appendix C.

3.4.2.4 Effective importance value

For each possible scenario (n), the estimated level of consequence (w), occurrence (P_{avg}) and statistical significance (S) of each parameter (x) were combined into one value that represents the relative priority of the scenario. This combined value is

referred to as an effective importance value (I_{eff}). The effective importance was then used to prioritise the set of possible scenarios. Fire incident data for two different building types (b) were used: apartments only and all residential structures.

An effective importance value ($I_{eff,b,n}$) for each possible fire scenario (n = combination of clusters from two categories) using each set of fire incident data for different building types (b = either apartments only or all residential structures) was calculated by:

$$I_{eff,b,n} = \sum_{x=1}^{3} w_x P_{avg,x,b,n} S_{x,b,n}$$

where w is an assigned weighting to represent the level of consequence of each parameter type used in the analysis (for this analysis values of 1 for fire incidents, 6 for fatalities and 2 for injuries were chosen),

P_{avg} is the average percentage, and

S is the estimated probability of the parameter value based on the New Zealand incident statistics, x, is within at least ±20%, if x=1 (for fire incidents), or at least ±50%, if x=2 or 3 (for fatalities or injuries, respectively), of representing the mean of an assumed normal distribution.

3.4.2.5 Effective importance value – considering ratios of casualties to fire incidents

If the available data set were statistically significant enough for the ratio of number of fatalities to fires and the ratio of number of injuries to fires associated with each possible fire scenario, then these could be used in a similar approach to calculate a relative importance value for use in prioritising the set.

For example, in order to estimate the impact of casualties per incident, an effective importance value based on ratios of casualties to fires $(I_{ratio,b,n})$ was calculated by:

$$I_{ratio,n,b,n} = \frac{w_2 P_{avg,2,b,n} S_{2,b,n} + w_3 P_{avg,3,b,n} S_{3,b,n}}{w_1 P_{avg,1,b,n} S_{1,b,n}}$$

Because of the limited size of the available data set in this study, this particular approach is not appropriate for this application.

3.5 Results – prioritised possible fire scenarios

Using the effective importance value approach that utilises the percentages of total numbers of fire incidents and casualties, the number of possible fire scenarios could be prioritised. In this case the top 10 ranked fire scenarios (ranked on the first approach to estimating an importance value based on apartment statistics) were:

Top 10 Ranked Fire Scenarios	Ranking for Apartments	Ranking for All Residential Structures
an unattended or careless cooking fire in the kitchen	1	1
deliberate or suspicious ignition in a bedroom	2	5
careless disposal of cigarettes, ashes, etc, in a bedroom	3	2
deliberate or suspicious ignition in the living or dining room	4	7
fire play, recklessness or carelessness in the living or dining room	5	3
fire play, recklessness or carelessness in a bedroom	6	4
an electric blanket or heater fire involving fabrics in a bedroom	7	6
an electrical failure of entertainment equipment or power transfer equipment in the living or dining room	8	8
an electrical failure of clothes washing machine or dryer in the laundry or bathroom	9	10
an electrical failure in an internal pathway	10	9

The ranking of scenarios for apartment buildings is used as an abbreviation to present a summary of example results in the figures presented in this section.

A summary of the results for the effective importance values for the set of possible fire scenarios is included in Appendix E.

When selecting the suite of design fire scenarios to be used in an engineering fire safety analysis, engineering judgement must be used to determine the applicability of available historical data (as represented by this set of top 10 fire scenarios) in conjunction with the design and intended functionality and use of the specific building design.

The intention of this document is to demonstrate the concept of the design fire scenario selection approach described here. There is no specific building design used in this demonstration. Therefore the top 10 fire scenarios, based on analysis of fire incident data, will be used as the suite of design fire scenarios.

3.5.1 Design fire scenario weightings

When the suite of design fire scenarios is chosen two approaches can be taken as to how the different scenarios are implemented in the engineering fire safety analysis. One approach is to work through the list using the same acceptance criteria for the level of analysis of each scenario. These acceptance criteria are associated with the

analysis techniques or methods, not the acceptance criteria associated with the fire safety.

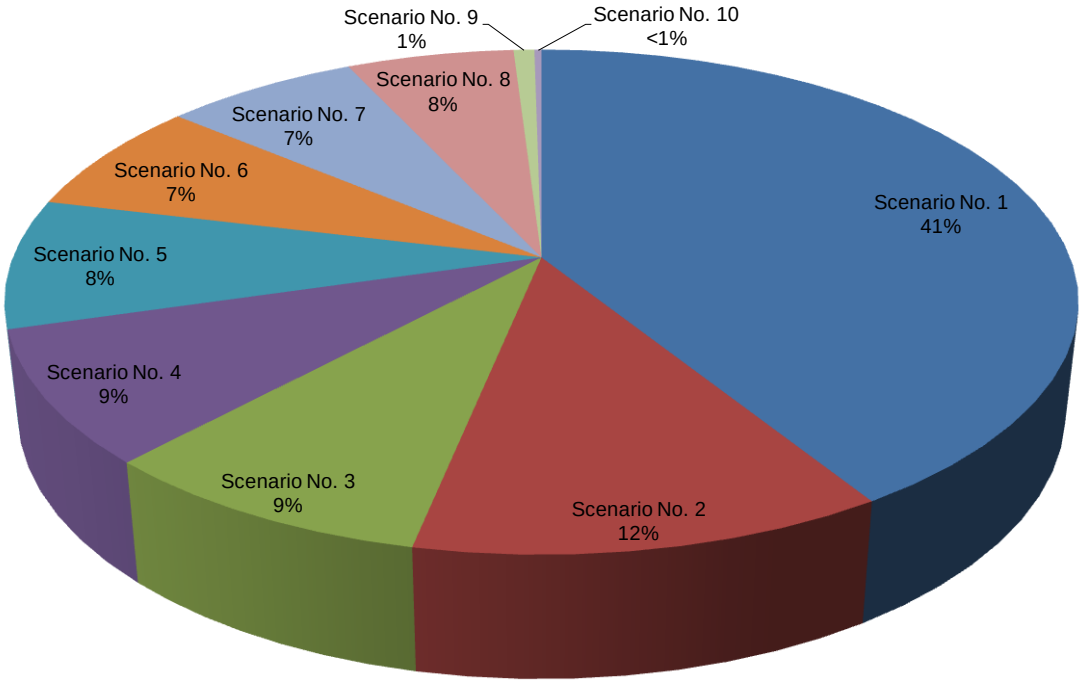
For example, if an iterative modelling approach with inputs sampled from distributions is used, then the same minimum number of iterations and convergence criteria would be used for each scenario. This effectively treats the scenarios as though their importance is uniform. Alternatively, the effective importance values for the selected fire scenarios can be normalised to provide an indication of design fire scenario weightings. The normalised weighting of each scenario may be used to distribute available computational attention. That is, the minimum number of iterations may be larger for the more highly weighted scenarios, having relatively higher likelihood, consequences or both.

As an example of the second approach, using the top 10 fire scenarios for prioritising the set of possible fire scenarios as the design fire scenario suite, the weighted effective importance value for these fire scenarios was normalised to provide an indication of design fire scenario weightings.

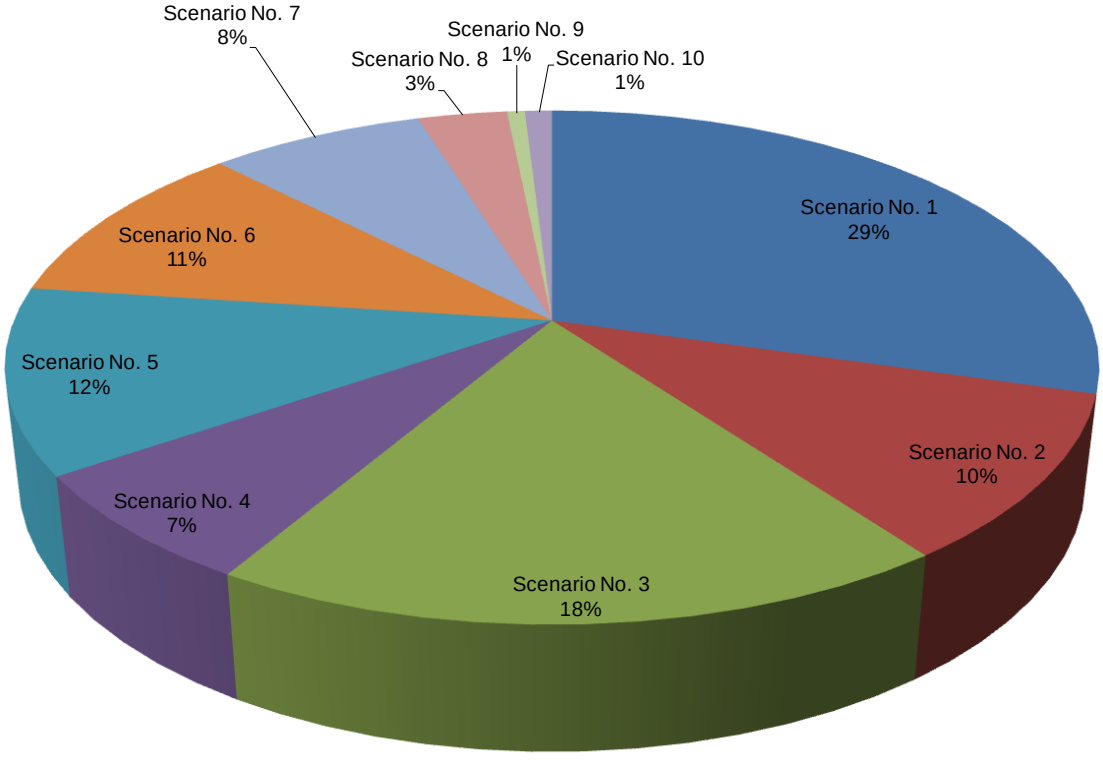
3.5.2 Example results

Examples of the results based on apartment and residential statistics are shown in Figures 5(a) and (b), respectively. An example of the results based on statistics for ratios of casualties to number of fires for apartments and all residential buildings is shown in Figures 6 (a) and (b), respectively. This normalised weighted effective importance approach provides values for a distribution for the design fire scenarios that could be used as input for the probabilistic model.

The weighted effective importance value based on ratios of casualties to number of fires provides a check to ensure that statistically costly scenarios are included appropriately. For example, in the case of the apartments (Figures 5(a) and (b)), the Scenario 10 (an electrical failure in an internal pathway) makes up 1% or less of the normalised distribution of scenarios based on percentage of fires and casualties and then accounts for approximately 90% from apartment statistics and 8% from all residential statistics of the normalised distribution of scenarios based on ratios of casualties to fires (i.e. the second approach to estimating an importance value). This comparison highlights the problem that there have been few apartment fires, and, of these, a small proportion of the incidents and casualties were located in internal pathways, resulting in both low frequencies and associated confidence in the values. However incidents in this area of fire origin were associated with a high cost in terms of casualties per incident. Therefore linearly combining the percentage-based and ratio-based estimates of importance ($I_{eff,b,n} I_{ratio,n,b,n}$) provides a relative measure of both the magnitude and severity of the scenarios. An example of such a distribution based on apartment and all residential statistics is shown in Figures 7 (a) and (b), respectively.

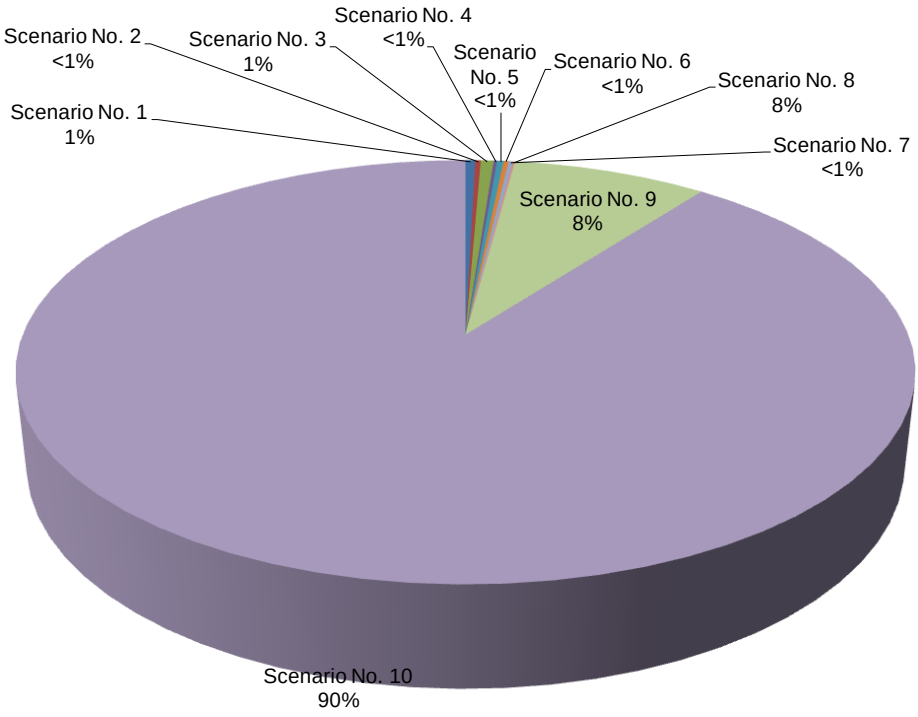


(a)

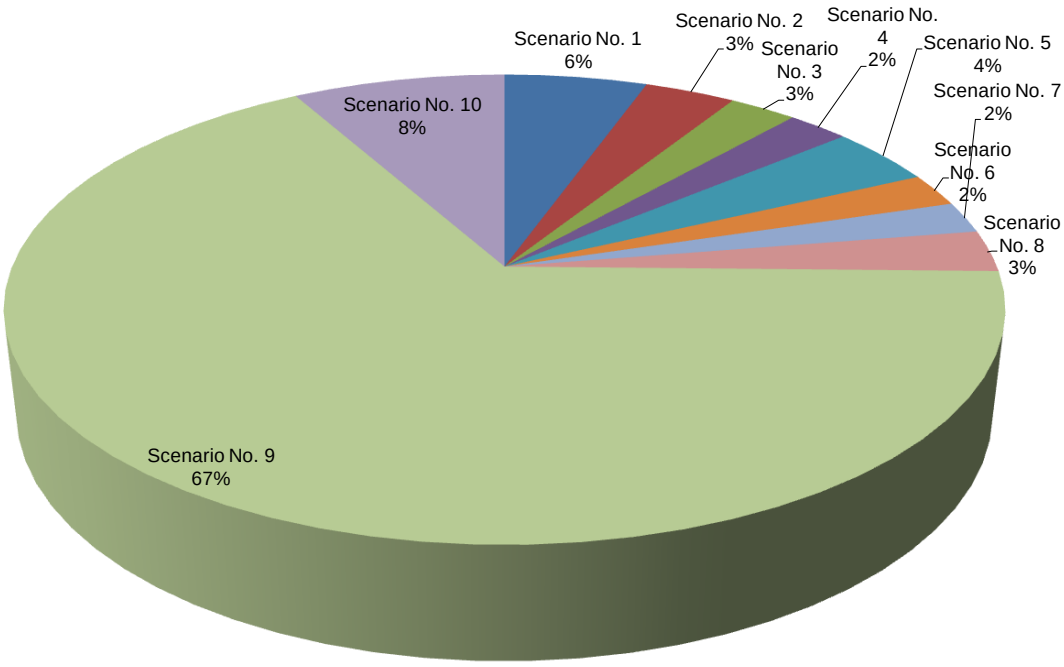


(b)

Figure 5: Normalised weightings of scenario set for (a) apartments and (b) all residential structures based on percentages of fire and casualty statistics

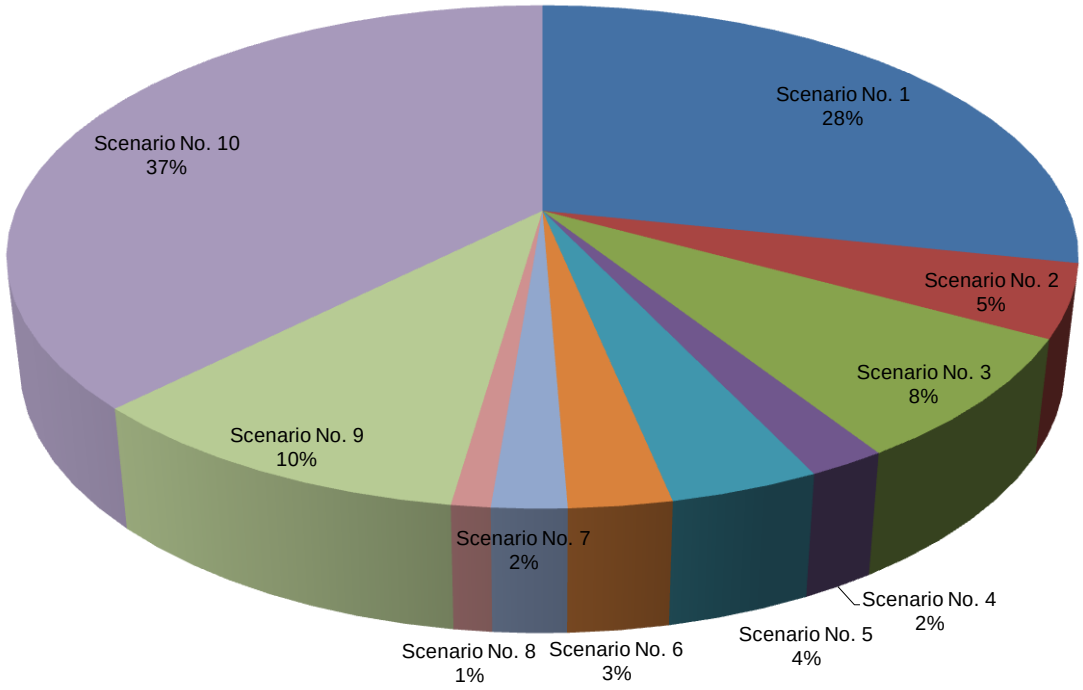


(a)

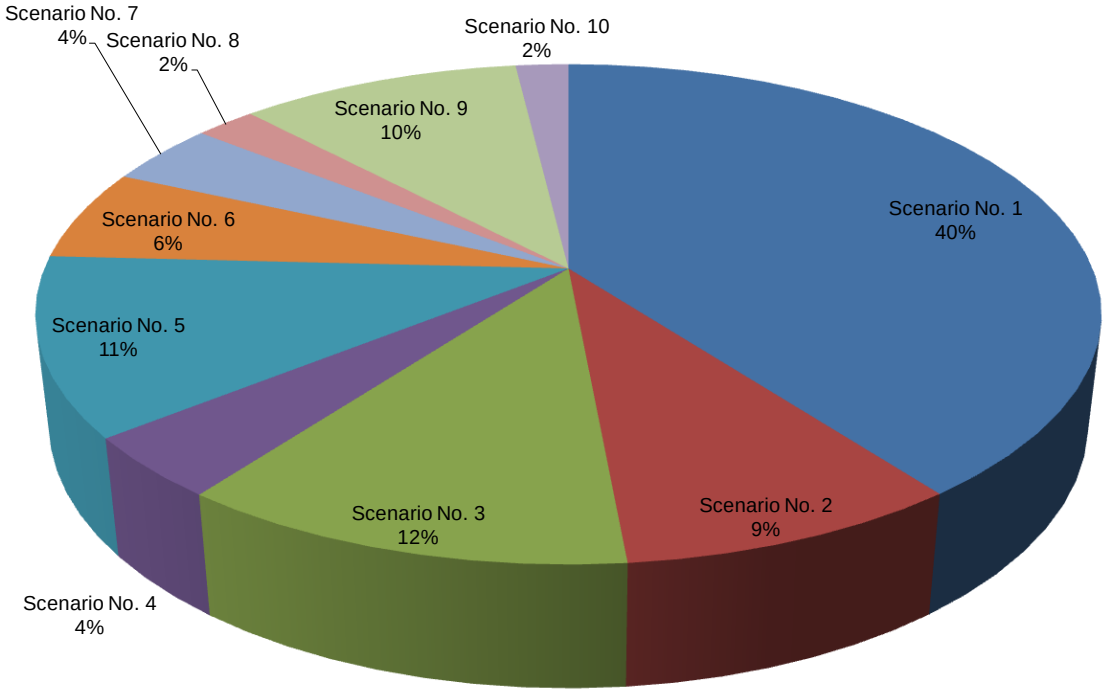


(b)

Figure 6: Normalised weightings of scenario set for (a) apartment and (b) all residential buildings based on ratios of casualties per fire



(a)



(b)

Figure 7: Normalised weightings of a design fire scenario set based on multiplying the results for the two approaches to estimating importance values together for (a) apartment and (b) all residential structures

Considering use of the weightings, once the suite of design fire scenarios is selected, the weightings of the scenarios could be considered as proportional to either the percentage of total iterations or possibly the convergence criteria, if the available computation time is critical and these assumptions are incorporated into the subsequent analysis. Otherwise, the weighting of each scenario is ignored and the same number of iterations or the same convergence criterion is used for each design fire scenario.

4. SUMMARY AND CONCLUSIONS

In summary, results and experience from analysis of New Zealand fire incident statistics were used to identify the most common, the most costly, and therefore the most important design fire scenarios for (apartment and all residential) building occupancies in terms of life safety.

A method to prioritise a set of possible design fire scenarios based on fire incident data was presented, using an effective importance value. The effective importance value is a relative measure of the consequence, likelihood and statistical significance using relevant parameters available from the fire incident data set.

The relative likelihood of the scenarios is estimated in terms of the percentage of incidents and casualties for each scenario or in terms of the ratios of casualties to fire incidents for each scenario. The relative levels of consequence are chosen for each fire incident parameter in terms of the impact on the fire safety objective. A measure of the confidence in the available statistics used in the analysis is estimated in terms of the sample size and spread of data compared to an assumed normal distribution for each of the scenarios considered.

Using the effective importance value as a method to prioritise the set of possible fire scenarios, the top fire scenarios to be included in the engineering fire safety analysis can be identified. It is expected that engineering judgement will be used in estimating the applicability of the available fire incident data to the design problem and therefore use the indicative results based on the historical records. It would also add relevant possible fire scenarios that could not be captured by fire incident data because of timing of changes in regulation requirements or building design features and intended usage specific to the design problem.

In addition, an approach for using the normalised effective importance value of design fire scenarios was suggested to identify areas where design and computational resources should be directed.

An example distribution of fire scenarios based on a normalised weighted combination of the importance values derived from percentages of casualties and incidents for apartment fire statistics is presented in a form that could be used as an input for the probabilistic model currently in development.

This approach may also be used for available fire incident data sets for other occupancies. The summary of the analysis presented here used an example of the fire safety objective of life safety of occupants. A similar approach may be used focusing on protection of property if, for example, the extent of area of flame damage statistics, monetary losses, etc, were used instead of (or in combination with) casualties.

5. REFERENCES

ISO/TS 16733. 2006. *Fire Safety Engineering – Selection of Design Fire Scenarios and Design Fires.* International Standards Organisation, Geneva, Switzerland.

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Appendix A SUMMARY OF NZ STATISTICAL RESULTS

A.1 Room of fire origin and equipment involved in ignition

Table 1: The most common combination of rooms of fire origin and equipment involved in ignition for apartment fires

Room of Fire Origin	Equipment Involved in Ignition	% Total Apartment Fires
Kitchen	Cooking equipment	29.09
Kitchen	Information not recorded	21.93
Bedroom	Information not recorded	9.28
Other	Information not recorded	7.96
Living/Dining Room	Information not recorded	7.08
Kitchen	Other	3.07
Living/Dining Room	Heater	1.92
Bedroom	Other	1.88
Internal Pathways	Information not recorded	1.84
Other	Other	1.81
Other	Power transfer equipment	1.64
Laundry/Bathroom	Clothes washing machine or dryer	1.58
Living/Dining Room	Other	1.51
Laundry/Bathroom	Information not recorded	1.41
Bedroom	Electric blanket	1.34
Living/Dining Room	Entertainment equipment	0.87
Bedroom	Heater	0.81
Internal Pathways	Power transfer equipment	0.56
Information not recorded	Information not recorded	0.49
Bedroom	Entertainment equipment	0.38
Laundry/Bathroom	Other	0.28
Living/Dining Room	Cooking equipment	0.28
Internal Pathways	Other	0.28
Living/Dining Room	Power transfer equipment	0.24
Kitchen	Heater	0.23
Other	Water heater	0.23
Laundry/Bathroom	Heater	0.21
Other	Heater	0.19
Kitchen	Power transfer equipment	0.17
Living/Dining Room	Electric blanket	0.15
Kitchen	Water heater	0.13
Bedroom	Power transfer equipment	0.13
Bedroom	Cooking equipment	0.11
Kitchen	Clothes washing machine or dryer	0.09

Table 2: The most common combination of rooms of fire origin and equipment involved in ignition for residential fires

Room of Fire Origin	Equipment Involved in Ignition	% Total Residential Fires
Kitchen	Cooking equipment	19.82
Kitchen	Information not recorded	17.47
Other	Information not recorded	12.71
Living/Dining Room	Information not recorded	10.38
Bedroom	Information not recorded	9.50
Kitchen	Other	2.92
Other	Other	2.91
Living/Dining Room	Heater	2.83
Laundry/Bathroom	Information not recorded	2.00
Internal Pathways	Information not recorded	1.96
Information not recorded	Information not recorded	1.86
Bedroom	Other	1.83
Living/Dining Room	Other	1.83
Laundry/Bathroom	Clothes washing machine or dryer	1.67
Bedroom	Electric blanket	1.39
Other	Power transfer equipment	1.38
Bedroom	Heater	0.75
Living/Dining Room	Entertainment equipment	0.71
Other	Heater	0.69
Internal Pathways	Power transfer equipment	0.55
Laundry/Bathroom	Other	0.44
Living/Dining Room	Power transfer equipment	0.41
Bedroom	Entertainment equipment	0.35
Other	Water heater	0.31
Internal Pathways	Heater	0.30
Kitchen	Power transfer equipment	0.28
Laundry/Bathroom	Heater	0.27
Internal Pathways	Other	0.26
Kitchen	Water heater	0.25
Kitchen	Heater	0.21
Living/Dining Room	Cooking equipment	0.21
Other	Clothes washing machine or dryer	0.21
Other	Cooking equipment	0.21

Table 3: The most common combination of rooms of fire origin and equipment involved in ignition for apartments in terms of the percentage of fatalities

Room of Fire Origin	Equipment Involved in Ignition	% Total Apartment Fatalities
Living/Dining Room	Information not recorded	31.43
Bedroom	Information not recorded	22.86
Kitchen	Cooking equipment	20.00
Kitchen	Information not recorded	5.71
Bedroom	Electric blanket	5.71
Living/Dining Room	Other	5.71
Living/Dining Room	Heater	2.86
Living/Dining Room	Entertainment equipment	2.86
Other	Information not recorded	2.86

Table 4: The most common combination of rooms of fire origin and equipment involved in ignition for residential fatalities

Room of Fire Origin	Equipment Involved in Ignition	% Total Residential Fatalities
Bedroom	Information not recorded	26.07
Living/Dining Room	Information not recorded	20.51
Kitchen	Information not recorded	12.82
Kitchen	Cooking equipment	9.83
Other	Information not recorded	4.27
Living/Dining Room	Other	3.85
Bedroom	Electric blanket	3.42
Living/Dining Room	Heater	2.56
Information not recorded	Information not recorded	2.56
Living/Dining Room	Cooking equipment	2.14
Living/Dining Room	Entertainment equipment	2.14
Kitchen	Other	1.71
Bedroom	Heater	1.28
Bedroom	Other	1.28
Internal Pathways	Power transfer equipment	1.28
Kitchen	Heater	0.85
Living/Dining Room	Electric blanket	0.85
Internal Pathways	Information not recorded	0.85
Bedroom	Water heater	0.43
Bedroom	Cooking equipment	0.43
Laundry/Bathroom	Information not recorded	0.43
Living/Dining Room	Power transfer equipment	0.43

Table 5: The most common combination of rooms of fire origin and equipment involved in ignition for apartment injuries

Room of Fire Origin	Equipment Involved in Ignition	% Total Apartment Injuries
Kitchen	Cooking equipment	22.17
Kitchen	Information not recorded	16.26
Bedroom	Information not recorded	15.27
Living/Dining Room	Information not recorded	12.32
Living/Dining Room	Entertainment equipment	7.55
Bedroom	Other	3.45
Bedroom	Entertainment equipment	3.28
Internal Pathways	Information not recorded	3.12
Kitchen	Other	2.46
Living/Dining Room	Heater	1.81
Other	Information not recorded	1.64
Bedroom	Electric blanket	1.31
Bedroom	Heater	1.31
Living/Dining Room	Other	1.15
Other	Other	1.15
Other	Heater	0.82
Living/Dining Room	Cooking equipment	0.66
Information not recorded	Information not recorded	0.66
Laundry/Bathroom	Clothes washing machine or dryer	0.33
Laundry/Bathroom	Information not recorded	0.33
Laundry/Bathroom	Other	0.33
Kitchen	Heater	0.16
Kitchen	Water heater	0.16
Kitchen	Power transfer equipment	0.16
Kitchen	Entertainment equipment	0.16
Bedroom	Cooking equipment	0.16
Laundry/Bathroom	Water heater	0.16
Laundry/Bathroom	Cooking equipment	0.16

Table 6: The most common combination of rooms of fire origin and equipment involved in ignition for residential injuries

Room of Fire Origin	Equipment Involved in Ignition	% Total Residential Injuries
Kitchen	Cooking equipment	22.15
Kitchen	Information not recorded	18.63
Bedroom	Information not recorded	18.03
Living/Dining Room	Information not recorded	11.06
Other	Information not recorded	5.10
Bedroom	Other	3.41
Living/Dining Room	Heater	2.85
Kitchen	Other	2.74
Bedroom	Electric blanket	2.14
Living/Dining Room	Other	1.84
Other	Other	1.65
Bedroom	Heater	1.57
Laundry/Bathroom	Information not recorded	1.31
Internal Pathways	Information not recorded	1.20
Living/Dining Room	Entertainment equipment	0.79
Bedroom	Entertainment equipment	0.67
Information not recorded	Information not recorded	0.49
Other	Heater	0.49
Laundry/Bathroom	Clothes washing machine or dryer	0.41
Living/Dining Room	Cooking equipment	0.37
Kitchen	Heater	0.34
Laundry/Bathroom	Other	0.30
Kitchen	Water heater	0.22
Internal Pathways	Power transfer equipment	0.19
Internal Pathways	Other	0.19
Other	Water heater	0.19
Other	Cooking equipment	0.19
Other	Power transfer equipment	0.19

Table 7: The most common combination of rooms of fire origin and equipment involved in ignition for ratios of fatalities to fires (i.e deaths per fire) for apartments

Room of Fire Origin	Equipment Involved in Ignition	Apartment Fatalities per Fire
Living/Dining Room	Information not recorded	4.44
Bedroom	Electric blanket	4.28
Living/Dining Room	Other	3.79
Living/Dining Room	Entertainment equipment	3.30
Bedroom	Information not recorded	2.46
Living/Dining Room	Heater	1.49
Kitchen	Cooking equipment	0.69
Other	Information not recorded	0.36
Kitchen	Information not recorded	0.26

Table 8: The most common combination of rooms of fire origin and equipment involved in ignition for ratios of fatalities to fire (i.e deaths per fire) for residential structures

Room of Fire Origin	Equipment Involved in Ignition	Residential Fatalities per Fire
Living/Dining Room	Electric blanket	14.76
Bedroom	Water heater	10.54
Living/Dining Room	Cooking equipment	9.97
Bedroom	Cooking equipment	8.68
Kitchen	Heater	3.99
Living/Dining Room	Entertainment equipment	3.00
Bedroom	Information not recorded	2.74
Bedroom	Electric blanket	2.46
Internal Pathways	Power transfer equipment	2.34
Living/Dining Room	Other	2.11
Living/Dining Room	Information not recorded	1.98
Bedroom	Heater	1.71
Information not recorded	Information not recorded	1.38
Living/Dining Room	Power transfer equipment	1.05
Living/Dining Room	Heater	0.91
Kitchen	Information not recorded	0.73
Bedroom	Other	0.70
Kitchen	Other	0.59
Kitchen	Cooking equipment	0.50
Internal Pathways	Information not recorded	0.44
Other	Information not recorded	0.34
Laundry/Bathroom	Information not recorded	0.21

Table 9: The most common combination of rooms of fire origin and equipment involved in ignition for ratios of injuries to fires (i.e injuries per fire) for apartments

Room of Fire Origin	Equipment Involved in Ignition	Apartment Injuries per Fire
Bedroom	Entertainment equipment	8.72
Living/Dining Room	Entertainment equipment	8.72
Kitchen	Entertainment equipment	8.72
Laundry/ Bathroom	Entertainment equipment	8.72
Internal Pathways	Cooking equipment	8.72
Other	Entertainment equipment	8.72
Other	Heater	4.36
Laundry/Bathroom	Water heater	4.36
Laundry/Bathroom	Cooking equipment	2.91
Living/Dining Room	Cooking equipment	2.33
Living/Dining Room	Water heater	2.18
Bedroom	Other	1.83
Living/Dining Room	Information not recorded	1.74
Internal Pathways	Information not recorded	1.69
Bedroom	Information not recorded	1.65
Bedroom	Heater	1.62
Bedroom	Cooking equipment	1.45
Information not recorded	Information not recorded	1.34
Kitchen	Water heater	1.25
Laundry/Bathroom	Other	1.16
Living/Dining Room	Electric blanket	1.09
Bedroom	Electric blanket	0.98
Kitchen	Power transfer equipment	0.97
Living/Dining Room	Heater	0.94
Kitchen	Other	0.80
Living/Dining Room	Other	0.76
Kitchen	Cooking equipment	0.76
Kitchen	Information not recorded	0.74

Table 10: The most common combination of rooms of fire origin and equipment involved in ignition for ratios of injuries to fires (i.e injuries per fire) for residential structures

Room of Fire Origin	Equipment Involved in Ignition	Residential Injuries per Fire
Information not recorded	Clothes washing machine or dryer	6.47
Internal Pathways	Clothes washing machine or dryer	3.24
Bedroom	Cooking equipment	3.05
Bedroom	Heater	2.10
Bedroom	Entertainment equipment	1.91
Bedroom	Information not recorded	1.90
Bedroom	Other	1.87
Bedroom	Water heater	1.85
Laundry/Bathroom	Cooking equipment	1.85
Living/Dining Room	Cooking equipment	1.75
Kitchen	Heater	1.57
Bedroom	Electric blanket	1.54
Internal Pathways	Cooking equipment	1.44
Living/Dining Room	Electric blanket	1.29
Laundry/Bathroom	Water heater	1.21
Kitchen	Cooking equipment	1.12
Living/Dining Room	Entertainment equipment	1.11
Kitchen	Information not recorded	1.07
Living/Dining Room	Information not recorded	1.07
Living/Dining Room	Heater	1.01
Living/Dining Room	Other	1.01
Internal Pathways	Water heater	1.00
Living/Dining Room	Water heater	0.96
Kitchen	Other	0.94
Other	Cooking equipment	0.91
Kitchen	Water heater	0.89
Living/Dining Room	Clothes washing machine or dryer	0.76
Internal Pathways	Other	0.71

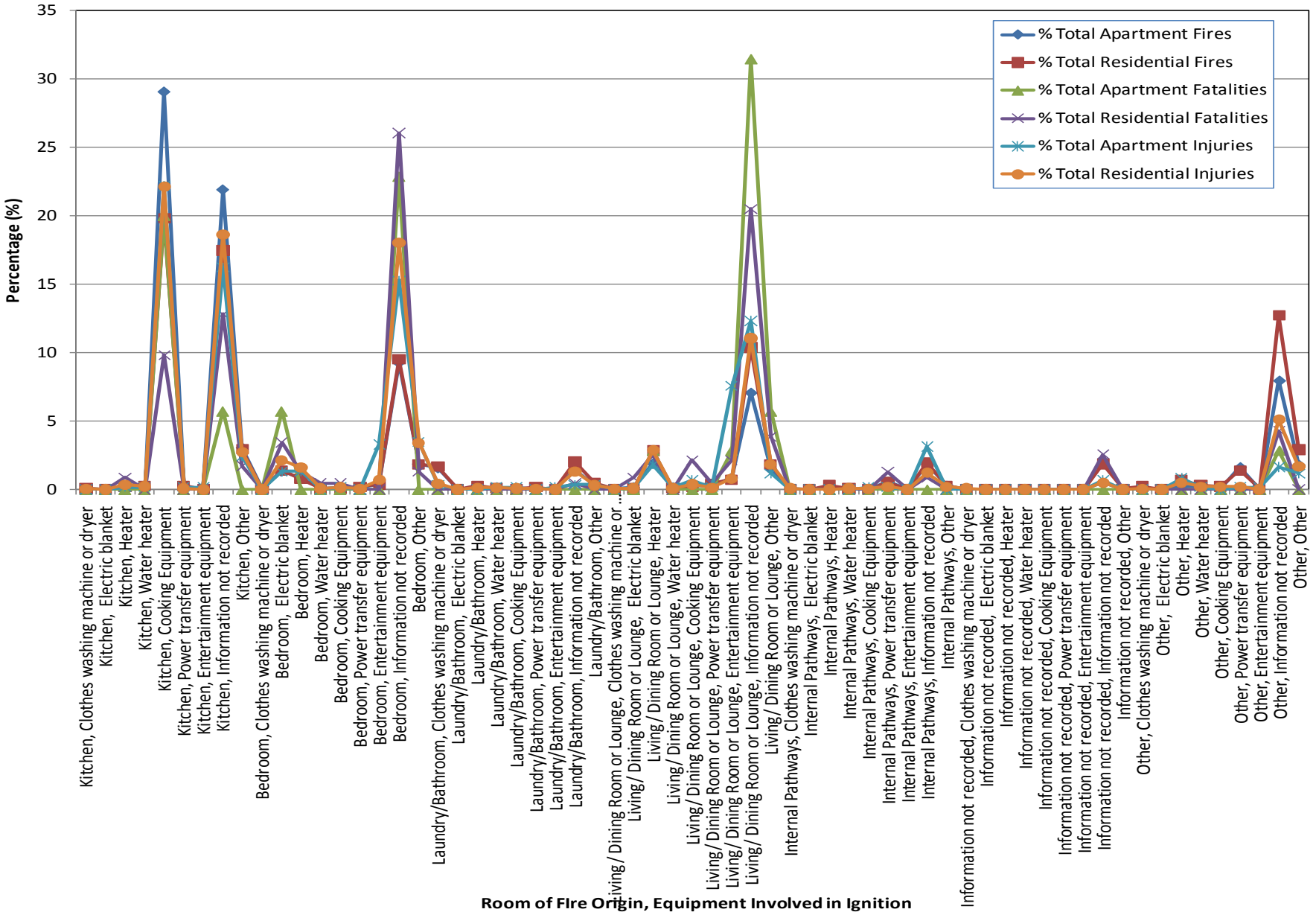


Figure 8: Percentages of total fires and casualties for apartments and all residential buildings for combinations of room of fire origin and equipment involved in ignition

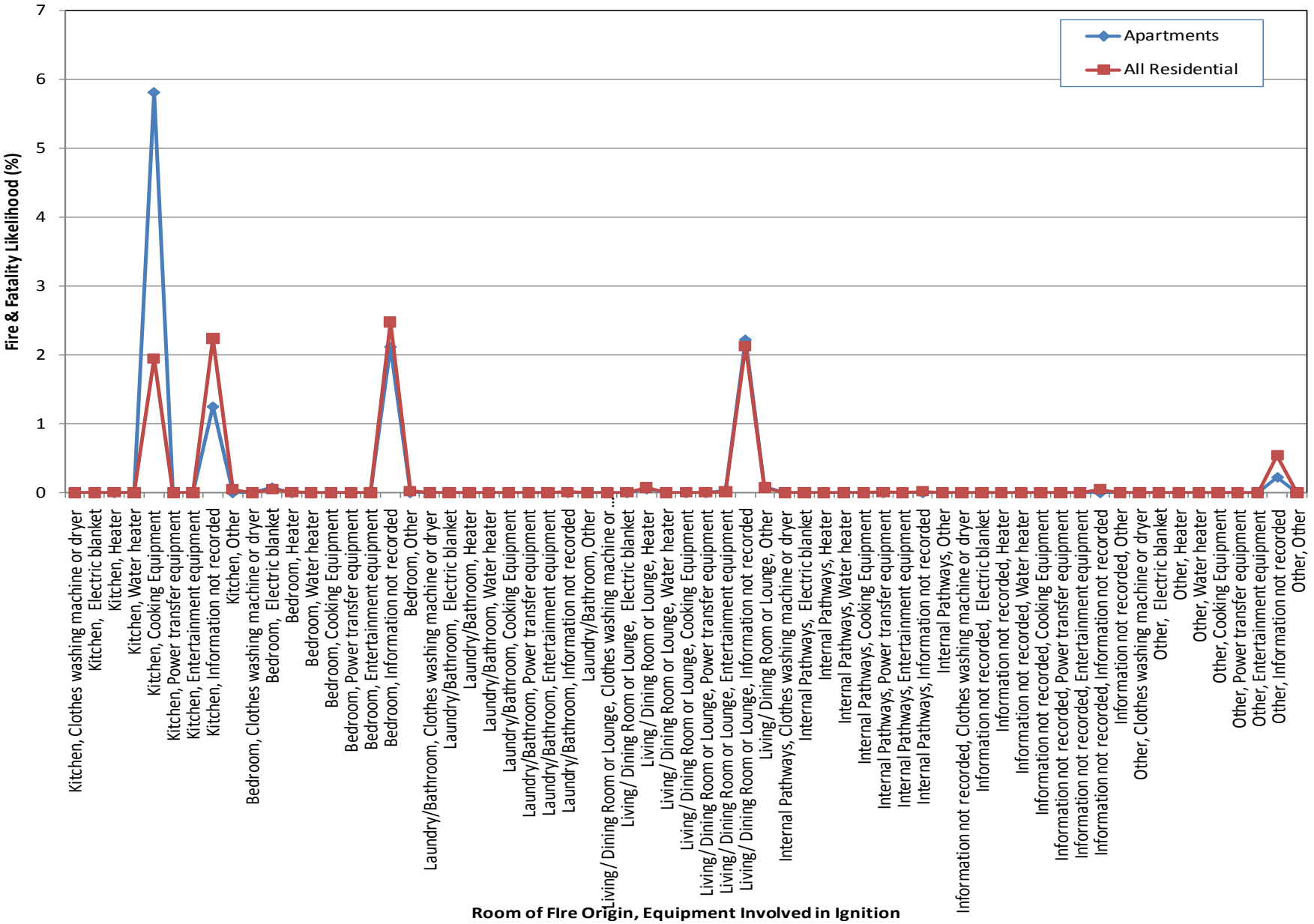


Figure 9: Combinations of percentages of total fires and fatalities for apartments and all residential buildings for combinations of room of fire origin and equipment involved in ignition

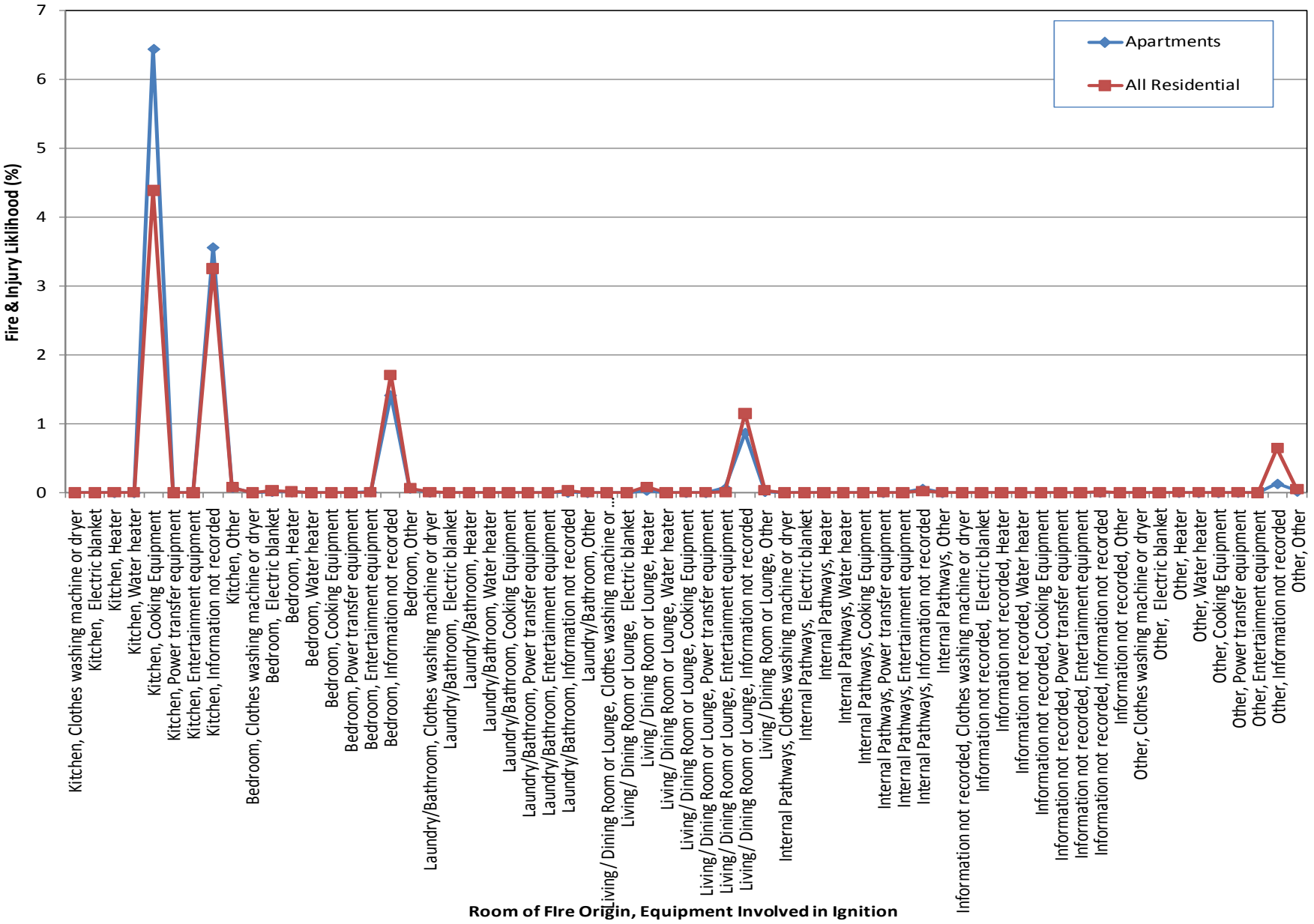


Figure 10: Combinations of percentages of total fires and injuries for apartments and all residential buildings for combinations of room of fire origin and equipment involved in ignition

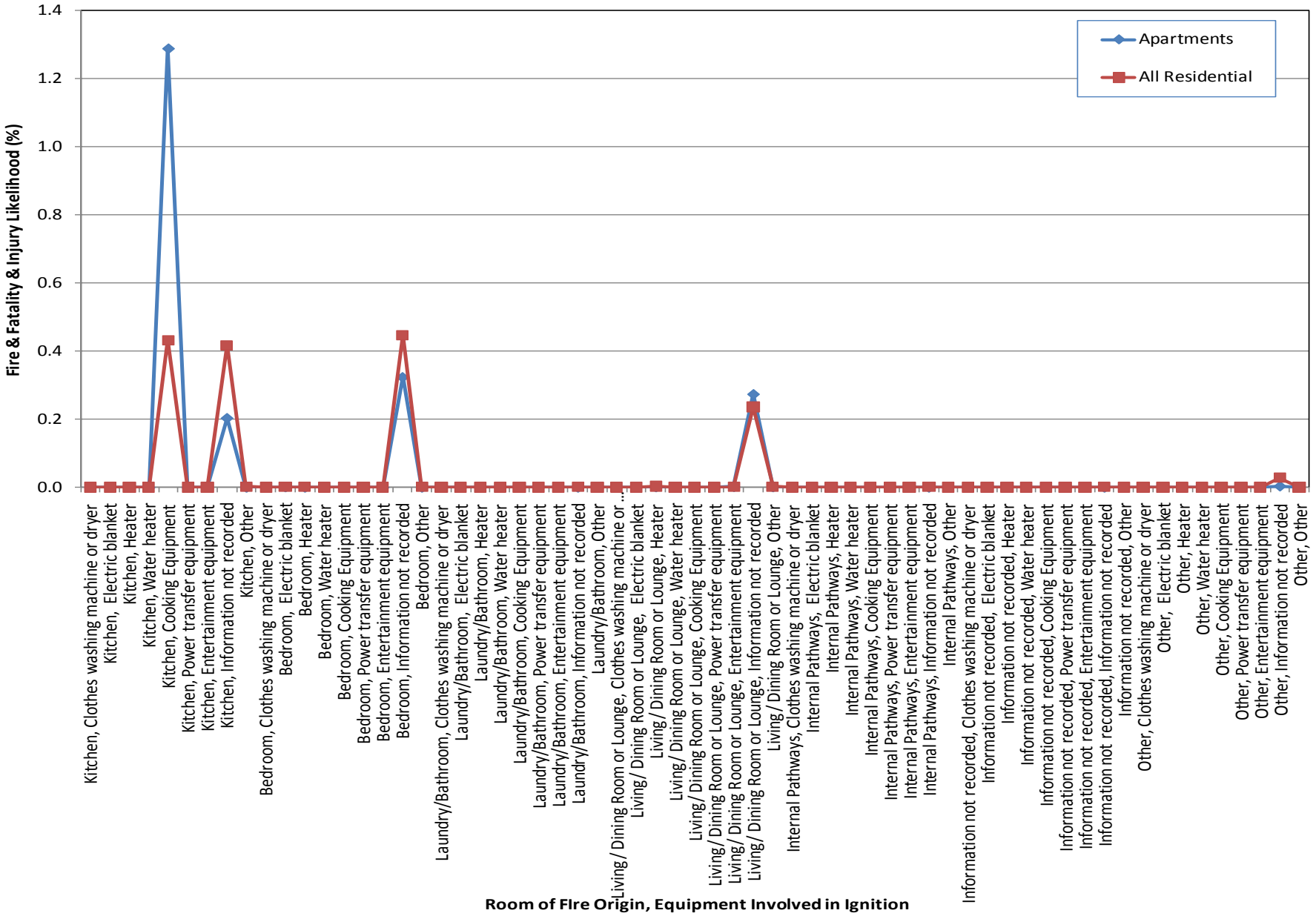


Figure 11: Combinations of percentages of total fires, fatalities and injuries for apartments and all residential buildings for combinations of room of fire origin and equipment involved in ignition

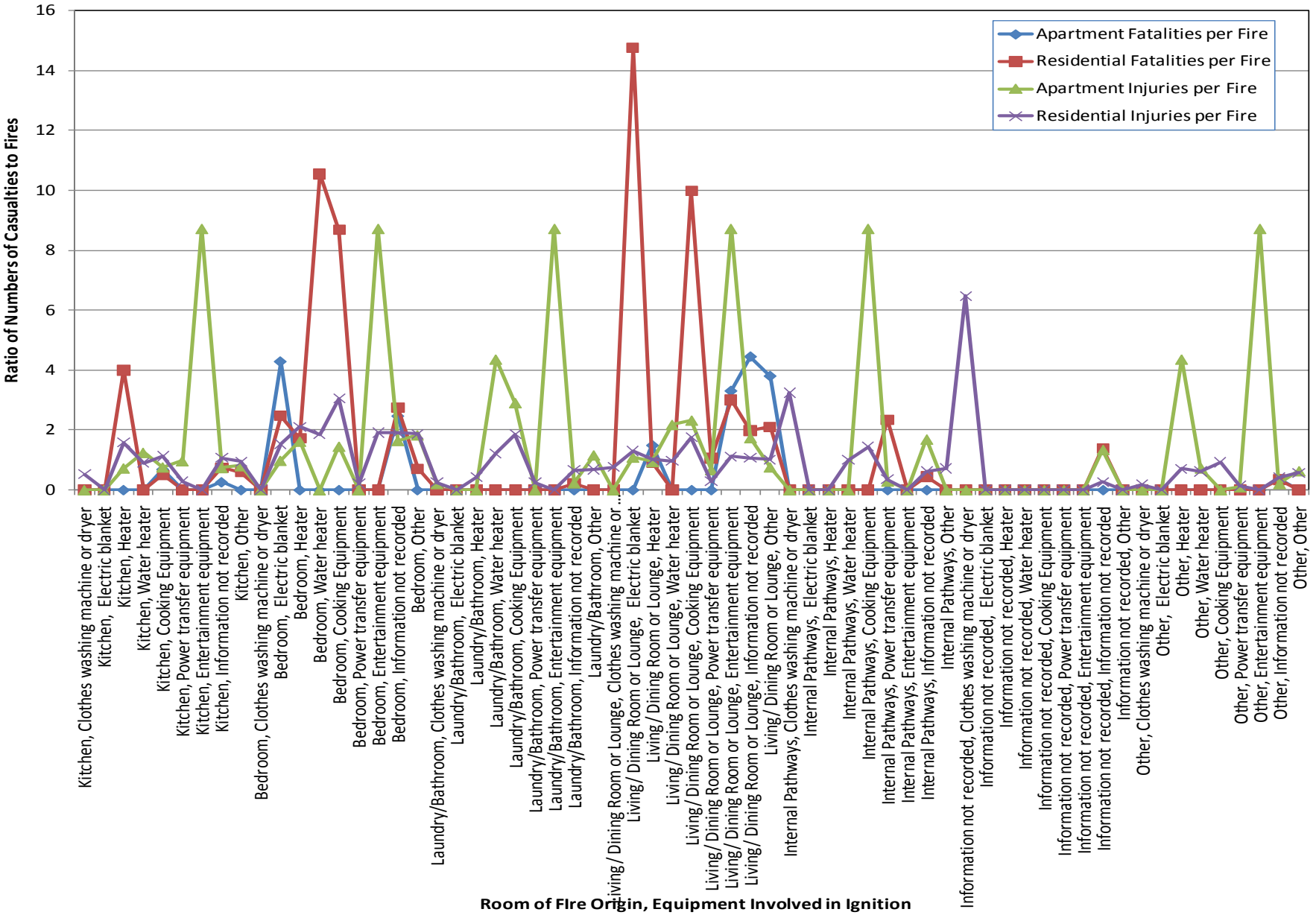


Figure 12: Ratios of casualties to fires for combinations of room of fire origin and equipment involved in ignition for apartments and all residential buildings

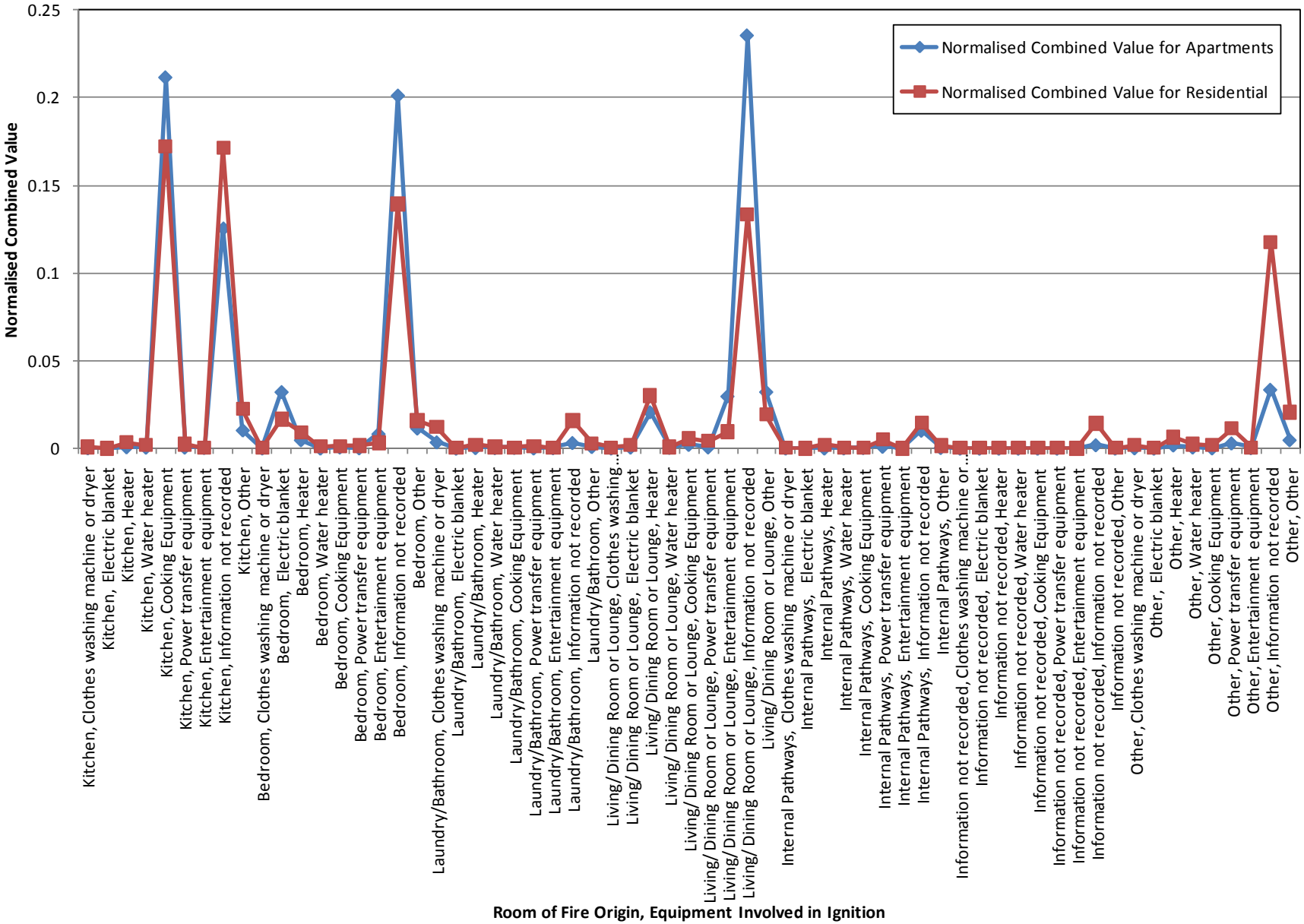


Figure 13: Normalised combined value incorporating weighted percentages of fires and casualties for combinations of room of fire origin and equipment involved in ignition

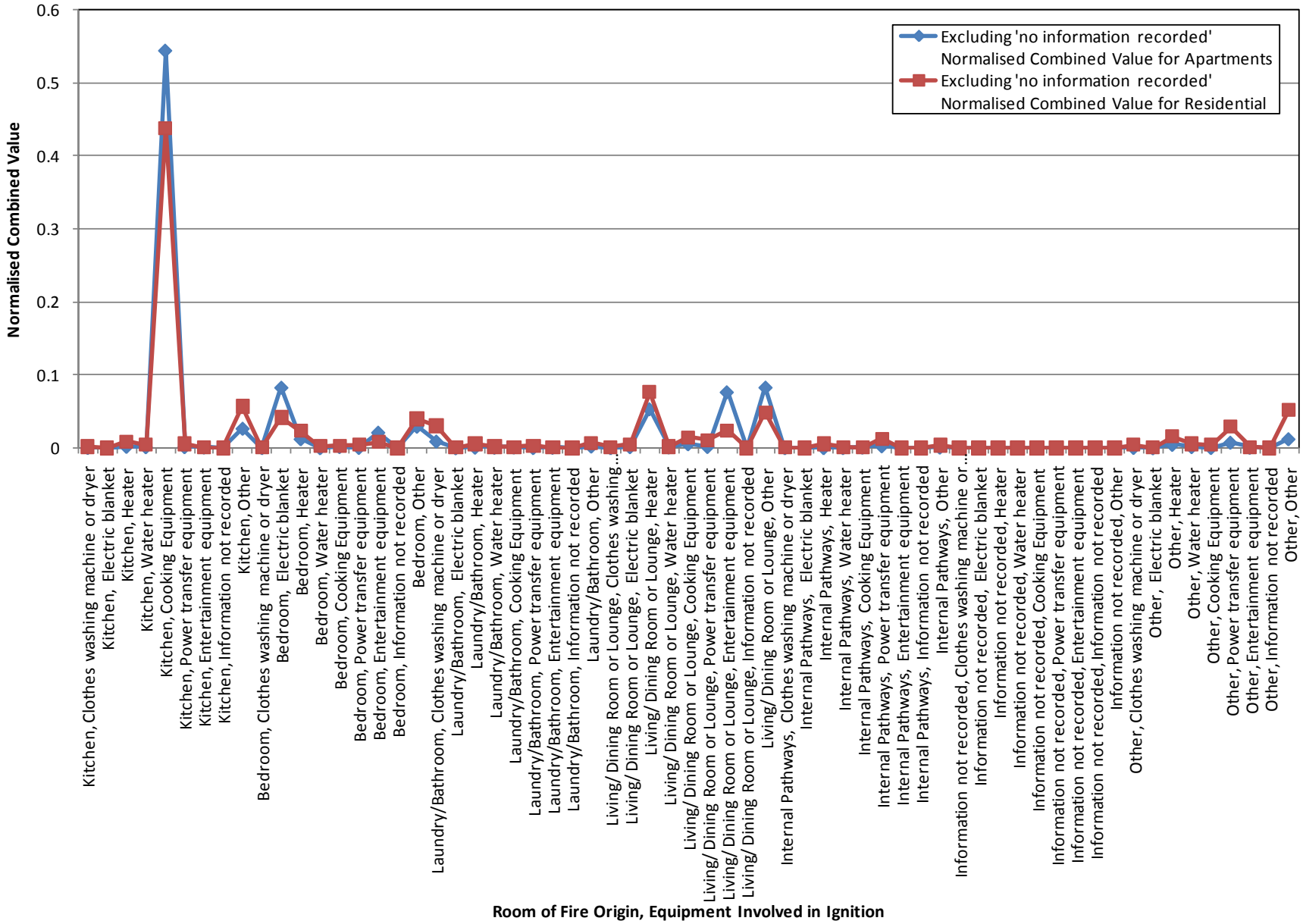


Figure 14: Normalised combined value incorporating weighted percentages of fires and casualties for combinations of room of fire origin and equipment involved in ignition, excluding values for 'no information recorded' clusters

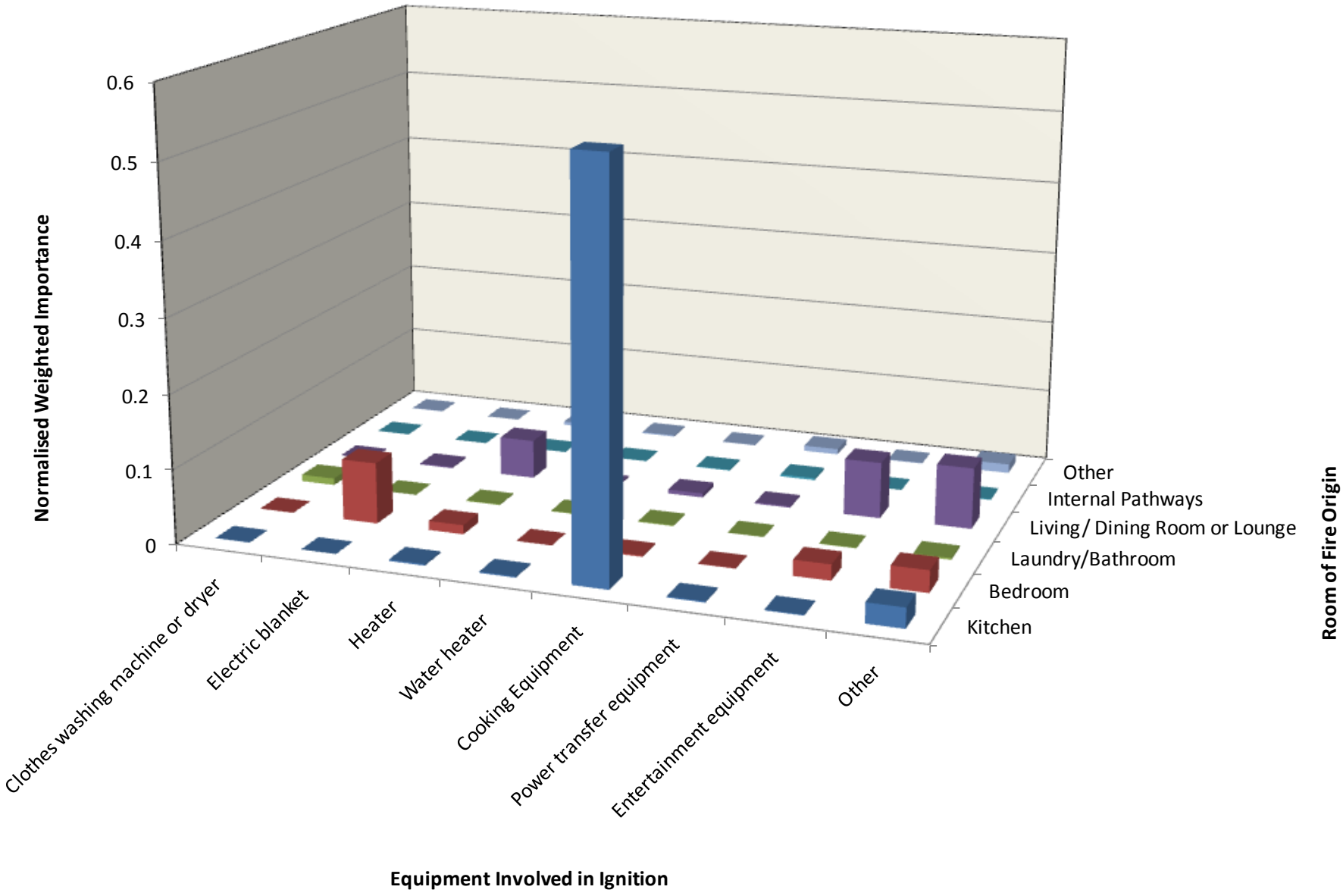


Figure 15: Summary of normalised weighted importance factor for clusters of room of fire origin and equipment involved in ignition for apartments, excluding 'no information recorded' clusters

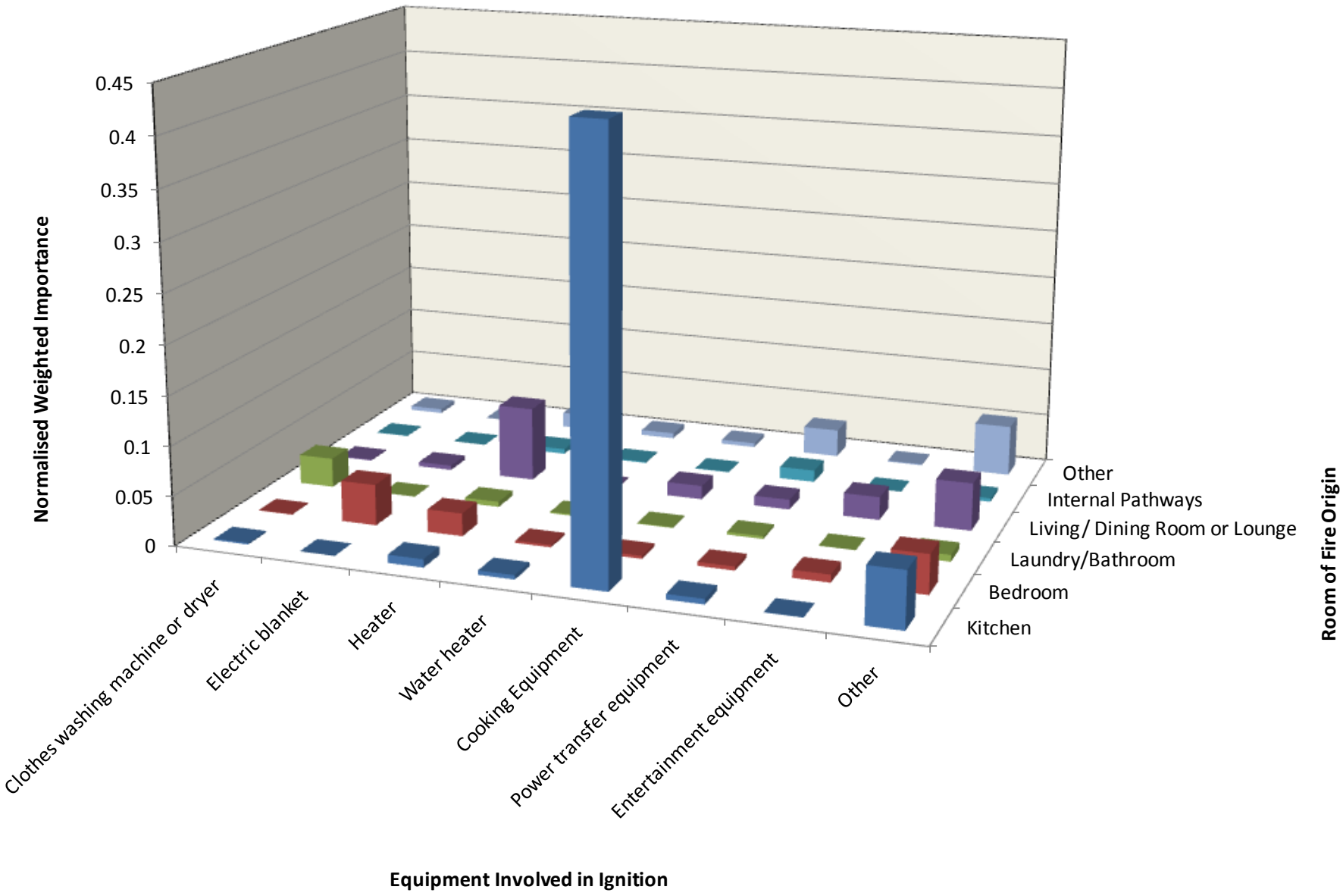


Figure 16: Summary of normalised weighted importance factor for clusters of room of fire origin and equipment involved in ignition for all residential structures, excluding 'no information recorded' clusters

Table 11: Normalised weighted importance factor for clusters of room of fire origin and equipment involved in ignition for apartments, excluding 'no information recorded' clusters

		Room of Fire Origin					
		Kitchen	Bedroom	Laundry/ Bathroom	Living/ Dining Room	Internal Pathways	Other
Equipment Involved in Ignition	Clothes washing machine or dryer	0.000	0.000	0.009	0.000	0.000	0.001
	Electric blanket	0.000	0.083	0.000	0.002	0.000	0.000
	Heater	0.002	0.012	0.001	0.053	0.000	0.005
	Water heater	0.001	0.000	0.001	0.001	0.000	0.002
	Cooking equipment	0.544	0.002	0.001	0.006	0.001	0.000
	Power transfer equipment	0.002	0.001	0.000	0.002	0.003	0.008
	Entertainment equipment	0.001	0.021	0.001	0.077	0.000	0.001
	Other	0.027	0.030	0.002	0.083	0.001	0.012

Table 12: Normalised weighted importance factor for clusters of room of fire origin and equipment involved in ignition for all residential structures, excluding 'no information recorded' clusters

		Room of Fire Origin					
		Kitchen	Bedroom	Laundry/ Bathroom	Living/ Dining Room	Internal Pathways	Other
Equipment Involved in Ignition	Clothes washing machine or dryer	0.001	0.001	0.030	0.001	0.000	0.004
	Electric blanket	0.000	0.042	0.000	0.005	0.000	0.000
	Heater	0.008	0.023	0.005	0.076	0.005	0.016
	Water heater	0.004	0.002	0.001	0.001	0.001	0.006
	Cooking equipment	0.438	0.003	0.001	0.014	0.000	0.004
	Power transfer equipment	0.005	0.004	0.003	0.010	0.012	0.029
	Entertainment equipment	0.000	0.008	0.000	0.024	0.000	0.001
	Other	0.057	0.040	0.007	0.049	0.004	0.052

A.2 Room of fire origin and material first ignited

Table 13: The most common combination of rooms of fire origin and material first ignited for apartment fires

Room of Fire Origin	Material First Ignited	% Total Apartment Fires
Kitchen	Fat or Food	34.8
Kitchen	Flammable or Combustible Liquid	8.0
Bedroom	Fabric	5.6
Other	Other	4.8
Kitchen	Polymer	4.4
Kitchen	Other	4.1
Bedroom	Other	4.0
Living/Dining Room	Other	3.7
Other	Polymer	3.4
Living/Dining Room	Polymer	3.2
Bedroom	Polymer	2.8
Living/Dining Room	Fabric	2.5
Kitchen	Information not recorded	1.9
Other	Finished timber	1.9
Laundry/Bathroom	Polymer	1.8
Living/Dining Room	Finished timber	1.1
Internal Pathways	Polymer	1.0
Laundry/Bathroom	Other	0.9
Internal Pathways	Other	0.9
Living/Dining Room	Information not recorded	0.9
Kitchen	Finished timber	0.8
Bedroom	Information not recorded	0.8
Other	Fabric	0.8
Other	Information not recorded	0.8
Kitchen	Fabric	0.6
Bedroom	Finished timber	0.5
Living/Dining Room	Flammable or Combustible Liquid	0.5
Laundry/Bathroom	Fabric	0.5
Other	Flammable or Combustible Liquid	0.4
Bedroom	Flammable or Combustible Liquid	0.3
Living/Dining Room	Fat or Food	0.3
Internal Pathways	Fabric	0.3

Table 14: The most common combination of rooms of fire origin and material first ignited for residential fires

Room of Fire Origin	Material First Ignited	% Total Residential Fires
Kitchen	Fat or Food	22.2
Kitchen	Flammable or Combustible Liquid	6.6
Other	Other	6.4
Bedroom	Fabric	5.2
Living/Dining Room	Other	5.1
Other	Finished timber	5.0
Kitchen	Polymer	4.8
Other	Polymer	4.1
Bedroom	Other	3.8
Kitchen	Other	3.7
Living/Dining Room	Polymer	3.5
Bedroom	Polymer	3.2
Living/Dining Room	Finished timber	2.9
Living/Dining Room	Fabric	2.7
Laundry/Bathroom	Polymer	2.0
Kitchen	Information not recorded	1.9
Living/Dining Room	Information not recorded	1.6
Internal Pathways	Polymer	1.3
Kitchen	Finished timber	1.2
Laundry/Bathroom	Other	1.2
Other	Information not recorded	1.2
Other	Fabric	1.0
Information not recorded	Information not recorded	1.0
Bedroom	Information not recorded	1.0
Internal Pathways	Other	0.8
Bedroom	Finished timber	0.7
Other	Flammable or Combustible Liquid	0.7
Kitchen	Fabric	0.7
Laundry/Bathroom	Fabric	0.7
Living/Dining Room	Flammable or Combustible Liquid	0.5
Laundry/Bathroom	Information not recorded	0.5
Internal Pathways	Finished timber	0.3
Internal Pathways	Fabric	0.3

Table 15: The most common combination of rooms of fire origin and material first ignited for apartment fatalities

Room of Fire Origin	Material First Ignited	% Total Apartment Fatalities
Living/Dining Room	Other	17.1
Living/Dining Room	Information not recorded	14.3
Kitchen	Other	8.6
Bedroom	Other	8.6
Living/Dining Room	Fabric	8.6
Kitchen	Fat or Food	5.7
Bedroom	Flammable or Combustible Liquid	5.7
Bedroom	Polymer	5.7
Bedroom	Information not recorded	5.7
Kitchen	Flammable or Combustible Liquid	2.9
Kitchen	Polymer	2.9
Kitchen	Finished timber	2.9
Kitchen	Information not recorded	2.9
Bedroom	Fabric	2.9
Living/Dining Room	Polymer	2.9
Other	Information not recorded	2.9

Table 16: The most common combination of rooms of fire origin and material first ignited for residential fatalities

Room of Fire Origin	Material First Ignited	% Total Residential Fatalities
Bedroom	Fabric	11.1
Kitchen	Fat or Food	7.7
Living/Dining Room	Fabric	7.3
Living/Dining Room	Information not recorded	7.3
Kitchen	Flammable or Combustible Liquid	6.8
Bedroom	Polymer	6.4
Living/Dining Room	Other	6.4
Bedroom	Other	5.6
Kitchen	Other	5.1
Bedroom	Information not recorded	5.1
Living/Dining Room	Polymer	5.1
Living/Dining Room	Flammable or Combustible Liquid	3.8
Bedroom	Flammable or Combustible Liquid	3.0
Kitchen	Information not recorded	2.1
Living/Dining Room	Finished timber	2.1
Information not recorded	Information not recorded	2.1
Kitchen	Finished timber	1.7
Bedroom	Finished timber	1.7
Other	Fabric	1.7
Internal Pathways	Finished timber	1.3
Other	Finished timber	1.3
Kitchen	Fabric	0.9

Table 17: The most common combination of rooms of fire origin and material first ignited for apartment injuries

Room of Fire Origin	Material First Ignited	% Total Apartment Injuries
Kitchen	Fat or Food	24.2
Kitchen	Flammable or Combustible Liquid	13.0
Bedroom	Fabric	10.4
Bedroom	Other	7.7
Living/Dining Room	Polymer	5.5
Living/Dining Room	Fabric	4.6
Kitchen	Other	4.2
Living/Dining Room	Other	4.0
Bedroom	Polymer	3.5
Kitchen	Polymer	2.4
Living/Dining Room	Information not recorded	2.4
Internal Pathways	Fabric	2.0
Other	Other	1.8
Bedroom	Information not recorded	1.5
Bedroom	Finished timber	1.1
Living/Dining Room	Flammable or Combustible Liquid	1.1
Internal Pathways	Information not recorded	1.1
Kitchen	Finished timber	0.9
Kitchen	Information not recorded	0.9
Other	Information not recorded	0.9
Living/Dining Room	Finished timber	0.7
Kitchen	Fabric	0.5
Laundry/Bathroom	Polymer	0.5
Living/Dining Room	Fat or Food	0.5
Information not recorded	Information not recorded	0.5
Other	Fabric	0.5
Other	Polymer	0.5
Bedroom	Flammable or Combustible Liquid	0.4

Table 18: The most common combination of rooms of fire origin and material first ignited for residential injuries

Room of Fire Origin	Material First Ignited	% Total Residential Injuries
Kitchen	Fat or Food	20.3
Kitchen	Flammable or Combustible Liquid	14.8
Bedroom	Fabric	10.7
Bedroom	Other	7.0
Bedroom	Polymer	4.9
Living/Dining Room	Other	4.9
Living/Dining Room	Polymer	4.5
Kitchen	Other	3.9
Living/Dining Room	Fabric	3.7
Kitchen	Polymer	2.8
Other	Other	2.4
Bedroom	Information not recorded	1.9
Living/Dining Room	Information not recorded	1.5
Other	Polymer	1.5
Living/Dining Room	Flammable or Combustible Liquid	1.3
Other	Finished timber	1.3
Other	Flammable or Combustible Liquid	1.2
Laundry/Bathroom	Other	0.9
Living/Dining Room	Finished timber	0.9
Kitchen	Finished timber	0.8
Kitchen	Information not recorded	0.8
Bedroom	Flammable or Combustible Liquid	0.8
Kitchen	Fabric	0.7
Bedroom	Finished timber	0.7
Other	Fabric	0.7
Other	Information not recorded	0.6
Laundry/Bathroom	Polymer	0.5
Laundry/Bathroom	Fabric	0.4

Table 19: The most common combination of rooms of fire origin and material first ignited for ratios of fatalities to fires for apartments

Room of Fire Origin	Material First Ignited	Apartment Fatalities per Fire
Bedroom	Flammable or Combustible Liquid	17.9
Living/Dining Room	Information not recorded	15.8
Bedroom	Information not recorded	7.1
Living/Dining Room	Other	4.6
Other	Information not recorded	3.8
Kitchen	Finished timber	3.4
Living/Dining Room	Fabric	3.4
Bedroom	Other	2.2
Kitchen	Other	2.1
Bedroom	Polymer	2.1
Kitchen	Information not recorded	1.5
Living/Dining Room	Polymer	0.9
Kitchen	Polymer	0.6
Bedroom	Fabric	0.5
Kitchen	Flammable or Combustible Liquid	0.4
Kitchen	Fat or Food	0.2

Table 20: The most common combination of rooms of fire origin and material first ignited for ratios of fatalities to fire for residential structures

Room of Fire Origin	Material First Ignited	Residential Fatalities per Fire
Bedroom	Flammable or Combustible Liquid	11.7
Living/Dining Room	Flammable or Combustible Liquid	7.9
Bedroom	Information not recorded	5.0
Living/Dining Room	Information not recorded	4.5
Internal Pathways	Finished timber	3.8
Internal Pathways	Information not recorded	3.4
Living/Dining Room	Fabric	2.7
Bedroom	Finished timber	2.5
Living/Dining Room	Fat or Food	2.2
Bedroom	Fabric	2.1
Information not recorded	Information not recorded	2.1
Bedroom	Polymer	2.0
Other	Fabric	1.6
Bedroom	Other	1.5
Living/Dining Room	Polymer	1.4
Information not recorded	Other	1.4
Kitchen	Finished timber	1.4
Kitchen	Other	1.4
Kitchen	Fabric	1.3
Living/Dining Room	Other	1.2
Kitchen	Information not recorded	1.1
Kitchen	Flammable or Combustible Liquid	1.0

Table 21: The most common combination of rooms of fire origin and material first ignited for ratios of injuries to fires for apartments

Room of Fire Origin	Material First Ignited	Apartment Injuries per Fire
Internal Pathways	Fabric	7.6
Internal Pathways	Information not recorded	5.3
Laundry/Bathroom	Fat or Food	4.9
Laundry/Bathroom	Flammable or Combustible Liquid	3.9
Living/Dining Room	Information not recorded	2.6
Living/Dining Room	Flammable or Combustible Liquid	2.3
Bedroom	Finished timber	2.1
Information not recorded	Information not recorded	2.1
Living/Dining Room	Fat or Food	1.9
Bedroom	Other	1.9
Bedroom	Fabric	1.9
Living/Dining Room	Fabric	1.8
Bedroom	Information not recorded	1.8
Living/Dining Room	Polymer	1.7
Kitchen	Flammable or Combustible Liquid	1.6
Information not recorded	Fat or Food	1.4
Bedroom	Polymer	1.3
Other	Information not recorded	1.2
Bedroom	Flammable or Combustible Liquid	1.1
Kitchen	Finished timber	1.1
Living/Dining Room	Other	1.1
Kitchen	Other	1.0
Internal Pathways	Flammable or Combustible Liquid	0.9
Kitchen	Fabric	0.9
Other	Fabric	0.7
Kitchen	Fat or Food	0.7
Living/Dining Room	Finished timber	0.7
Kitchen	Polymer	0.5

Table 22: The most common combination of rooms of fire origin and material first ignited for ratios of injuries to fires for residential structures

Room of Fire Origin	Material First Ignited	Residential Injuries per Fire
Bedroom	Flammable or Combustible Liquid	3.2
Living/Dining Room	Flammable or Combustible Liquid	2.8
Laundry/Bathroom	Flammable or Combustible Liquid	2.3
Kitchen	Flammable or Combustible Liquid	2.2
Bedroom	Fabric	2.1
Bedroom	Information not recorded	1.9
Bedroom	Other	1.9
Other	Flammable or Combustible Liquid	1.8
Living/Dining Room	Fat or Food	1.7
Bedroom	Polymer	1.6
Internal Pathways	Fabric	1.5
Living/Dining Room	Fabric	1.4
Internal Pathways	Flammable or Combustible Liquid	1.3
Bedroom	Fat or Food	1.3
Living/Dining Room	Polymer	1.3
Laundry/Bathroom	Fat or Food	1.2
Kitchen	Fabric	1.1
Internal Pathways	Information not recorded	1.1
Kitchen	Other	1.0
Bedroom	Finished timber	1.0
Living/Dining Room	Other	0.9
Living/Dining Room	Information not recorded	0.9
Information not recorded	Flammable or Combustible Liquid	0.9
Other	Fat or Food	0.9
Kitchen	Fat or Food	0.9
Information not recorded	Fat or Food	0.8
Laundry/Bathroom	Other	0.8

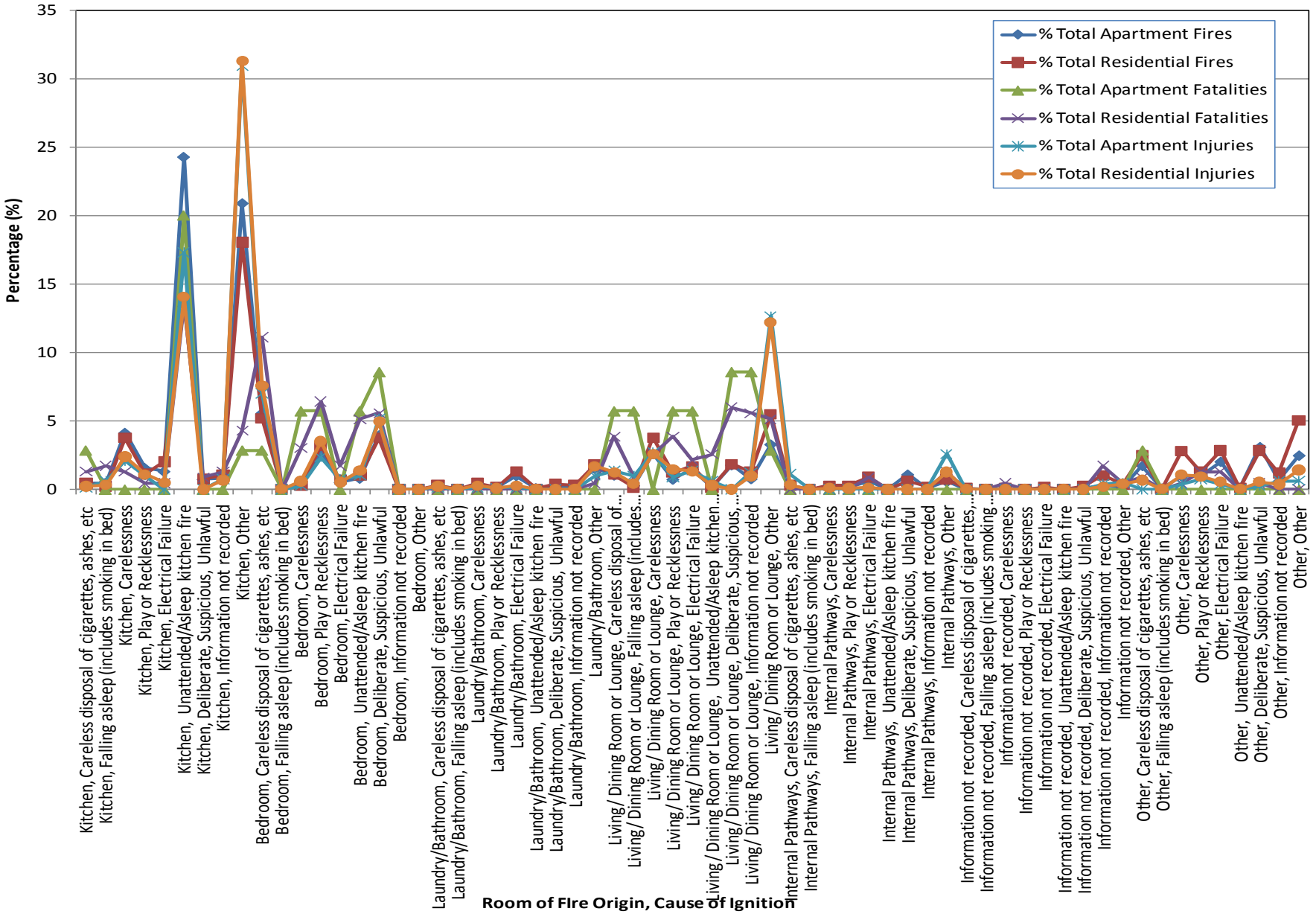


Figure 17: Percentages of total fires and casualties for apartments and all residential buildings for combinations of room of fire origin and material first ignited

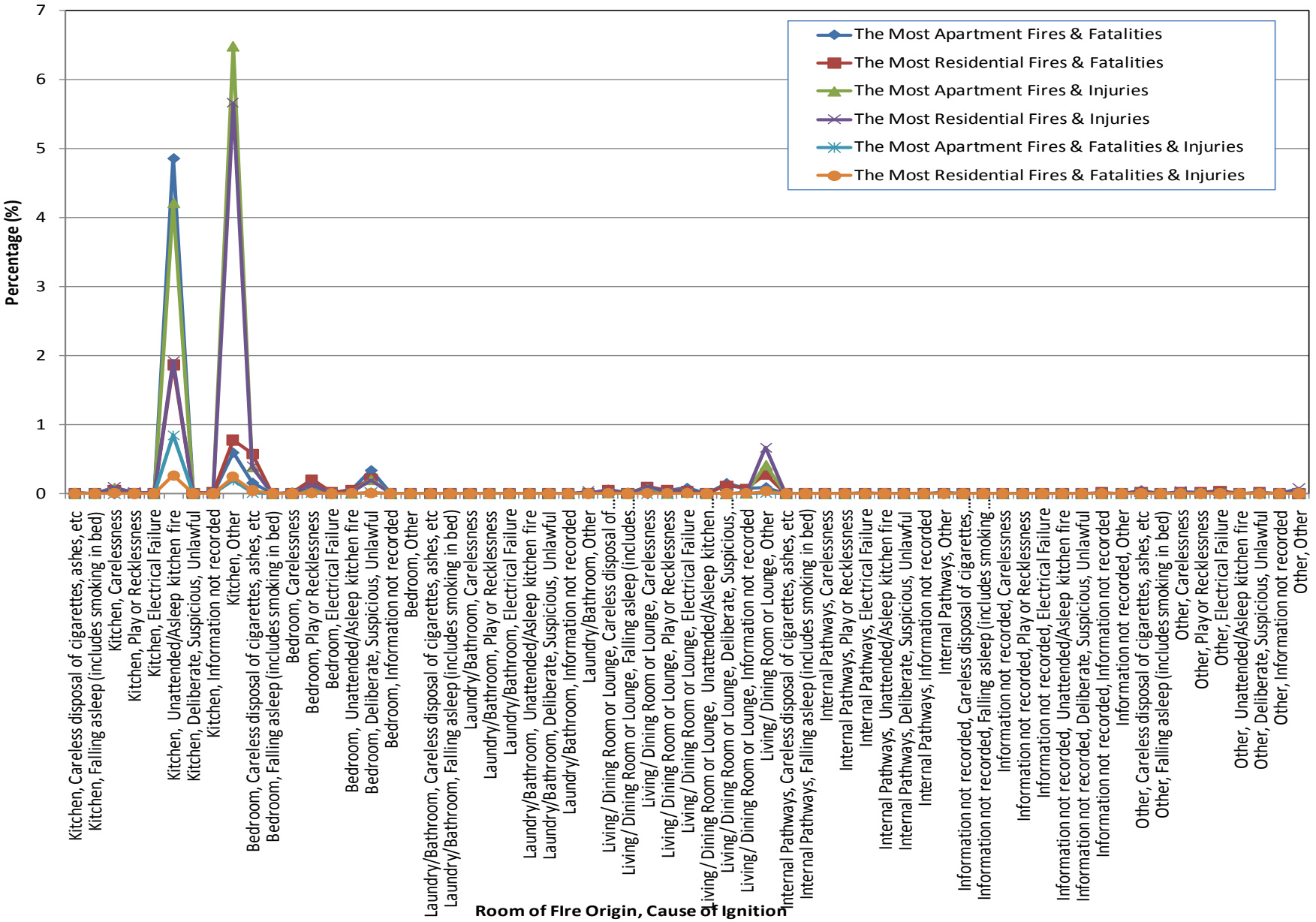


Figure 18: Combinations of percentages of total fires and casualties for apartments and all residential buildings for combinations of room of fire origin and material first ignited

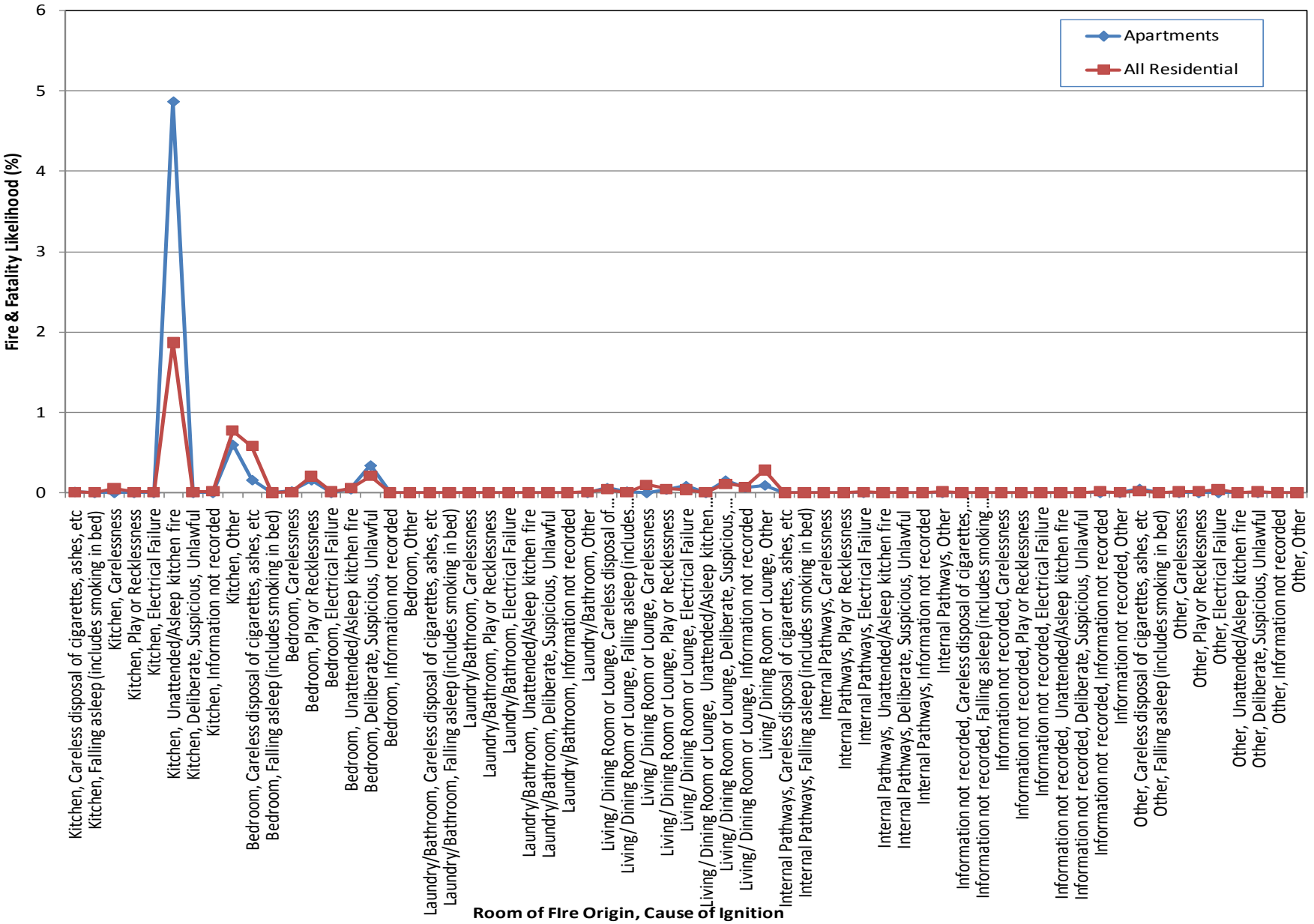


Figure 19: Combinations of percentages of total fires and fatalities for apartments and all residential buildings for combinations of room of fire origin and material first ignited

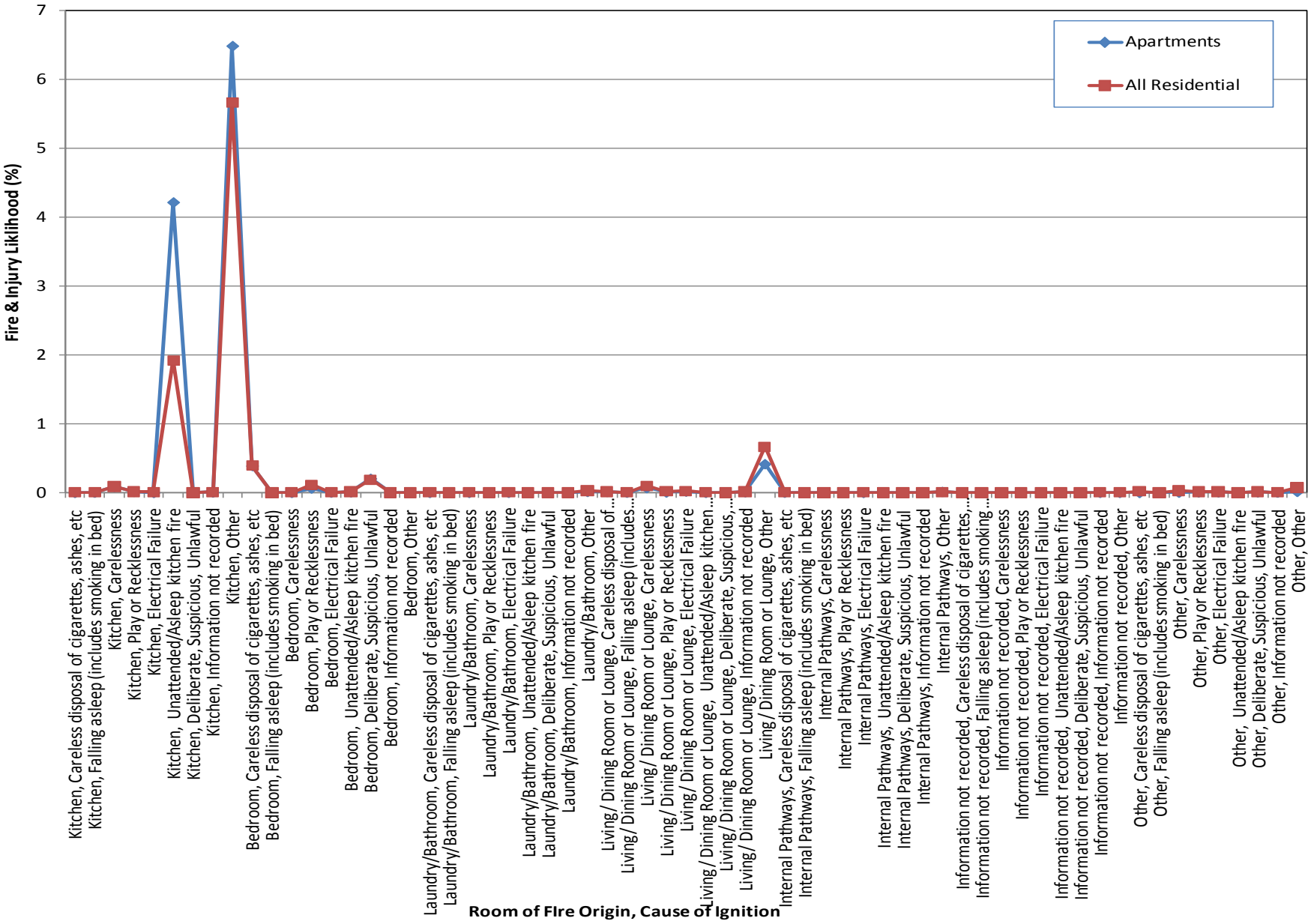


Figure 20: Combinations of percentages of total fires and injuries for apartments and all residential buildings for combinations of room of fire origin and material first ignited

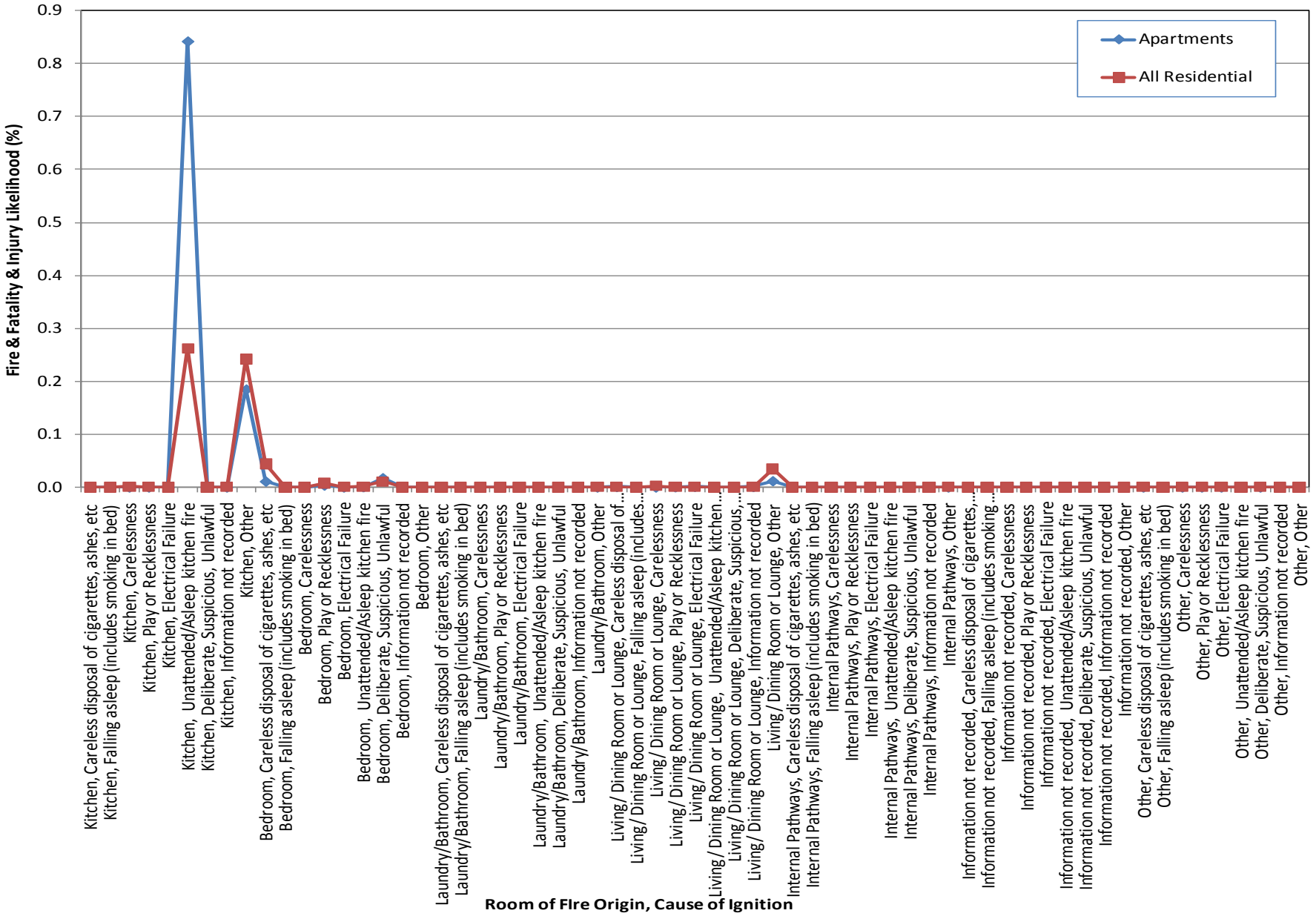


Figure 21: Combinations of percentages of total fires, fatalities and injuries for apartments and all residential buildings for combinations of room of fire origin and material first ignited

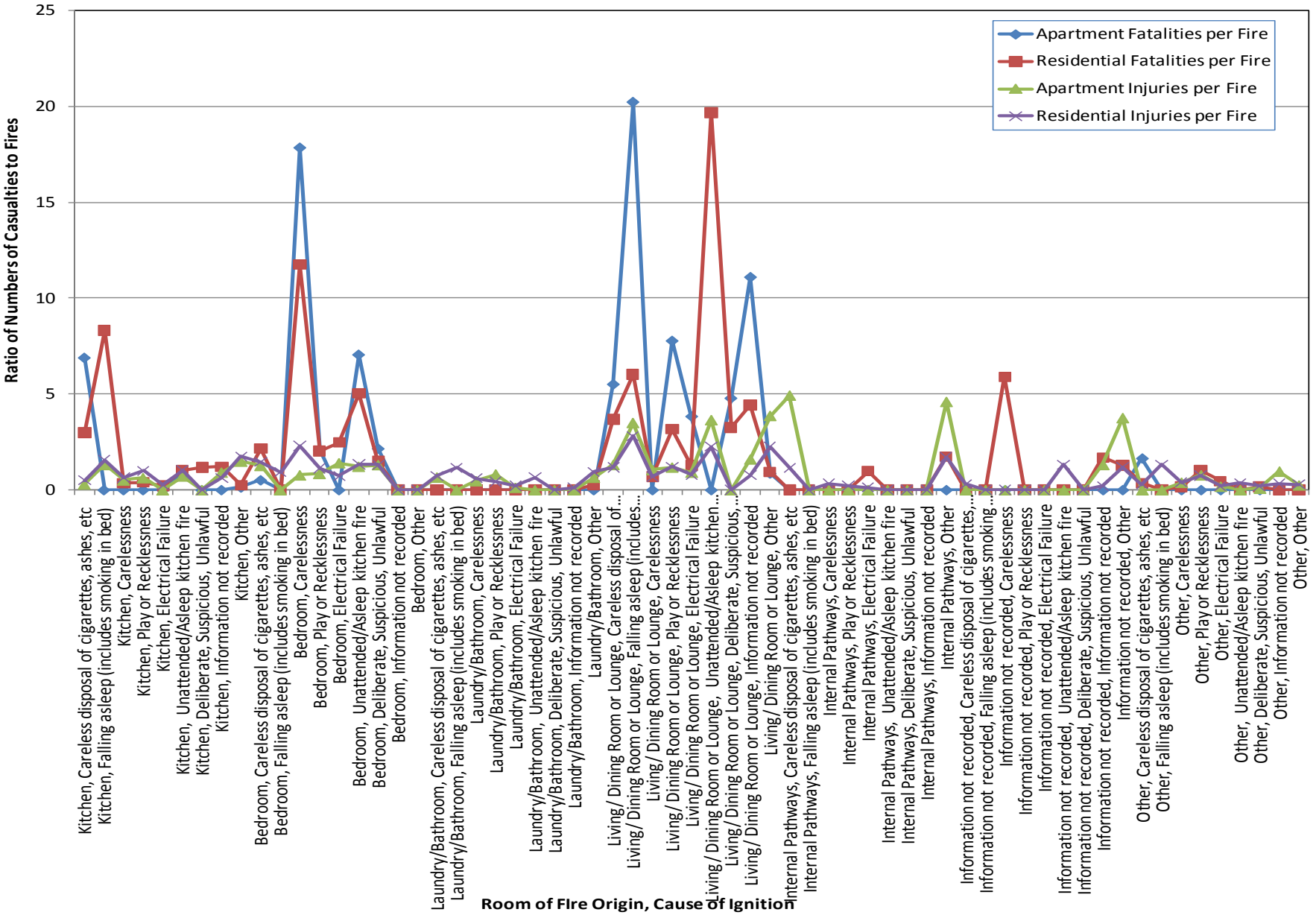


Figure 22: Ratios of casualties to fires for combinations of room of fire origin and material first ignited for apartments and all residential buildings

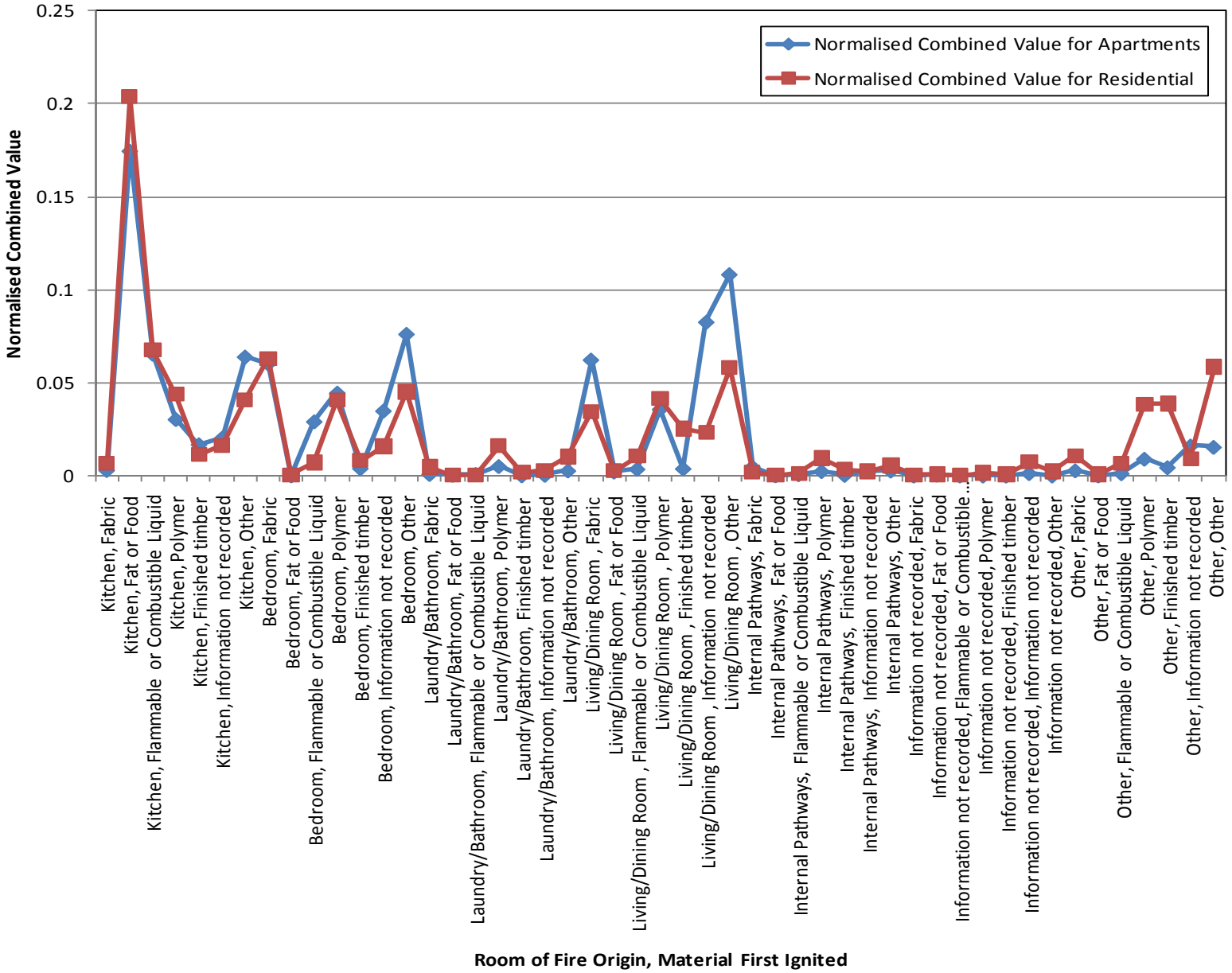


Figure 23: Normalised combined value incorporating weighted percentages of fires and casualties for combinations of room of fire origin and material first ignited

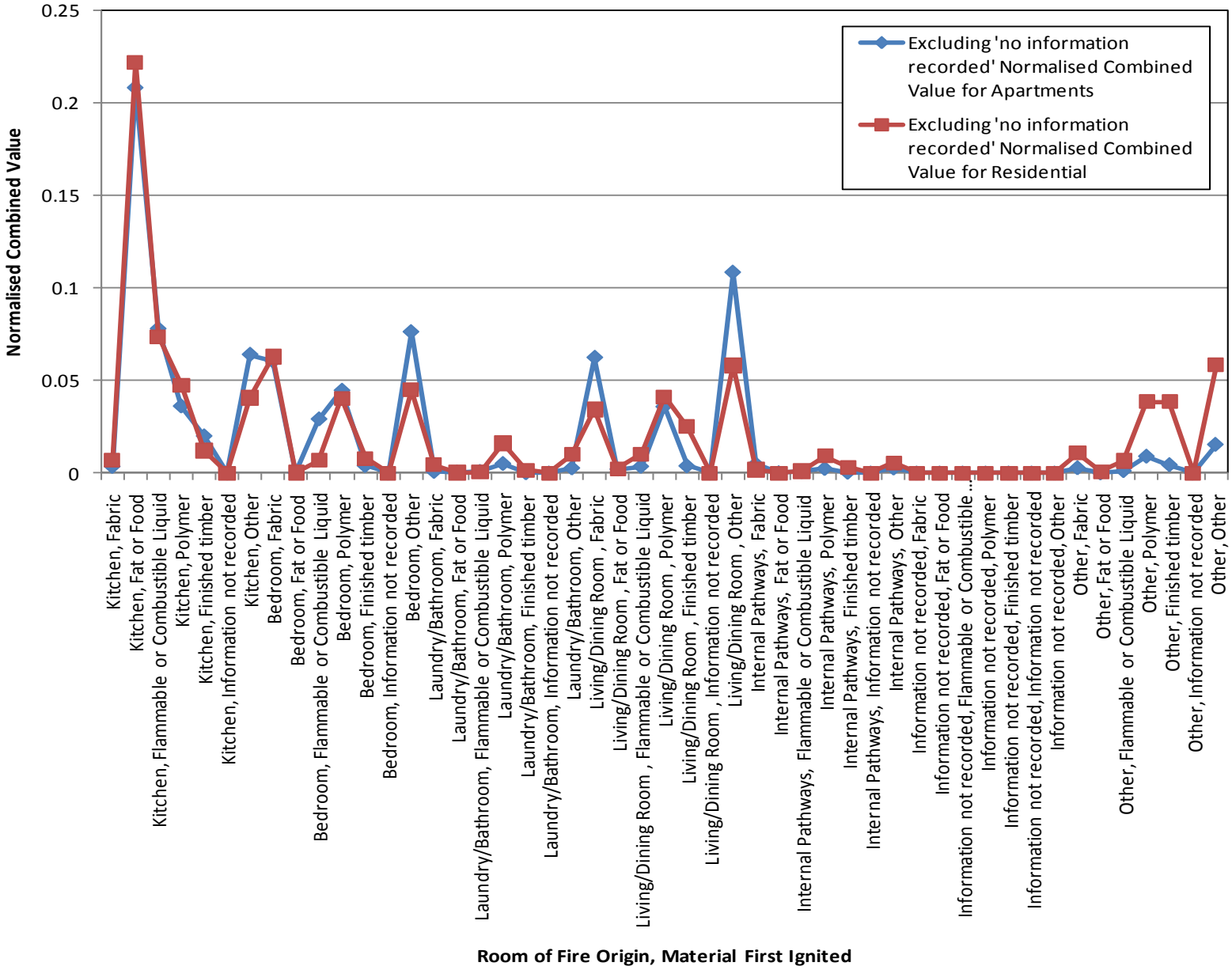


Figure 24: Normalised combined value incorporating weighted percentages of fires and casualties for combinations of room of fire origin and material first ignited, excluding values for 'no information recorded' clusters

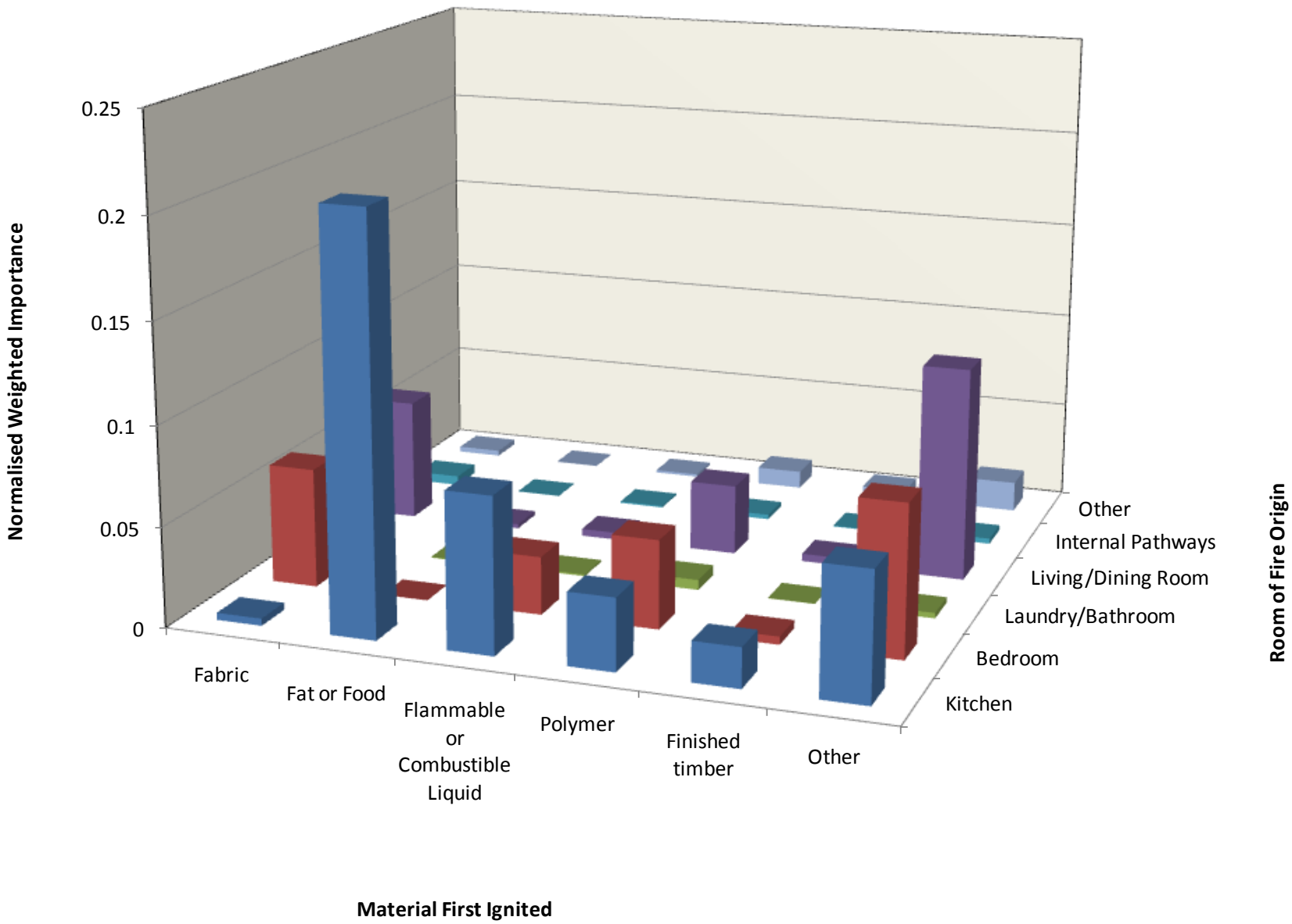


Figure 25: Summary of normalised weighted importance factor for clusters of room of fire origin and material first ignited for apartments, excluding 'no information recorded' clusters

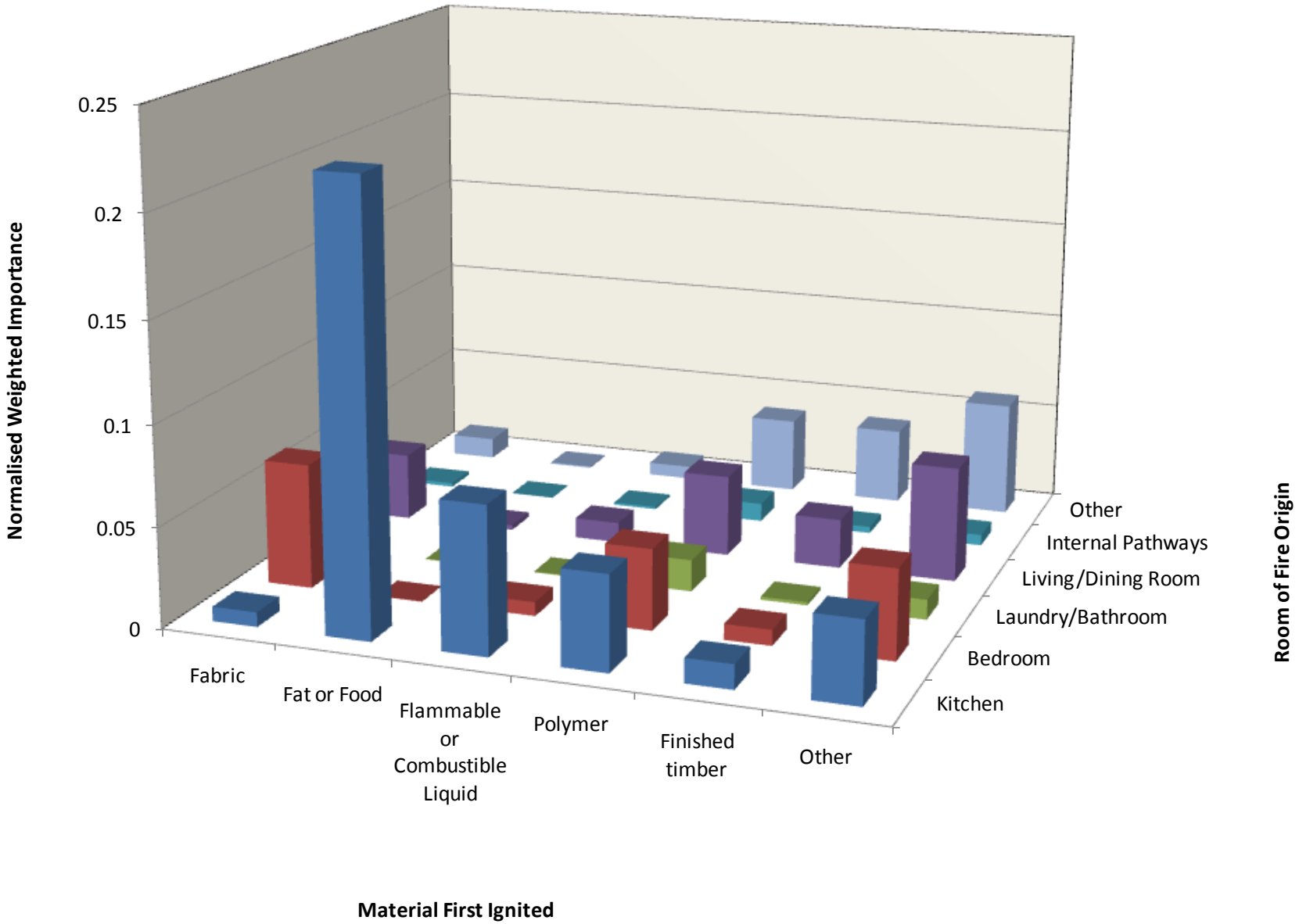


Figure 26: Summary of normalised weighted importance factor for clusters of room of fire origin and material first ignited for all residential structures, excluding 'no information recorded' clusters

Table 23: Normalised weighted importance factor for clusters of room of fire origin and material first ignited for apartments, excluding 'no information recorded' clusters

		Room of Fire Origin					
		Kitchen	Bedroom	Laundry/ Bathroom	Living/ Dining Room	Internal Pathways	Other
Material First Ignited	Fabric	0.004	0.060	0.0009	0.062	0.005	0.003
	Fat or Food	0.208	0.0001	0.000	0.002	0.000	0.000
	Flammable or Combustible Liquid	0.078	0.029	0.000	0.004	0.001	0.001
	Polymer	0.036	0.045	0.005	0.036	0.002	0.009
	Finished timber	0.020	0.004	0.000	0.004	0.000	0.005
	Other	0.064	0.076	0.003	0.108	0.003	0.015

Table 24: Normalised weighted importance factor for clusters of room of fire origin and material first ignited in ignition for all residential structures, excluding 'no information recorded' clusters

		Room of Fire Origin					
		Kitchen	Bedroom	Laundry/ Bathroom	Living/ Dining Room	Internal Pathways	Other
Material First Ignited	Fabric	0.007	0.063	0.005	0.0343	0.002	0.01
	Fat or Food	0.222	0.000	0.000	0.002	0.000	0.001
	Flammable or Combustible Liquid	0.074	0.007	0.001	0.010	0.001	0.007
	Polymer	0.048	0.041	0.016	0.041	0.009	0.039
	Finished timber	0.012	0.008	0.002	0.025	0.003	0.039
	Other	0.041	0.045	0.010	0.058	0.006	0.059

A.3 Room of fire origin and cause of ignition

Table 25: The most common combination of rooms of fire origin and cause of ignition for apartment fires

Room of Fire Origin	Cause of Ignition	% Total Apartment Fires
Kitchen	Unattended/Asleep kitchen fire	24.3
Kitchen	Other	20.9
Bedroom	Careless disposal of cigarettes, ashes, etc	5.6
Kitchen	Carelessness	4.1
Bedroom	Deliberate, Suspicious, Unlawful	4.0
Living/Dining Room or Lounge	Other	3.3
Other	Deliberate, Suspicious, Unlawful	3.1
Bedroom	Play or Recklessness	2.8
Living/Dining Room or Lounge	Carelessness	2.6
Other	Other	2.5
Other	Electrical Failure	2.0
Living/Dining Room or Lounge	Deliberate, Suspicious, Unlawful	1.8
Other	Careless disposal of cigarettes, ashes, etc	1.7
Kitchen	Play or Recklessness	1.6
Laundry/Bathroom	Other	1.5
Living/Dining Room or Lounge	Electrical Failure	1.5
Kitchen	Electrical Failure	1.3
Internal Pathways	Deliberate, Suspicious, Unlawful	1.1
Living/Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	1.0
Laundry/Bathroom	Electrical Failure	1.0
Other	Carelessness	1.0
Other	Play or Recklessness	1.0
Kitchen	Information not recorded	0.8
Bedroom	Unattended/Asleep kitchen fire	0.8
Living/Dining Room or Lounge	Information not recorded	0.8
Kitchen	Deliberate, Suspicious, Unlawful	0.7
Living/Dining Room or Lounge	Play or Recklessness	0.7
Other	Information not recorded	0.6
Internal Pathways	Electrical Failure	0.6
Internal Pathways	Other	0.6
Bedroom	Electrical Failure	0.5

Table 26: The most common combination of rooms of fire origin and cause of ignition for residential fires.

Room of Fire Origin	Cause of Ignition	% Total Residential Fires
Kitchen	Other	18.1
Kitchen	Unattended/Asleep kitchen fire	13.7
Living/Dining Room or Lounge	Other	5.5
Bedroom	Careless disposal of cigarettes, ashes, etc	5.2
Other	Other	5.0
Living/Dining Room or Lounge	Carelessness	3.8
Kitchen	Carelessness	3.8
Bedroom	Deliberate, Suspicious, Unlawful	3.8
Bedroom	Play or Recklessness	3.2
Other	Electrical Failure	2.8
Other	Deliberate, Suspicious, Unlawful	2.8
Other	Carelessness	2.8
Other	Careless disposal of cigarettes, ashes, etc	2.4
Kitchen	Electrical Failure	2.0
Living/Dining Room or Lounge	Deliberate, Suspicious, Unlawful	1.8
Laundry/Bathroom	Other	1.8
Living/Dining Room or Lounge	Electrical Failure	1.7
Laundry/Bathroom	Electrical Failure	1.3
Living/Dining Room or Lounge	Information not recorded	1.3
Other	Play or Recklessness	1.2
Living/Dining Room or Lounge	Play or Recklessness	1.2
Other	Information not recorded	1.2
Kitchen	Play or Recklessness	1.1
Kitchen	Information not recorded	1.1
Living/Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	1.0
Bedroom	Unattended/Asleep kitchen fire	1.0
Information not recorded	Information not recorded	1.0
Internal Pathways	Electrical Failure	0.9
Kitchen	Deliberate, Suspicious, Unlawful	0.7
Internal Pathways	Other	0.7
Bedroom	Electrical Failure	0.7
Internal Pathways	Deliberate, Suspicious, Unlawful	0.6
Laundry/Bathroom	Carelessness	0.5

Table 27: The most common combination of rooms of fire origin and cause of ignition for apartment fatalities.

Room of Fire Origin	Cause of Ignition	% Total Apartment Fatalities
Kitchen	Unattended/Asleep kitchen fire	20.0
Bedroom	Deliberate, Suspicious, Unlawful	8.6
Living/Dining Room or Lounge	Deliberate, Suspicious, Unlawful	8.6
Living/Dining Room or Lounge	Information not recorded	8.6
Bedroom	Carelessness	5.7
Bedroom	Play or Recklessness	5.7
Bedroom	Unattended/Asleep kitchen fire	5.7
Living/Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	5.7
Living/Dining Room or Lounge	Falling asleep (includes smoking in bed)	5.7
Living/Dining Room or Lounge	Play or Recklessness	5.7
Living/Dining Room or Lounge	Electrical Failure	5.7
Kitchen	Careless disposal of cigarettes, ashes, etc	2.9
Kitchen	Other	2.9
Bedroom	Careless disposal of cigarettes, ashes, etc	2.9
Living/Dining Room or Lounge	Other	2.9
Other	Careless disposal of cigarettes, ashes, etc	2.9

Table 28: The most common combination of rooms of fire origin and cause of ignition for residential fatalities.

Room of Fire Origin	Cause of Ignition	% Total Residential Fatalities
Kitchen	Unattended/Asleep kitchen fire	13.7
Bedroom	Careless disposal of cigarettes, ashes, etc	11.1
Bedroom	Play or Recklessness	6.4
Living/Dining Room or Lounge	Deliberate, Suspicious, Unlawful	6.0
Bedroom	Deliberate, Suspicious, Unlawful	5.6
Living/Dining Room or Lounge	Information not recorded	5.6
Bedroom	Unattended/Asleep kitchen fire	5.1
Living/Dining Room or Lounge	Other	5.1
Kitchen	Other	4.3
Living/Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	3.8
Living/Dining Room or Lounge	Play or Recklessness	3.8
Bedroom	Carelessness	3.0
Living/Dining Room or Lounge	Carelessness	2.6
Living/Dining Room or Lounge	Unattended/Asleep kitchen fire	2.6
Living/Dining Room or Lounge	Electrical Failure	2.1
Kitchen	Falling asleep (includes smoking in bed)	1.7
Bedroom	Electrical Failure	1.7
Information not recorded	Information not recorded	1.7
Kitchen	Careless disposal of cigarettes, ashes, etc	1.3
Kitchen	Carelessness	1.3
Kitchen	Information not recorded	1.3
Internal Pathways	Other	1.3

Table 29: The most common combination of rooms of fire origin and cause of ignition for apartment injuries.

Room of Fire Origin	Cause of Ignition	% Total Apartment Injuries
Kitchen	Other	31.0
Kitchen	Unattended/Asleep kitchen fire	17.3
Living/Dining Room or Lounge	Other	12.7
Bedroom	Careless disposal of cigarettes, ashes, etc	7.0
Bedroom	Deliberate, Suspicious, Unlawful	5.2
Living/Dining Room or Lounge	Carelessness	2.7
Internal Pathways	Other	2.6
Bedroom	Play or Recklessness	2.3
Kitchen	Carelessness	2.1
Living/Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	1.4
Living/Dining Room or Lounge	Electrical Failure	1.4
Living/Dining Room or Lounge	Information not recorded	1.2
Internal Pathways	Careless disposal of cigarettes, ashes, etc	1.1
Kitchen	Play or Recklessness	1.0
Bedroom	Unattended/Asleep kitchen fire	1.0
Laundry/Bathroom	Other	1.0
Living/Dining Room or Lounge	Falling asleep (includes smoking in bed)	1.0
Living/Dining Room or Lounge	Play or Recklessness	0.9
Kitchen	Information not recorded	0.7
Bedroom	Electrical Failure	0.7
Other	Play or Recklessness	0.7
Kitchen	Falling asleep (includes smoking in bed)	0.6
Living/Dining Room or Lounge	Unattended/Asleep kitchen fire	0.6
Other	Information not recorded	0.6
Other	Other	0.6
Information not recorded	Other	0.5
Information not recorded	Information not recorded	0.4
Other	Carelessness	0.4

Table 30: The most common combination of rooms of fire origin and cause of in ignition for residential injuries.

Room of Fire Origin	Cause of Ignition	% Total Residential Injuries
Kitchen	Other	31.3
Kitchen	Unattended/Asleep kitchen fire	14.1
Living/Dining Room or Lounge	Other	12.2
Bedroom	Careless disposal of cigarettes, ashes, etc	7.6
Bedroom	Deliberate, Suspicious, Unlawful	4.9
Bedroom	Play or Recklessness	3.5
Living/Dining Room or Lounge	Carelessness	2.6
Kitchen	Carelessness	2.4
Laundry/Bathroom	Other	1.7
Living/Dining Room or Lounge	Play or Recklessness	1.5
Other	Other	1.4
Bedroom	Unattended/Asleep kitchen fire	1.4
Living/Dining Room or Lounge	Electrical Failure	1.3
Internal Pathways	Other	1.2
Living/Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	1.2
Kitchen	Play or Recklessness	1.1
Other	Carelessness	1.1
Living/Dining Room or Lounge	Information not recorded	1.0
Other	Play or Recklessness	0.9
Kitchen	Information not recorded	0.7
Other	Careless disposal of cigarettes, ashes, etc	0.7
Bedroom	Carelessness	0.6
Other	Electrical Failure	0.5
Other	Deliberate, Suspicious, Unlawful	0.5
Bedroom	Electrical Failure	0.5
Kitchen	Electrical Failure	0.5
Living/Dining Room or Lounge	Falling asleep (includes smoking in bed)	0.4
Information not recorded	Other	0.4

Table 31: The most common combination of rooms of fire origin and cause of ignition for ratios of fatalities to fires for apartments.

Room of Fire Origin	Cause of Ignition	Apartment Fatalities per Fire
Living/Dining Room or Lounge	Falling asleep (includes smoking in bed)	20.2
Bedroom	Carelessness	17.9
Living/Dining Room or Lounge	Information not recorded	11.1
Living/Dining Room or Lounge	Play or Recklessness	7.8
Bedroom	Unattended/Asleep kitchen fire	7.1
Kitchen	Careless disposal of cigarettes, ashes, etc	6.9
Living/Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	5.5
Living/Dining Room or Lounge	Deliberate, Suspicious, Unlawful	4.8
Living/Dining Room or Lounge	Electrical Failure	3.8
Bedroom	Deliberate, Suspicious, Unlawful	2.2
Bedroom	Play or Recklessness	2.1
Other	Careless disposal of cigarettes, ashes, etc	1.6
Living/Dining Room or Lounge	Other	0.9
Kitchen	Unattended/Asleep kitchen fire	0.8
Bedroom	Careless disposal of cigarettes, ashes, etc	0.5
Kitchen	Other	0.1

Table 32: The most common combination of rooms of fire origin and cause of ignition for ratios of fatalities to fire for residential structures.

Room of Fire Origin	Cause of Ignition	Residential Fatalities per Fire
Living/Dining Room or Lounge	Unattended/Asleep kitchen fire	19.7
Bedroom	Carelessness	11.7
Kitchen	Falling asleep (includes smoking in bed)	8.3
Living/Dining Room or Lounge	Falling asleep (includes smoking in bed)	6.0
Information not recorded	Carelessness	5.9
Bedroom	Unattended/Asleep kitchen fire	5.0
Living/Dining Room or Lounge	Information not recorded	4.4
Living/Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	3.7
Living/Dining Room or Lounge	Deliberate, Suspicious, Unlawful	3.2
Living/Dining Room or Lounge	Play or Recklessness	3.2
Kitchen	Careless disposal of cigarettes, ashes, etc	3.0
Bedroom	Electrical Failure	2.5
Bedroom	Careless disposal of cigarettes, ashes, etc	2.1
Bedroom	Play or Recklessness	2.0
Internal Pathways	Other	1.7
Information not recorded	Information not recorded	1.7
Bedroom	Deliberate, Suspicious, Unlawful	1.5
Living/Dining Room or Lounge	Electrical Failure	1.3
Information not recorded	Other	1.3
Kitchen	Information not recorded	1.2
Kitchen	Deliberate, Suspicious, Unlawful	1.2
Other	Play or Recklessness	1.0

Table 33: The most common combination of rooms of fire origin and cause of ignition for ratios of injuries to fires for apartments.

Room of Fire Origin	Cause of Ignition	Apartment Injuries per Fire
Internal Pathways	Careless disposal of cigarettes, ashes, etc	4.9
Internal Pathways	Other	4.6
Living/Dining Room or Lounge	Other	3.8
Information not recorded	Other	3.7
Living/Dining Room or Lounge	Unattended/Asleep kitchen fire	3.6
Living/Dining Room or Lounge	Falling asleep (includes smoking in bed)	3.5
Living/Dining Room or Lounge	Information not recorded	1.6
Kitchen	Other	1.5
Bedroom	Electrical Failure	1.4
Kitchen	Falling asleep (includes smoking in bed)	1.3
Living/Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	1.3
Information not recorded	Information not recorded	1.3
Bedroom	Deliberate, Suspicious, Unlawful	1.3
Bedroom	Careless disposal of cigarettes, ashes, etc	1.3
Bedroom	Unattended/Asleep kitchen fire	1.2
Living/Dining Room or Lounge	Play or Recklessness	1.2
Living/Dining Room or Lounge	Carelessness	1.0
Other	Information not recorded	1.0
Kitchen	Information not recorded	0.9
Living/Dining Room or Lounge	Electrical Failure	0.9
Bedroom	Play or Recklessness	0.8
Laundry/Bathroom	Play or Recklessness	0.8
Bedroom	Carelessness	0.8
Other	Play or Recklessness	0.8
Kitchen	Unattended/Asleep kitchen fire	0.7
Laundry/Bathroom	Careless disposal of cigarettes, ashes, etc	0.7
Laundry/Bathroom	Other	0.6
Kitchen	Play or Recklessness	0.6

Table 34: The most common combination of rooms of fire origin and cause of ignition for ratios of injuries to fires for residential structures.

Room of Fire Origin	Cause of Ignition	Residential Injuries per Fire
Bedroom	Carelessness	2.3
Living/Dining Room or Lounge	Unattended/Asleep kitchen fire	2.2
Living/Dining Room or Lounge	Other	2.2
Kitchen	Other	1.7
Internal Pathways	Other	1.7
Kitchen	Falling asleep (includes smoking in bed)	1.6
Bedroom	Careless disposal of cigarettes, ashes, etc	1.5
Bedroom	Unattended/Asleep kitchen fire	1.3
Bedroom	Deliberate, Suspicious, Unlawful	1.3
Information not recorded	Unattended/Asleep kitchen fire	1.3
Other	Falling asleep (includes smoking in bed)	1.3
Living/Dining Room or Lounge	Play or Recklessness	1.2
Information not recorded	Other	1.2
Living/ Dining Room or Lounge	Careless disposal of cigarettes, ashes, etc	1.2
Internal Pathways	Careless disposal of cigarettes, ashes, etc	1.1
Laundry/Bathroom	Falling asleep (includes smoking in bed)	1.1
Bedroom	Play or Recklessness	1.1
Kitchen	Unattended/Asleep kitchen fire	1.0
Kitchen	Play or Recklessness	1.0
Laundry/Bathroom	Other	0.9
Bedroom	Falling asleep (includes smoking in bed)	0.9
Living/Dining Room or Lounge	Electrical Failure	0.8
Living/Dining Room or Lounge	Information not recorded	0.8
Other	Play or Recklessness	0.7
Bedroom	Electrical Failure	0.7
Laundry/Bathroom	Careless disposal of cigarettes, ashes, etc	0.7
Living/Dining Room or Lounge	Carelessness	0.7

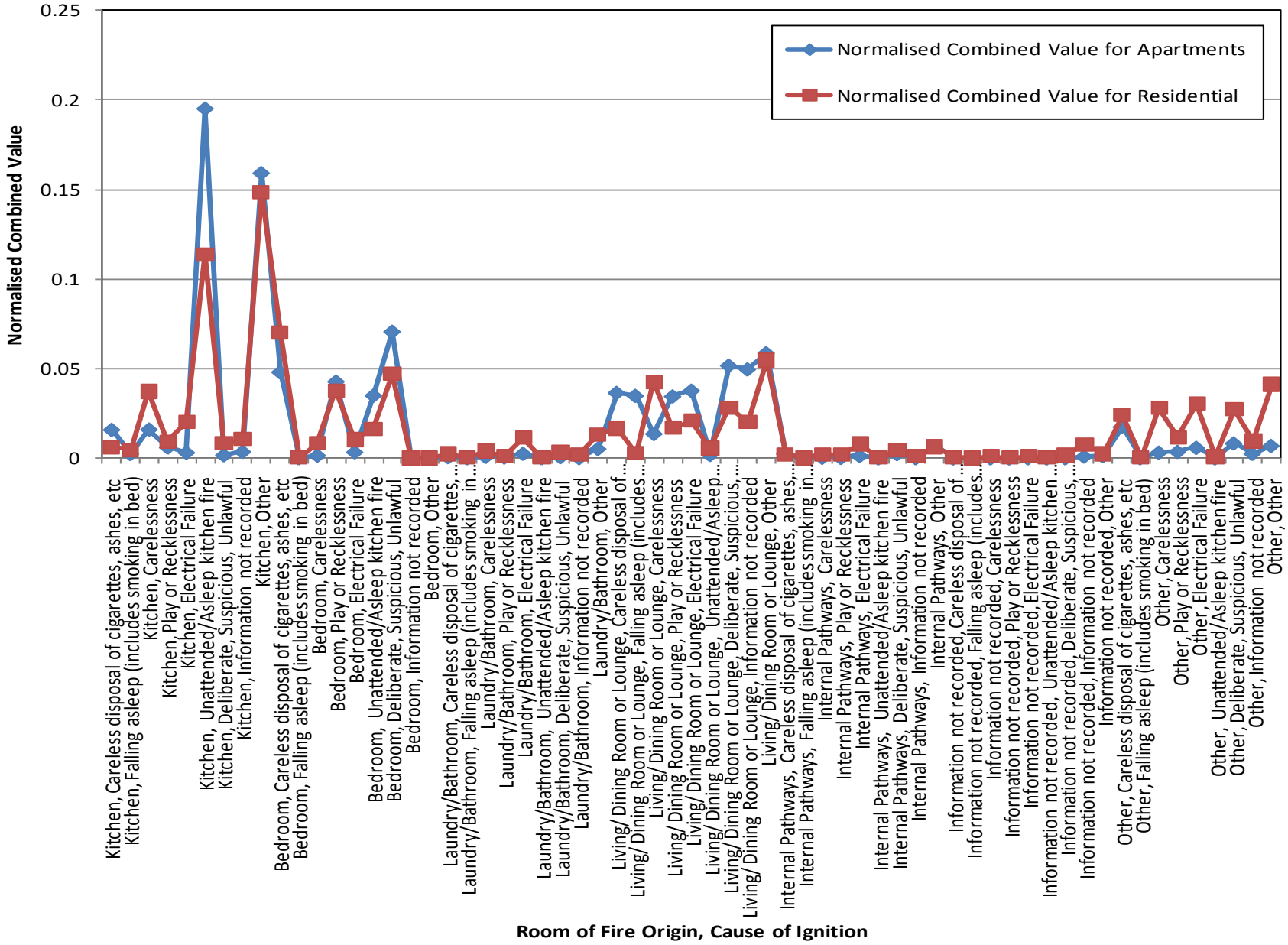


Figure 27: Normalised combined value incorporating weighted percentages of fires and casualties for combinations of room of fire origin and cause of ignition

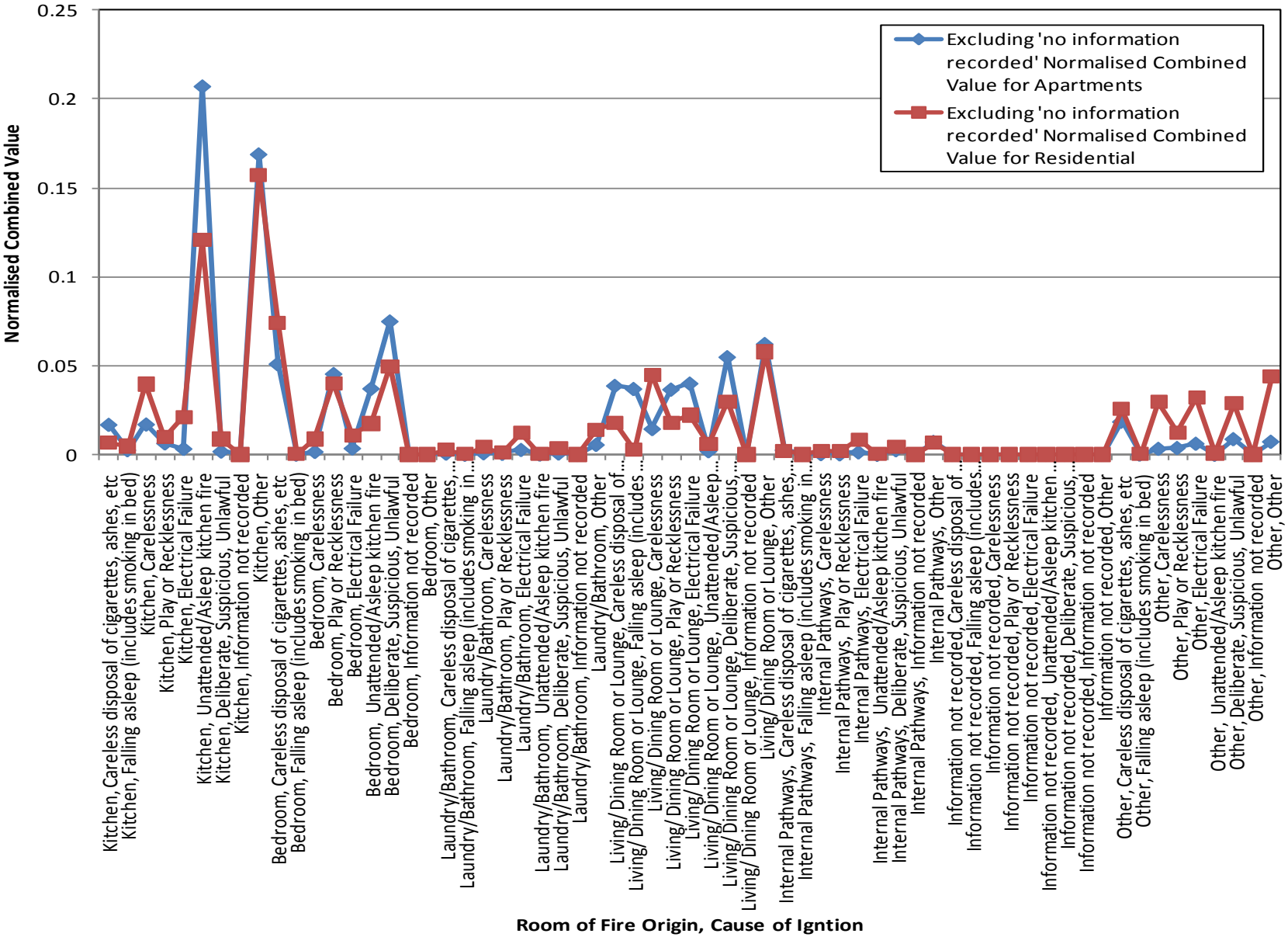


Figure 28: Normalised combined value incorporating weighted percentages of fires and casualties for combinations of room of fire origin and cause of ignition, excluding values for 'no information recorded' clusters

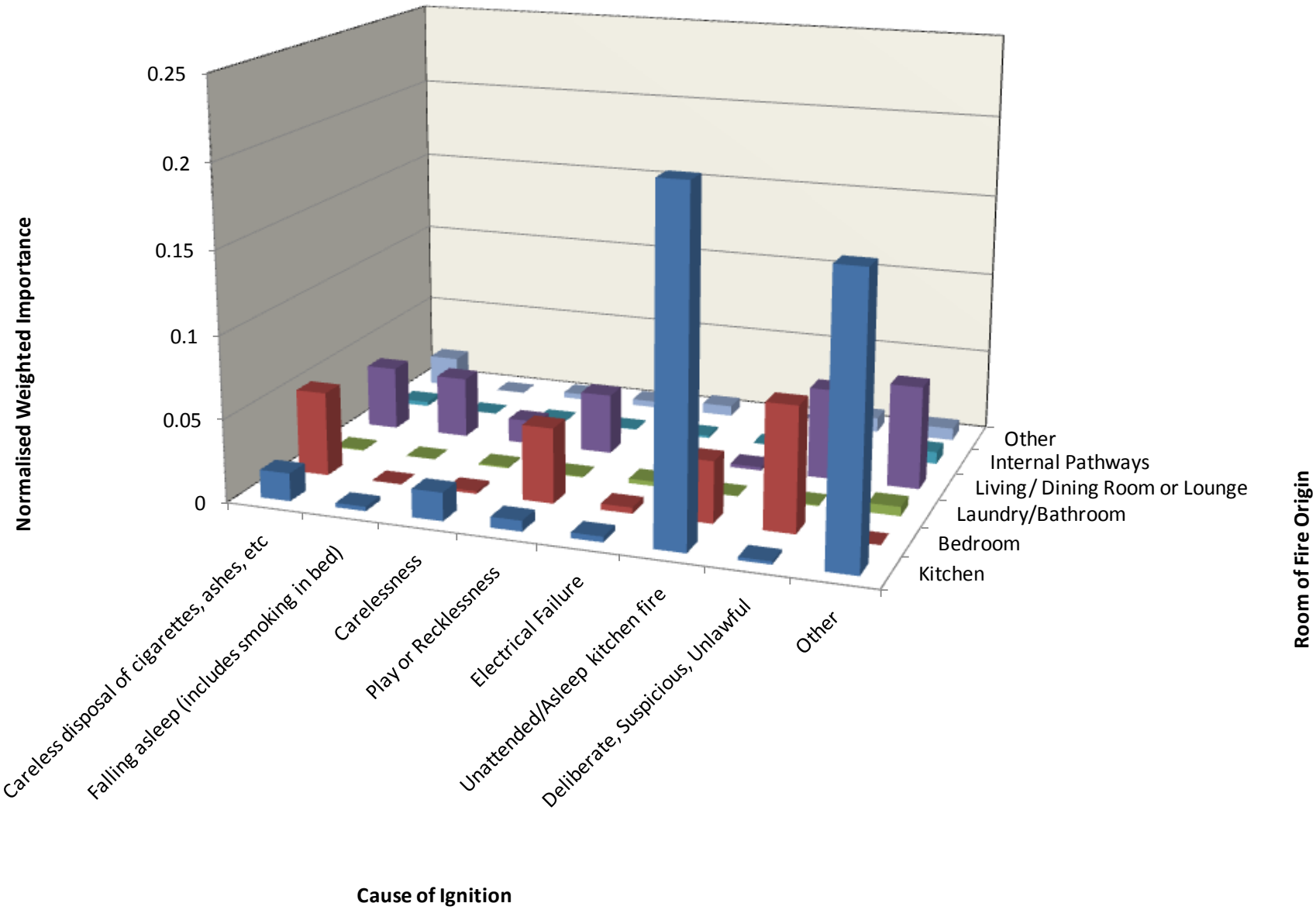


Figure 29: Summary of normalised weighted importance factor for clusters of room of fire origin and cause of ignition for apartments, excluding 'no information recorded' clusters

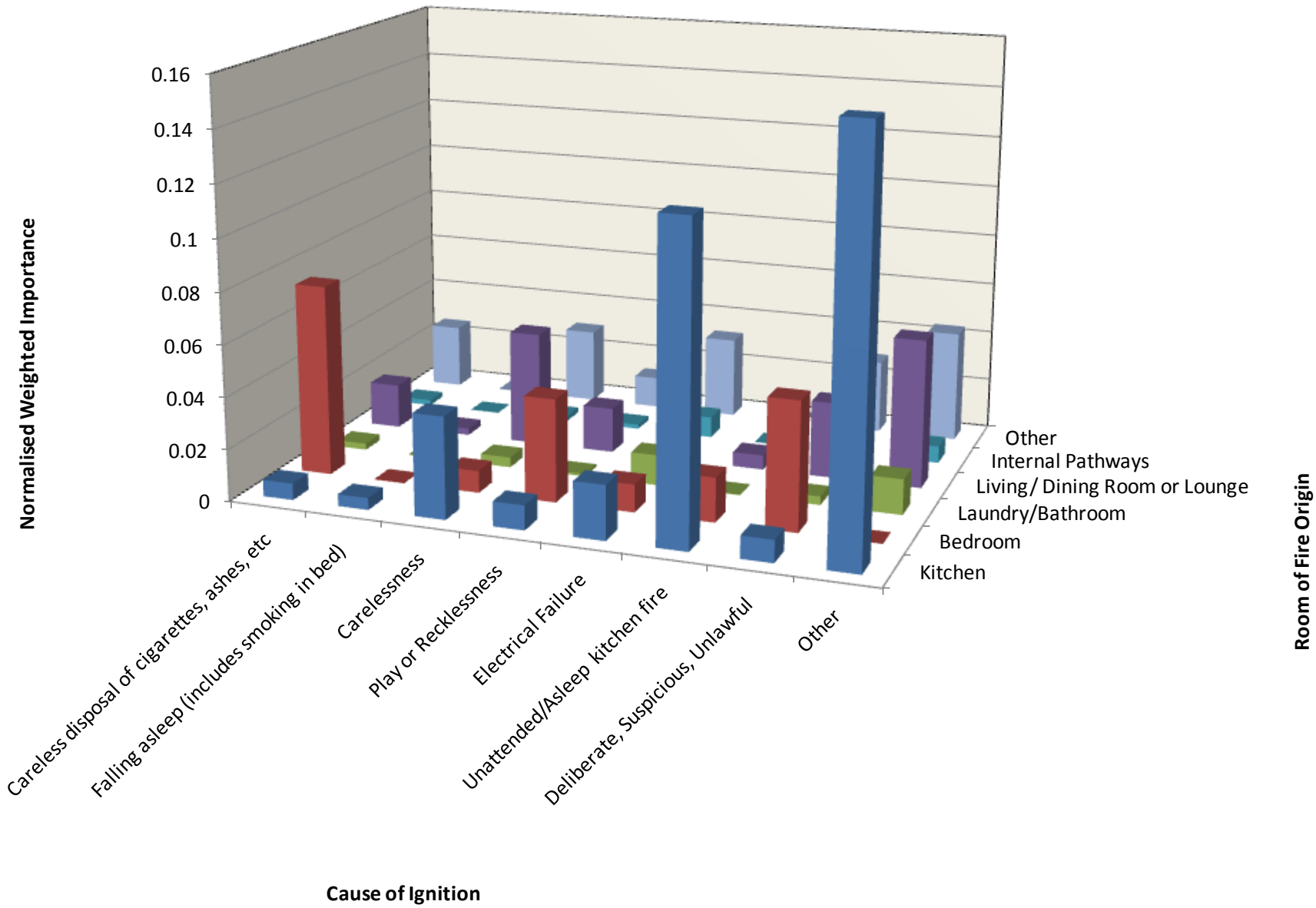


Figure 30: Summary of normalised weighted importance factor for clusters of room of fire origin and cause of ignition for all residential structures, excluding 'no information recorded' clusters

Table 35: Normalised weighted importance factor for clusters of room of fire origin and cause of ignition for apartments, excluding 'no information recorded' clusters

		Room of Fire Origin					
		Kitchen	Bedroom	Laundry/ Bathroom	Living/ Dining Room	Internal Pathways	Other
Cause of Ignition	Careless disposal of cigarettes, ashes, etc	0.017	0.051	0.001	0.039	0.003	0.019
	Falling asleep (includes smoking in bed)	0.003	0.000	0.000	0.037	0.000	0.000
	Carelessness	0.017	0.002	0.001	0.015	0.000	0.003
	Play or Recklessness	0.006	0.045	0.001	0.037	0.000	0.004
	Electrical Failure	0.003	0.004	0.003	0.040	0.001	0.006
	Unattended/Asleep kitchen fire	0.207	0.037	0.000	0.002	0.000	0.000
	Deliberate, Suspicious, Unlawful	0.002	0.075	0.001	0.055	0.003	0.009
	Other	0.169	0.000	0.006	0.062	0.007	0.007

Table 36: Normalised weighted importance factor for clusters of room of fire origin and cause of ignition for all residential structures, excluding 'no information recorded' clusters

		Room of Fire Origin					
		Kitchen	Bedroom	Laundry/ Bathroom	Living/ Dining Room	Internal Pathways	Other
Cause of Ignition	Careless disposal of cigarettes, ashes, etc	0.006	0.074	0.002	0.018	0.002	0.025
	Falling asleep (includes smoking in bed)	0.005	0.000	0.000	0.003	0.000	0.000
	Carelessness	0.039	0.009	0.004	0.045	0.002	0.029
	Play or Recklessness	0.010	0.040	0.001	0.018	0.002	0.012
	Electrical Failure	0.021	0.011	0.012	0.022	0.008	0.032
	Unattended/Asleep kitchen fire	0.121	0.017	0.000	0.006	0.000	0.001
	Deliberate, Suspicious, Unlawful	0.009	0.050	0.003	0.030	0.004	0.029
	Other	0.157	0.000	0.014	0.058	0.007	0.044

Appendix B SUMMARY OF SCENARIO SETS

B.1 Room of fire origin and equipment involved in ignition

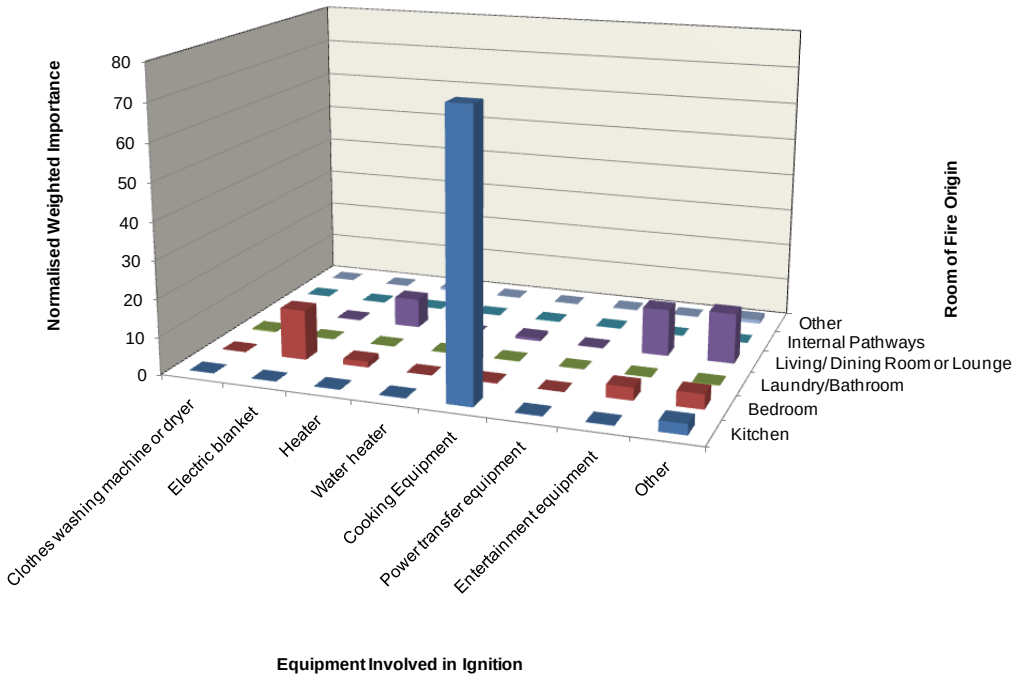


Figure 31: Normalised weighted importance factor for clusters of room of fire origin and equipment involved in ignition based on apartment fire statistics

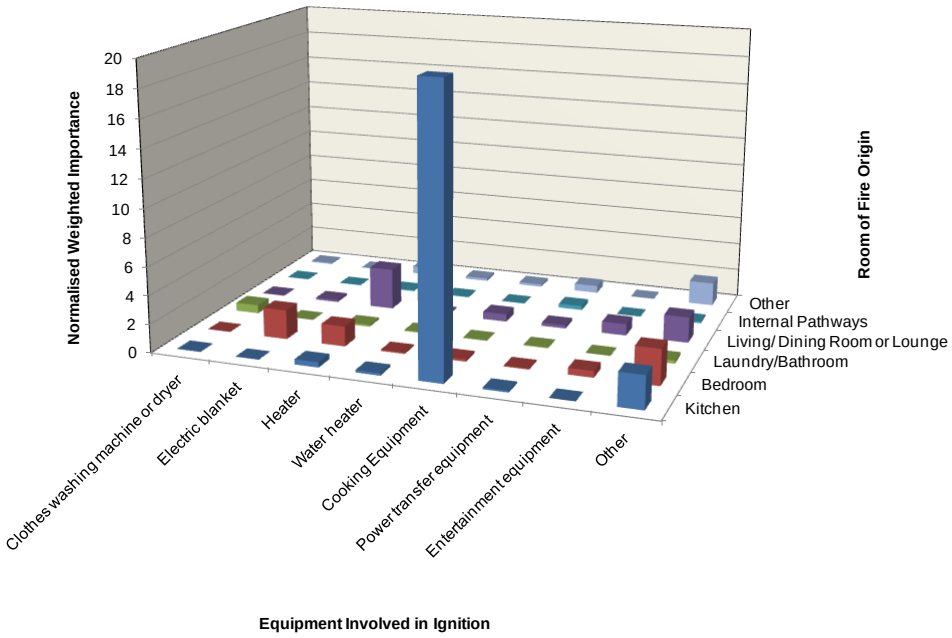


Figure 32: Normalised weighted importance factor for clusters of room of fire origin and equipment involved in ignition based on all residential structure fire statistics

B.2 Room of Fire Origin and Material First Ignited

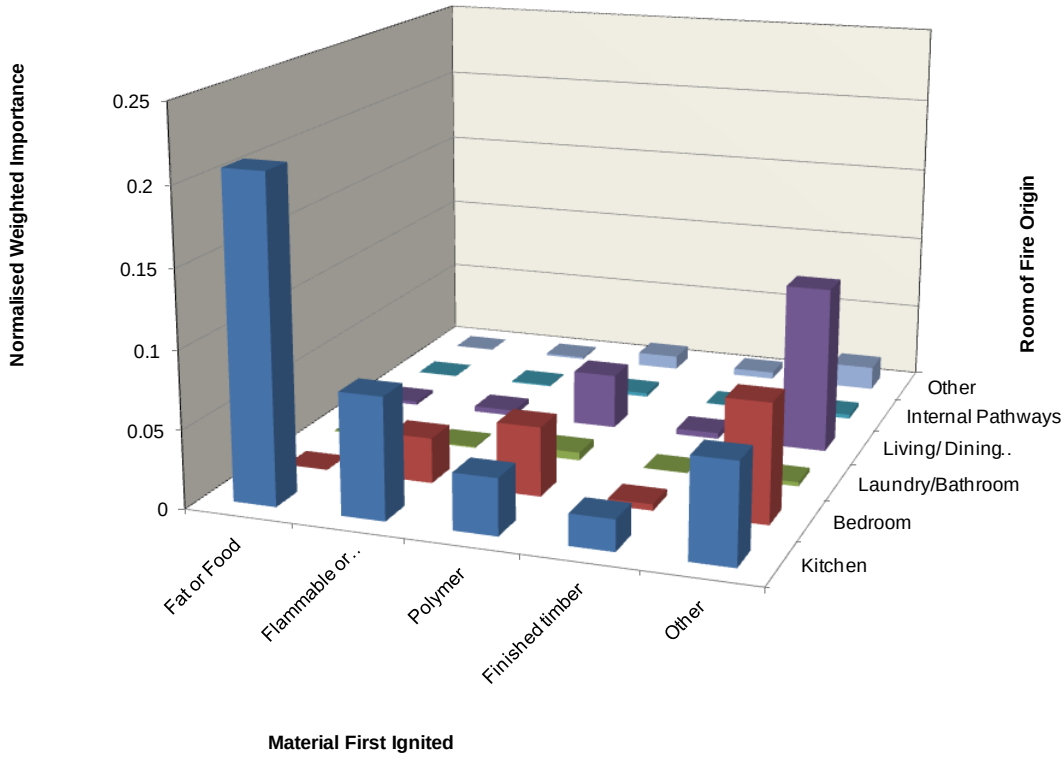


Figure 33: Normalised weighted importance factor for clusters of room of fire origin and material first ignited based on apartment fire statistics

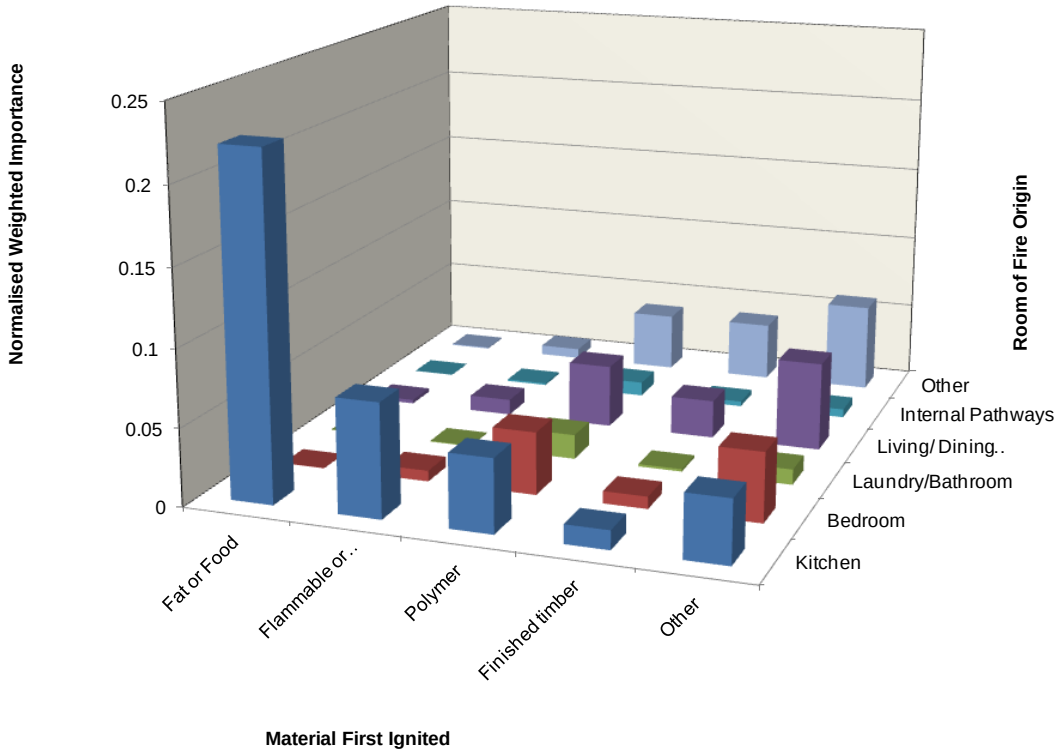


Figure 34: Normalised weighted importance factor for clusters of room of fire origin and material first ignited based on all residential structure fire statistics

B.3 Room of fire origin and cause of ignition

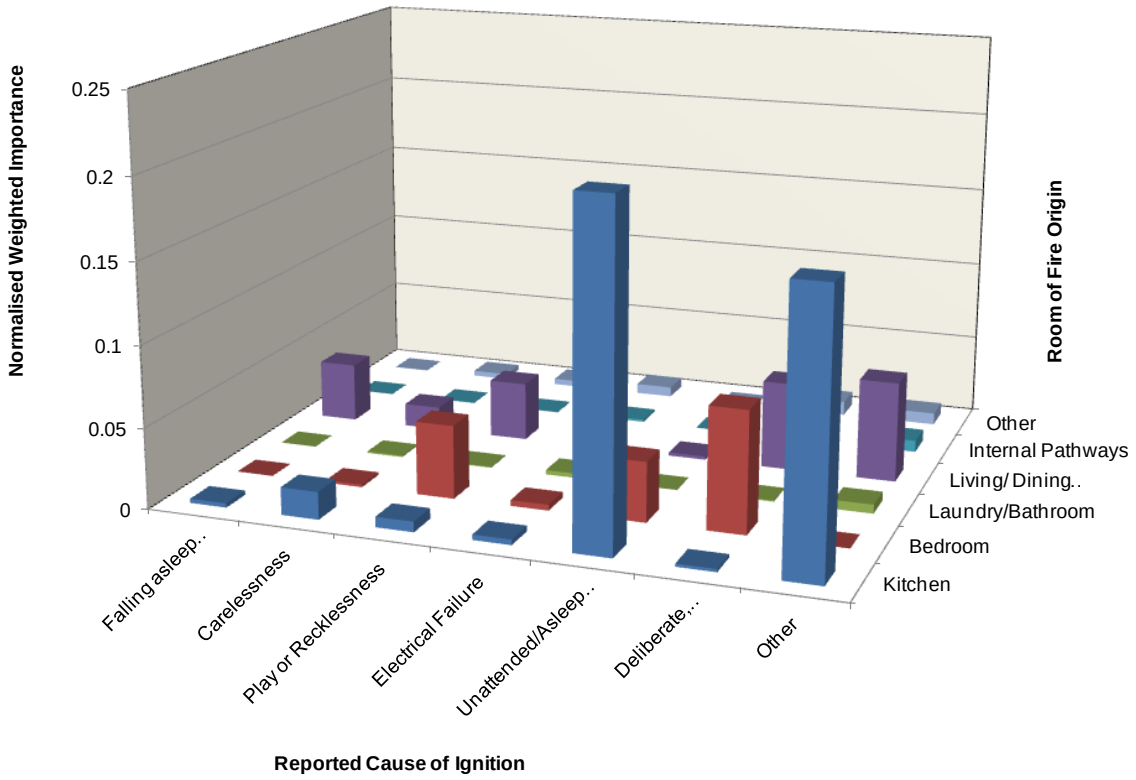


Figure 35: Normalised weighted importance factor for clusters of room of fire origin and reported cause of ignition based on apartment fire statistics

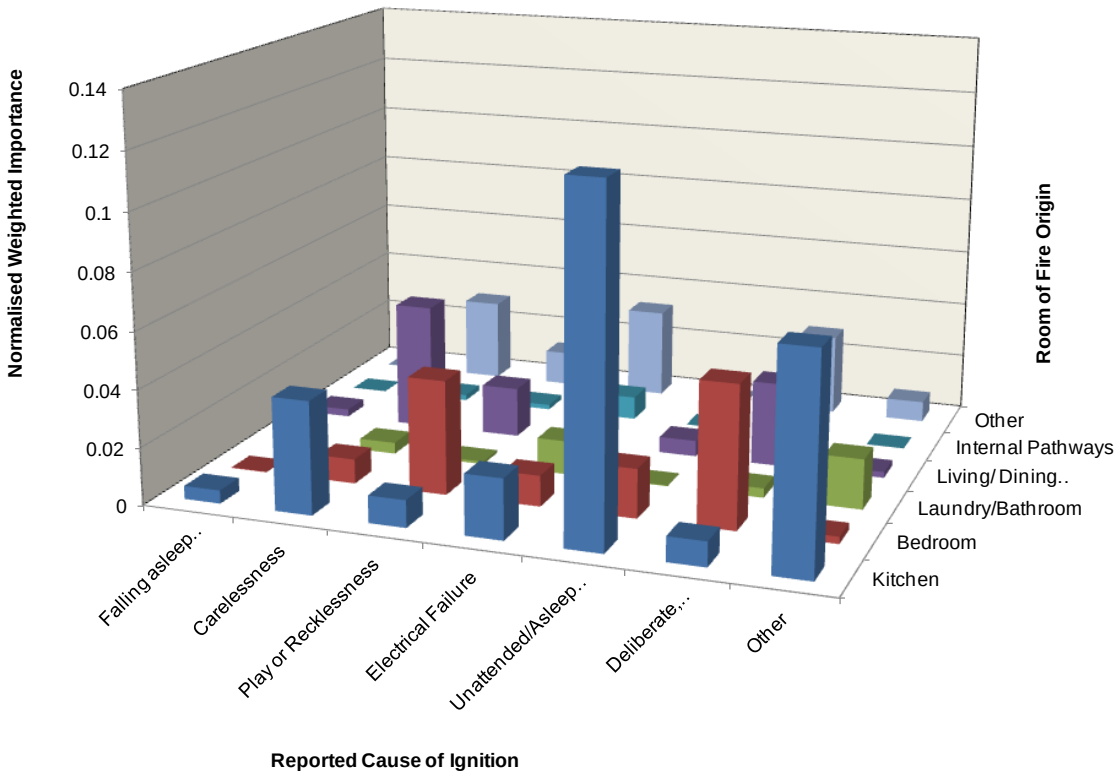


Figure 36: Normalised weighted importance factor for clusters of room of fire origin and reported cause of ignition based on all residential structure fire statistics

B.4 Room of fire origin and the highest importance values

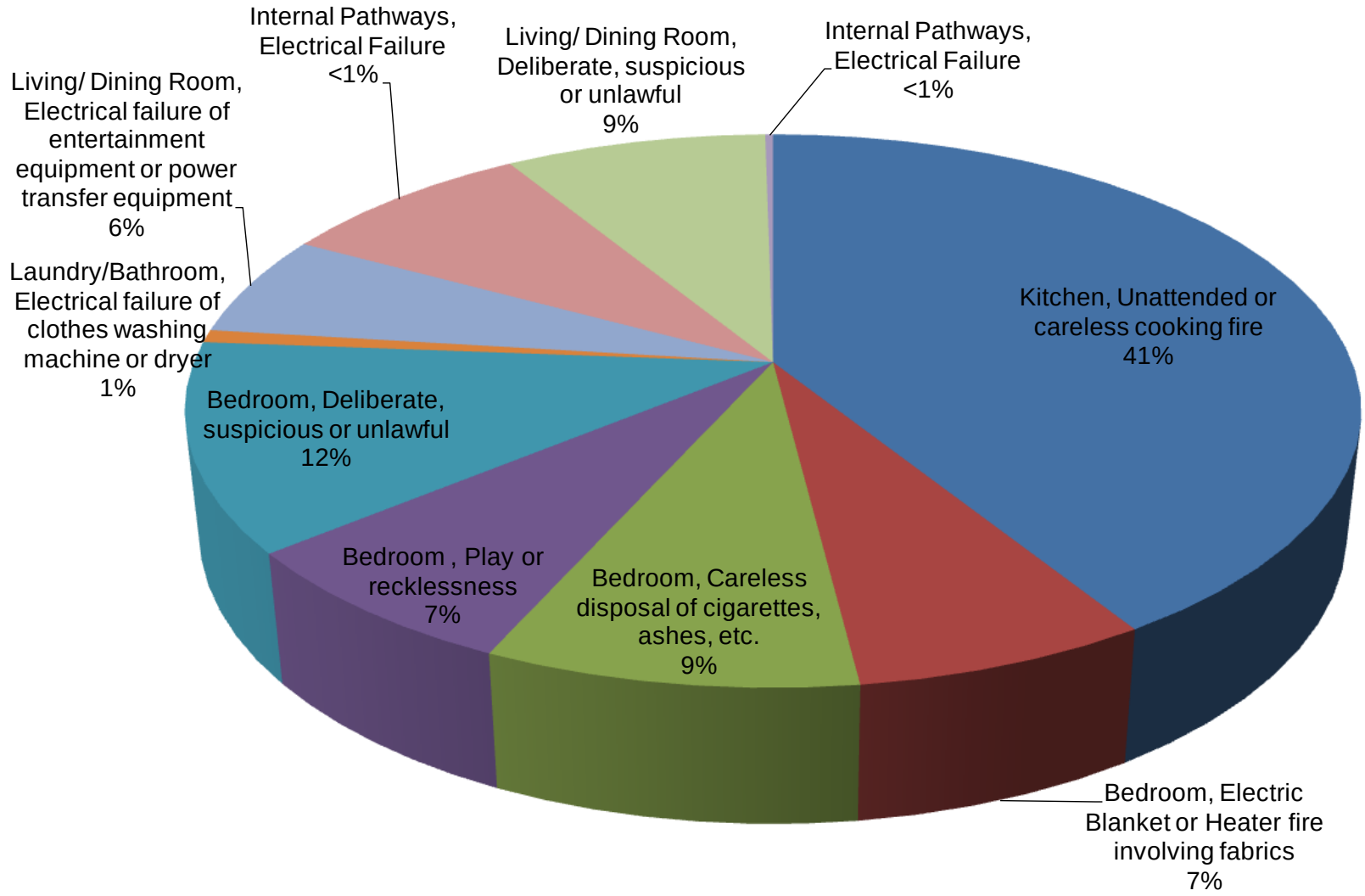


Figure 37: Normalised weighted importance factor for clusters of room of fire origin and reported cause of ignition based on apartment fire statistics, including deliberate, suspicious or unlawful fires

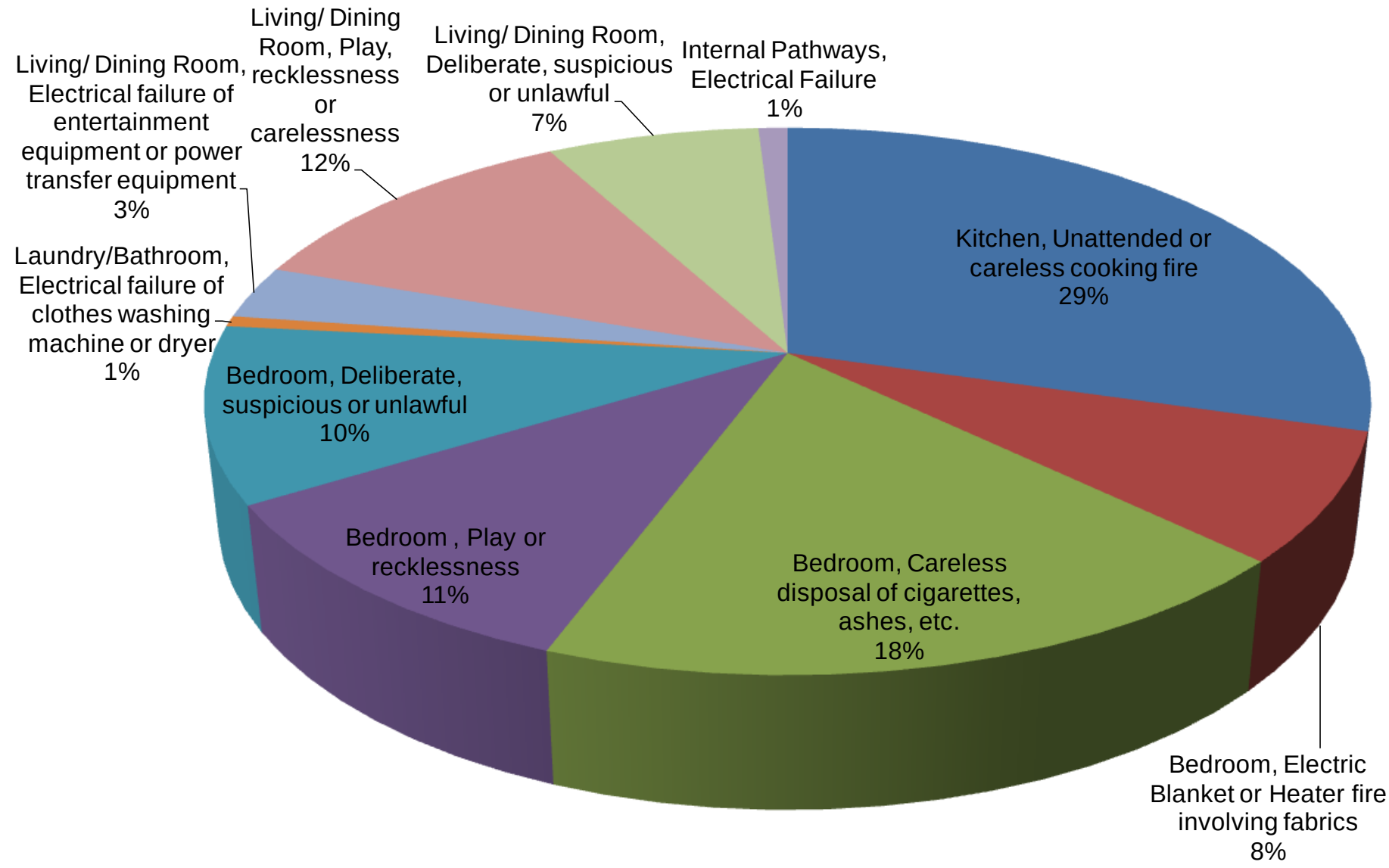


Figure 38: Normalised weighted importance factor for clusters of room of fire origin and reported cause of ignition based on all residential structure fire statistics, including deliberate, suspicious or unlawful fires

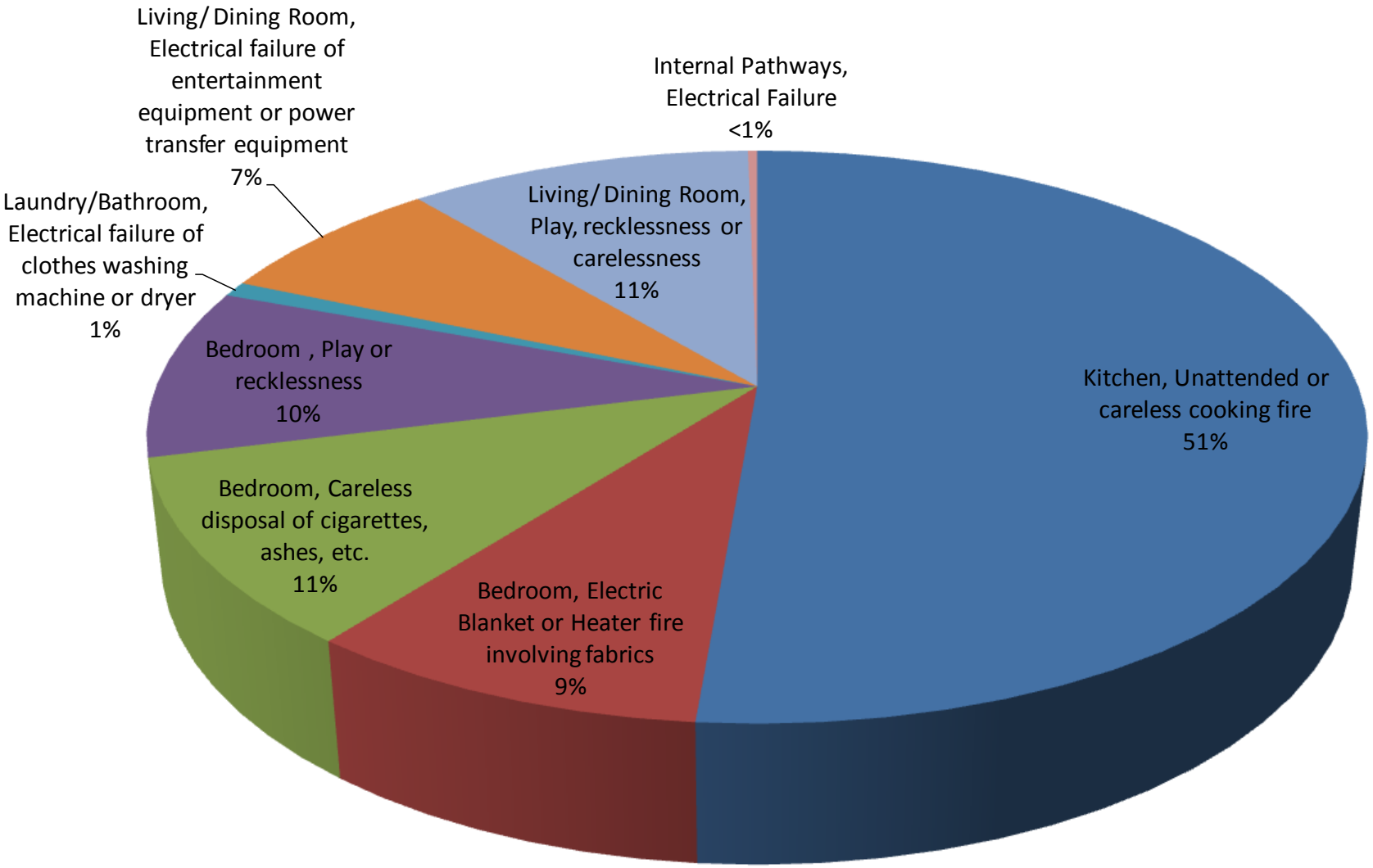


Figure 39: Normalised weighted importance factor for clusters of room of fire origin and reported cause of ignition based on apartment fire statistics, excluding deliberate, suspicious or unlawful fires

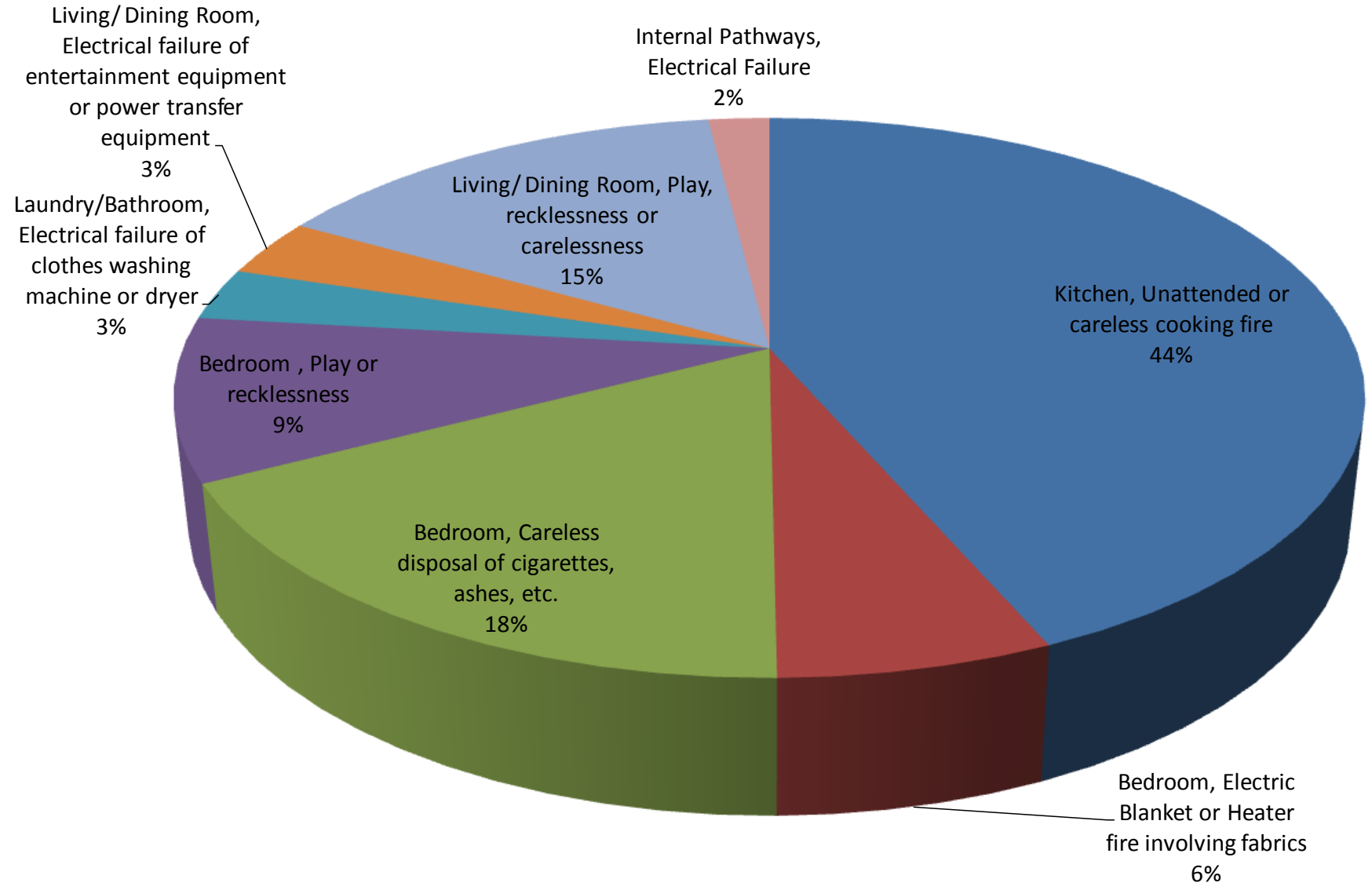
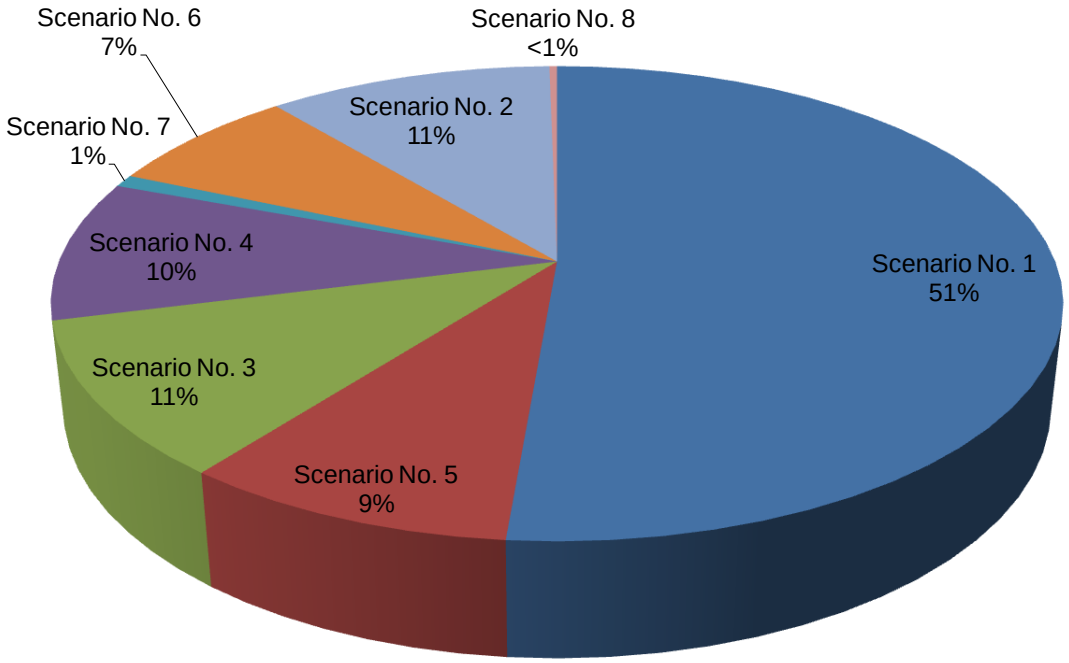


Figure 40: Normalised weighted importance factor for clusters of room of fire origin and reported cause of ignition based on all residential structure fire statistics, excluding deliberate, suspicious or unlawful fires

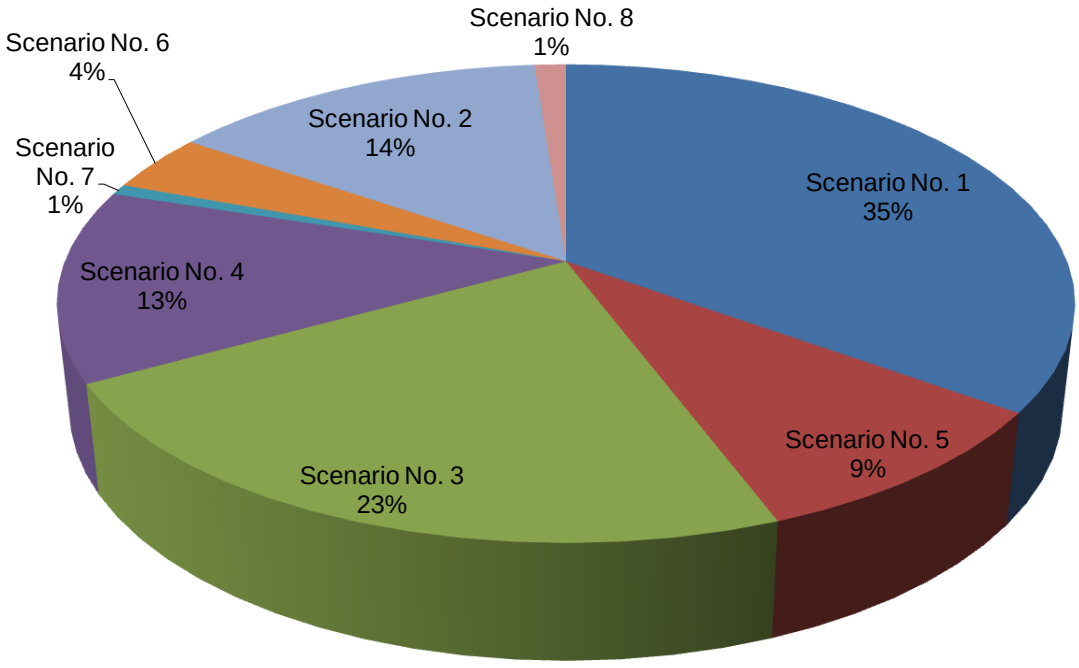
If all deliberately ignited fires were excluded from the set of design fires, then the results would be such that the top eight possible fire scenarios were (ranked on the first approach to estimating an importance value based on apartment statistics):

1. An unattended or careless cooking fire in the kitchen.
2. Fire play, recklessness or carelessness in the living or dining room.
3. Careless disposal of cigarettes, ashes, etc, in a bedroom.
4. Fire play, recklessness or carelessness in a bedroom.
5. An electric blanket or heater fire involving fabrics in a bedroom.
6. An electrical failure of entertainment equipment or power transfer equipment in the living or dining room.
7. An electrical failure of clothes washing machine or dryer in the laundry or bathroom.
8. An electrical failure in an internal pathway.

This ranking of scenarios is used to present a summary of these example results in the figures presented in this section.

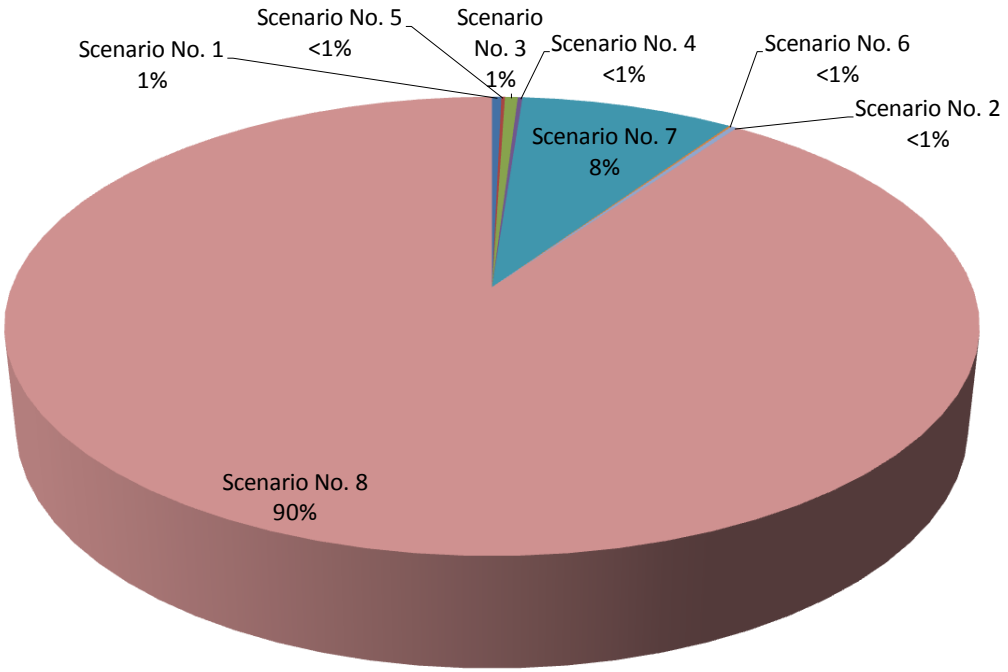


(a)

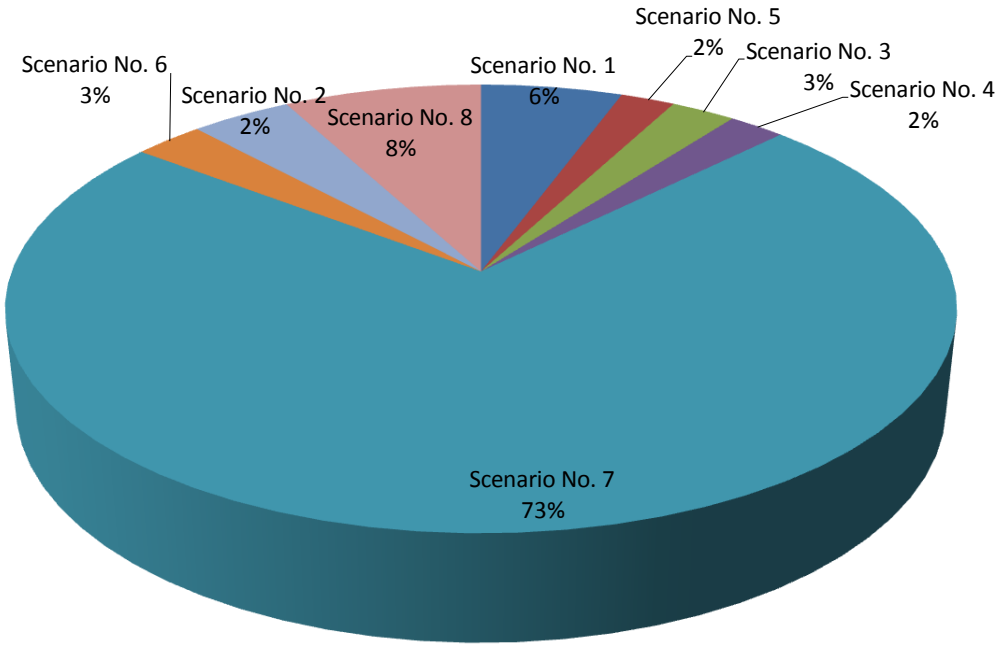


(b)

Figure 41: Normalised weightings of scenario set based on (a) apartments and (b) all residential structure fire and casualty statistics

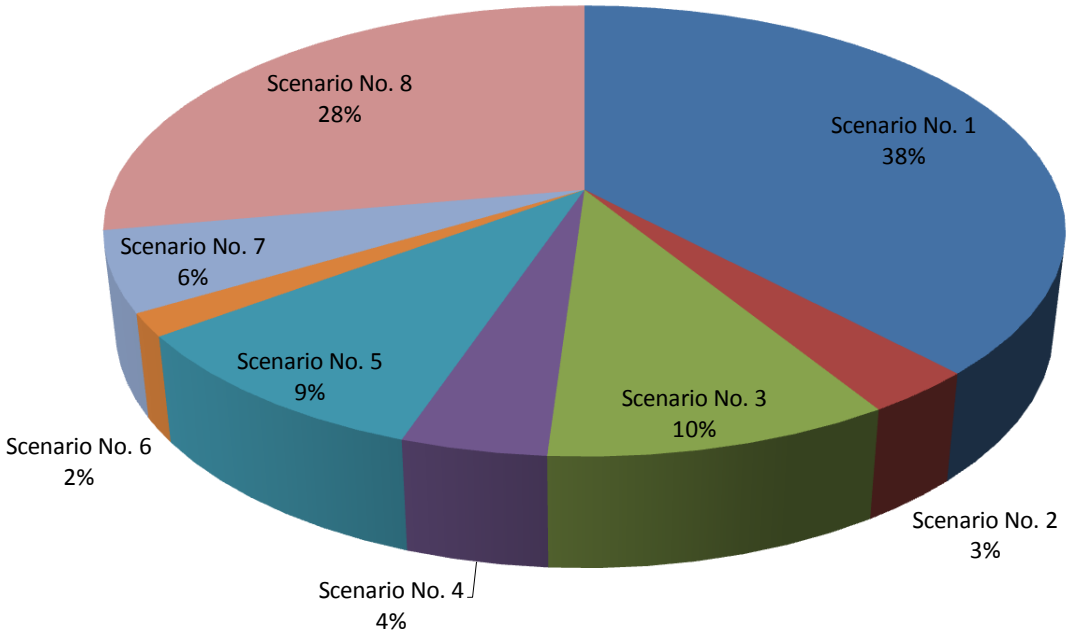


(a)

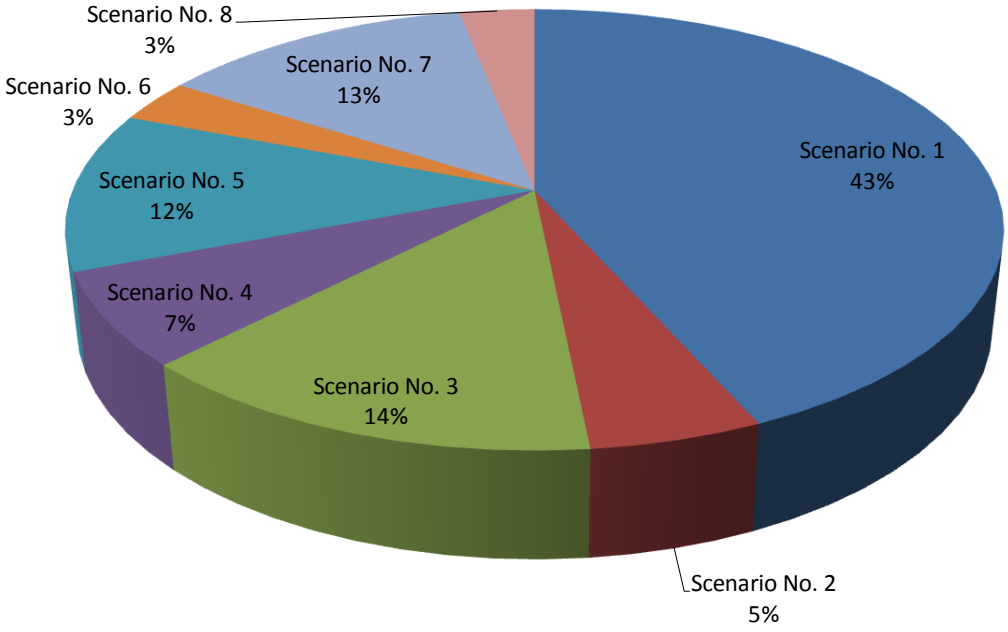


(b)

Figure 42: Normalised weightings of scenario set based on ratios of (a) apartment and (b) all residential casualty and fire statistics



(a)



(b)

Figure 43: Normalised weightings of a design fire scenario set based on multiplying the results for the two approaches to estimating importance values together for (a) apartment and (b) all residential fire statistics

Appendix C SUMMARY OF ESTIMATES OF STATISTICAL SIGNIFICANCE

A measure of the statistical significance of the fire incident and casualty percentages was estimated by calculating the statistical confidence of the percentage value being within a chosen percentage of the mean, assuming a normal distribution is appropriate for the description of the population (if a larger sample size was available). For fire incidents, the maximum percentage deviation from the mean was chosen to be ±20%. For fire casualties, since the data sets were small and therefore larger deviations are expected, the maximum percentage deviation from the mean was chosen to be ±50%.

The appropriateness of the assumption that a normal distribution reasonably describes the data is not known. However all the data is handled with the same treatment and therefore the relative values from this type of analysis is important. There would not be direct correlation between the results from the analysis of this data set and other data sets.

The following table presents an example of the estimated values for the statistical significance associated with each of the probabilities of each parameter for each fire incident percentages being within ±20% of the mean value, and casualty percentages being within ±50% of the mean value, assuming a normal distribution is a reasonable representation of the data.

Table 37: Examples of estimated values of the statistical significance of the probabilities being reasonable representations

Scenario Description	Percentage of Total						Statistical Significance (decimal)					
	Fire Incidents		Fatalities		Injuries		Fire Incidents		Fatalities		Injuries	
	Apart.	All Res.	Apart.	All Res.	Apart.	All Res.	Apart.	All Res.	Apart.	All Res.	Apart.	All Res.
Kitchen, Unattended or careless cooking fire	55.94	44.42	33.33	18.40	43.53	46.76	0.72	0.67	0.35	0.47	0.61	0.65
Bedroom, Electric blanket or heater fire involving fabrics	4.13	4.80	9.52	8.80	5.16	7.83	0.76	0.72	0.33	0.42	0.54	0.69
Bedroom, Careless disposal of cigarettes, ashes, etc	10.83	11.71	4.76	20.80	13.75	16.04	0.96	0.85	0.34	0.44	0.53	0.75
Bedroom , Play or recklessness	5.32	7.11	9.52	12.00	4.58	7.41	0.79	0.71	0.34	0.47	0.61	0.78
Bedroom, Deliberate, suspicious or unlawful	7.64	8.42	14.29	10.40	10.13	10.43	0.97	0.86	0.34	0.45	0.56	0.71
Laundry/Bathroom, Electrical failure of clothes washing machine or dryer	3.04	3.74	0.00	0.00	0.64	0.87	0.84	0.61	0.00	0.00	0.31	0.41
Living/Dining Room, Electrical failure of entertainment equipment or power transfer equipment	2.14	2.51	4.76	4.80	15.16	1.90	0.81	0.73	0.33	0.39	0.41	0.53
Living/Dining Room, Play, recklessness or carelessness	6.41	11.21	9.52	12.00	7.00	8.53	0.92	0.82	0.35	0.47	0.52	0.74
Living/ Dining Room, Deliberate, suspicious or unlawful	3.44	4.13	14.29	11.20	0.02	0.00	0.98	0.83	0.36	0.45	0.47	0.64
Internal Pathways, Electrical failure	1.12	1.96	0.00	1.60	0.02	0.22	0.88	0.66	0.00	0.32	0.36	0.47

Appendix D SUMMARY OF INFLUENCE OF CHOICE OF RELATIVE CONSEQUENCE LEVELS

The influence of the choice of values for the relative consequence levels for the historical record of a fire incident versus a civilian fatality versus a civilian injury (moderate to severe) was investigated.

A variation of ±10% in the value of 1 for the relative consequence level for the historical record of a fire incident results in a variation of up to ±10% in the values for effective importance value for both apartments and all residential buildings.

Similarly, a variation of ±10% in the value of 6 for the relative consequence level for the historical record of a civilian fatality results in a variation of up to ±9% and ±10%, for apartments and all residential buildings, in the values for effective importance value.

Finally, a variation of ±10% in the value of 6 for the relative consequence level for the historical record of a civilian injury results in a variation of up to ±9% in the values for effective importance value for both apartments and all residential buildings.

Table 38: Summary of percentage of change for ±10% of the consequence levels

Description	+10% for fire incidence		-10% for fire incidence		+10% for fatalities		-10% for fatalities		+10% for injuries		-10% for injuries	
	Apart.	All Res.	Apart.	All Res.	Apart.	All Res.	Apart.	All Res.	Apart.	All Res.	Apart.	All Res.
Kitchen, Clothes washing machine or dryer	-10	-6	10	6	0	0	0	0	0	-4	0	4
Kitchen, Electric blanket												
Kitchen, Heater	-5	-1	5	1	0	-8	0	8	-5	-2	5	2
Kitchen, Water heater	-4	-4	4	4	0	0	0	0	-6	-6	6	6
Kitchen, Cooking equipment	-2	-2	2	2	-5	-4	5	4	-3	-4	3	4
Kitchen, Power transfer equipment	-4	-7	4	7	0	0	0	0	-6	-3	6	3
Kitchen, Entertainment equipment	-1	-10	1	10	0	0	0	0	-9	0	9	0
Kitchen, Information not recorded	-3	-2	3	2	-3	-5	3	5	-4	-3	4	3
Kitchen, Other	-4	-2	4	2	0	-5	0	5	-6	-3	6	3
Bedroom, Clothes washing machine or dryer	-10	-10	10	10	0	0	0	0	0	0	0	0
Bedroom, Electric blanket	-1	-1	1	1	-8	-7	8	7	-1	-2	1	2
Bedroom, Heater	-3	-1	3	1	0	-5	0	5	-7	-4	7	4
Bedroom, Water heater	-10	0	10	0	0	-9	0	9	0	-1	0	1
Bedroom, Cooking equipment	-3	0	3	0	0	-8	0	8	-7	-1	7	1
Bedroom, Power transfer equipment	-10	-8	10	8	0	0	0	0	0	-2	0	2
Bedroom, Entertainment equipment	-1	-3	1	3	0	0	0	0	-9	-7	9	7
Bedroom, Information not recorded	-1	-1	1	1	-7	-7	7	7	-3	-2	3	2
Bedroom, Other	-3	-1	3	1	0	-4	0	4	-7	-5	7	5
Laundry/Bathroom, Clothes washing machine or dryer	-9	-8	9	8	0	0	0	0	-1	-2	1	2

Laundry/Bathroom, Electric blanket		-10		10		0		0		0		0
Laundry/Bathroom, Heater	-10	-6	10	6	0	0	0	0	0	-4	0	4
Laundry/Bathroom, Water heater	-2	-3	2	3	0	0	0	0	-8	-7	8	7
Laundry/Bathroom, Cooking equipment	-2	-2	2	2	0	0	0	0	-8	-8	8	8
Laundry/Bathroom, Power transfer equipment	-10	-7	10	7	0	0	0	0	0	-3	0	3
Laundry/Bathroom, Entertainment equipment	-1	-10	1	10	0	0	0	0	-9	0	9	0
Laundry/Bathroom, Information not recorded	-8	-3	8	3	0	-3	0	3	-2	-4	2	4
Laundry/Bathroom, Other	-4	-5	4	5	0	0	0	0	-6	-5	6	5
Living/ Dining Room or Lounge, Clothes washing machine or dryer	-10	-5	10	5	0	0	0	0	0	-5	0	5
Living/ Dining Room or Lounge, Electric blanket	-4	0	4	0	0	-9	0	9	-6	0	6	0
Living/ Dining Room or Lounge, Heater	-2	-2	2	2	-6	-5	6	5	-2	-3	2	3
Living/ Dining Room or Lounge, Water heater	-3	-4	3	4	0	0	0	0	-7	-6	7	6
Living/ Dining Room or Lounge, Cooking equipment	-2	0	2	0	0	-9	0	9	-8	-1	8	1
Living/ Dining Room or Lounge, Power transfer equipment	-6	-2	6	2	0	-7	0	7	-4	-1	4	1
Living/ Dining Room or Lounge, Entertainment equipment	-1	-1	1	1	-4	-8	4	8	-5	-1	5	1
Living/ Dining Room or Lounge, Information not recorded	-1	-1	1	1	-8	-7	8	7	-2	-2	2	2
Living/ Dining Room or Lounge, Other	-1	-1	1	1	-9	-7	9	7	-1	-2	1	2
Internal Pathways, Clothes washing machine or dryer	-10	-2	10	2	0	0	0	0	0	-8	0	8
Internal Pathways, Electric blanket												
Internal Pathways, Heater	-10	-10	10	10	0	0	0	0	0	0	0	0
Internal Pathways, Water heater	-10	-4	10	4	0	0	0	0	0	-6	0	6
Internal Pathways, Cooking equipment	-1	-3	1	3	0	0	0	0	-9	-7	9	7
Internal Pathways, Power transfer equipment	-8	-1	8	1	0	-8	0	8	-2	-1	2	1
Internal Pathways, Entertainment equipment												
Internal Pathways, Information not recorded	-3	-3	3	3	0	-5	0	5	-7	-3	7	3
Internal Pathways, Other	-10	-5	10	5	0	0	0	0	0	-5	0	5
Information not recorded, Clothes washing machine or dryer		-1		1		0		0		-9		9
Information not recorded, Electric blanket		-10		10		0		0		0		0
Information not recorded, Heater		-10		10		0		0		0		0
Information not recorded, Water heater		-10		10		0		0		0		0
Information not recorded, Cooking equipment		-10		10		0		0		0		0
Information not recorded, Power transfer equipment		-10		10		0		0		0		0
Information not recorded, Entertainment equipment												

Information not recorded, Information not recorded	-3	-1	3	1	0	-8	0	8	-7	-1	7	1
Information not recorded, Other	-10	-10	10	10	0	0	0	0	0	0	0	0
Other, Clothes washing machine or dryer	-10	-8	10	8	0	0	0	0	0	-2	0	2
Other, Electric blanket		-10		10		0		0		0		0
Other, Heater	-2	-4	2	4	0	0	0	0	-8	-6	8	6
Other, Water heater	-6	-5	6	5	0	0	0	0	-4	-5	4	5
Other, Cooking equipment	-10	-4	10	4	0	0	0	0	0	-6	0	6
Other, Power transfer equipment	-9	-8	9	8	0	0	0	0	-1	-2	1	2
Other, Entertainment equipment	-1	-10	1	10	0	0	0	0	-9	0	9	0
Other, Information not recorded	-5	-3	5	3	-4	-4	4	4	-1	-3	1	3
Other, Other	-6	-5	6	5	0	0	0	0	-4	-5	4	5

Appendix E SUMMARY OF EFFECTIVE IMPORTANCE VALUES

Table 39: A summary of the effective importance values for selection of the combinations of room of fire origin and equipment involved in ignition

Scenario Description	Importance Value for Apartments	Importance Value for Residential	Normalised Importance Value for Apartments	Normalised Importance Value for Residential
Kitchen, Clothes washing machine or dryer	0.08	0.09	0.083	0.089
Kitchen, Electric blanket	0.00	0.00	0.000	0.000
Kitchen, Heater	0.34	0.83	0.351	0.828
Kitchen, Water heater	0.25	0.39	0.257	0.390
Kitchen, Cooking equipment	89.87	44.68	93.533	44.778
Kitchen, Power transfer equipment	0.26	0.27	0.275	0.267
Kitchen, Entertainment equipment	0.17	0.01	0.177	0.010
Kitchen, Information not recorded	53.29	42.88	55.463	42.976
Kitchen, Other	4.43	5.19	4.612	5.206
Bedroom, Clothes washing machine or dryer	0.05	0.02	0.052	0.018
Bedroom, Electric blanket	13.70	4.68	14.254	4.686
Bedroom, Heater	2.06	3.21	2.145	3.215
Bedroom, Water heater	0.03	0.21	0.029	0.212
Bedroom, Cooking equipment	0.29	0.36	0.306	0.366
Bedroom, Power transfer equipment	0.09	0.18	0.096	0.181
Bedroom, Entertainment equipment	3.54	1.04	3.682	1.046
Bedroom, Information not recorded	85.45	43.40	88.935	43.502
Bedroom, Other	4.89	5.68	5.086	5.689
Laundry/Bathroom, Clothes washing machine or dryer	1.53	1.36	1.591	1.366
Laundry/Bathroom, Electric blanket	0.00	0.00	0.000	0.003
Laundry/Bathroom, Heater	0.15	0.29	0.153	0.295
Laundry/Bathroom, Water heater	0.13	0.14	0.135	0.143
Laundry/Bathroom, Cooking equipment	0.17	0.10	0.182	0.100
Laundry/Bathroom, Power transfer equipment	0.05	0.13	0.052	0.126

Laundry/Bathroom, Entertainment equipment	0.12	0.01	0.123	0.005
Laundry/Bathroom, Information not recorded	1.37	2.83	1.429	2.834
Laundry/Bathroom, Other	0.40	0.49	0.415	0.493
Living/Dining Room or Lounge, Clothes washing machine or dryer	0.03	0.08	0.035	0.076
Living/Dining Room or Lounge, Electric blanket	0.26	0.34	0.273	0.345
Living/Dining Room or Lounge, Heater	8.82	6.63	9.182	6.640
Living/Dining Room or Lounge, Water heater	0.19	0.13	0.199	0.130
Living/Dining Room or Lounge, Cooking equipment	0.92	1.22	0.957	1.221
Living/Dining Room or Lounge, Power transfer equipment	0.31	0.51	0.318	0.514
Living/Dining Room or Lounge, Entertainment equipment	12.66	1.85	13.178	1.858
Living/Dining Room or Lounge, Information not recorded	100.02	29.86	104.097	29.925
Living/Dining Room or Lounge, Other	13.72	4.12	14.279	4.127
Internal Pathways, Clothes washing machine or dryer	0.03	0.06	0.032	0.065
Internal Pathways, Electric blanket	0.00	0.00	0.000	0.000
Internal Pathways, Heater	0.04	0.17	0.040	0.173
Internal Pathways, Water heater	0.05	0.09	0.052	0.088
Internal Pathways, Cooking equipment	0.15	0.05	0.157	0.046
Internal Pathways, Power transfer equipment	0.46	0.65	0.480	0.652
Internal Pathways, Entertainment equipment	0.00	0.00	0.000	0.000
Internal Pathways, Information not recorded	4.35	2.43	4.527	2.437
Internal Pathways, Other	0.17	0.26	0.174	0.261
Information not recorded, Clothes washing machine or dryer	0.00	0.05	0.000	0.055
Information not recorded, Electric blanket	0.00	0.00	0.000	0.001
Information not recorded, Heater	0.00	0.01	0.000	0.008
Information not recorded, Water heater	0.00	0.00	0.000	0.004
Information not recorded, Cooking equipment	0.00	0.01	0.000	0.006
Information not recorded, Power transfer equipment	0.00	0.00	0.000	0.004
Information not recorded, Entertainment equipment	0.00	0.00	0.000	0.000
Information not recorded, Information not recorded	0.83	1.93	0.869	1.932
Information not recorded, Other	0.01	0.01	0.008	0.011
Other, Clothes washing machine or dryer	0.08	0.19	0.088	0.192
Other, Electric blanket	0.00	0.01	0.000	0.009
Other, Heater	0.78	1.22	0.816	1.223

Other, Water heater	0.28	0.41	0.292	0.406
Other, Cooking equipment	0.07	0.40	0.074	0.405
Other, Power transfer equipment	1.27	1.19	1.321	1.192
Other, Entertainment equipment	0.13	0.03	0.135	0.033
Other, Information not recorded	14.25	18.33	14.832	18.377
Other, Other	2.05	3.76	2.139	3.766

Table 40: A summary of the effective importance values for selection of the combinations of room of fire origin and recorded cause of ignition

Scenario Description	Importance Value for Apartments	Importance Value for Residential	Normalised Importance Value for Apartments	Normalised Importance Value for Residential
Kitchen, Careless disposal of cigarettes, ashes, etc	5.82	0.97	0.016	0.006
Kitchen, Falling asleep (includes smoking in bed)	0.67	1.00	0.002	0.004
Kitchen, Carelessness	2.86	7.00	0.016	0.037
Kitchen, Play or Recklessness	1.28	2.40	0.006	0.009
Kitchen, Electrical Failure	0.12	2.45	0.003	0.020
Kitchen, Unattended/Asleep kitchen fire	62.52	28.50	0.195	0.114
Kitchen, Deliberate, Suspicious, Unlawful	0.07	0.81	0.002	0.008
Kitchen, Information not recorded	0.85	1.94	0.004	0.010
Kitchen, Other	46.37	57.64	0.159	0.148
Bedroom, Careless disposal of cigarettes, ashes, etc	13.77	18.66	0.048	0.070
Bedroom, Falling asleep (includes smoking in bed)	0.00	0.06	0.000	0.000
Bedroom, Carelessness	0.33	2.05	0.002	0.008
Bedroom, Play or Recklessness	14.60	9.57	0.043	0.038
Bedroom, Electrical Failure	0.86	1.86	0.003	0.010
Bedroom, Unattended/Asleep kitchen fire	13.10	3.81	0.035	0.016
Bedroom, Deliberate, Suspicious, Unlawful	23.87	11.69	0.071	0.047
Bedroom, Information not recorded	0.00	0.00	0.000	0.000
Bedroom, Other	0.00	0.00	0.000	0.000
Laundry/Bathroom, Careless disposal of cigarettes, ashes, etc	0.10	0.43	0.001	0.002
Laundry/Bathroom, Falling asleep (includes smoking in bed)	0.00	0.04	0.000	0.000
Laundry/Bathroom, Carelessness	0.12	0.64	0.001	0.004
Laundry/Bathroom, Play or Recklessness	0.11	0.13	0.001	0.001
Laundry/Bathroom, Electrical Failure	0.18	1.27	0.003	0.011
Laundry/Bathroom, Unattended/Asleep kitchen fire	0.01	0.05	0.000	0.000
Laundry/Bathroom, Deliberate, Suspicious, Unlawful	0.03	0.27	0.001	0.003

Laundry/Bathroom, Information not recorded	0.01	0.19	0.000	0.002
Laundry/Bathroom, Other	0.95	3.00	0.005	0.013
Living/Dining Room or Lounge, Careless disposal of cigarettes, ashes, etc	13.23	3.55	0.037	0.017
Living/Dining Room or Lounge, Falling asleep (includes smoking in bed)	13.32	0.84	0.035	0.002
Living/Dining Room or Lounge, Carelessness	3.07	7.87	0.014	0.042
Living/Dining Room or Lounge, Play or Recklessness	12.85	4.02	0.035	0.017
Living/Dining Room or Lounge, Electrical Failure	13.29	3.88	0.038	0.021
Living/Dining Room or Lounge, Unattended/Asleep kitchen fire	0.64	1.12	0.002	0.005
Living/Dining Room or Lounge, Deliberate, Suspicious, Unlawful	18.45	3.14	0.052	0.028
Living/Dining Room or Lounge, Information not recorded	18.64	3.66	0.050	0.020
Living/Dining Room or Lounge, Other	20.18	22.48	0.059	0.054
Internal Pathways, Careless disposal of cigarettes, ashes, etc	0.80	0.46	0.003	0.002
Internal Pathways, Falling asleep (includes smoking in bed)	0.00	0.00	0.000	0.000
Internal Pathways, Carelessness	0.02	0.24	0.000	0.002
Internal Pathways, Play or Recklessness	0.01	0.19	0.000	0.002
Internal Pathways, Electrical Failure	0.05	0.84	0.001	0.008
Internal Pathways, Unattended/Asleep kitchen fire	0.00	0.01	0.000	0.000
Internal Pathways, Deliberate, Suspicious, Unlawful	0.10	0.36	0.002	0.004
Internal Pathways, Information not recorded	0.00	0.09	0.000	0.001
Internal Pathways, Other	2.27	1.81	0.007	0.006
Information not recorded, Careless disposal of cigarettes, ashes, etc	0.00	0.07	0.000	0.001
Information not recorded, Falling asleep (includes smoking in bed)	0.00	0.00	0.000	0.000
Information not recorded, Carelessness	0.00	0.13	0.000	0.001
Information not recorded, Play or Recklessness	0.00	0.01	0.000	0.000
Information not recorded, Electrical Failure	0.00	0.09	0.000	0.001
Information not recorded, Unattended/Asleep kitchen fire	0.00	0.03	0.000	0.000
Information not recorded, Deliberate, Suspicious, Unlawful	0.00	0.12	0.000	0.001
Information not recorded, Information not recorded	0.27	0.96	0.001	0.007
Information not recorded, Other	0.41	0.59	0.001	0.002
Other, Careless disposal of cigarettes, ashes, etc	5.25	3.13	0.017	0.024
Other, Falling asleep (includes smoking in bed)	0.01	0.05	0.000	0.000
Other, Carelessness	0.41	4.17	0.003	0.028

Other, Play or Recklessness	0.72	2.57	0.004	0.012
Other, Electrical Failure	0.48	3.54	0.006	0.030
Other, Unattended/Asleep kitchen fire	0.00	0.08	0.000	0.001
Other, Deliberate, Suspicious, Unlawful	0.50	3.12	0.008	0.027
Other, Information not recorded	0.53	1.35	0.003	0.009
Other, Other	0.78	5.70	0.007	0.041

Table 41: A summary of the effective importance values for selection of the combinations of room of fire origin and material first ignited

Scenario Description	Importance Value for Apartments	Importance Value for Residential	Normalised Importance Value for Apartments	Normalised Importance Value for Residential
Kitchen, Fabric	0.79	1.85	0.003	0.007
Kitchen, Fat or Food	46.78	53.15	0.175	0.204
Kitchen, Flammable or Combustible Liquid	20.97	29.13	0.066	0.068
Kitchen, Polymer	9.01	8.47	0.030	0.044
Kitchen, Finished timber	6.46	2.36	0.017	0.011
Kitchen, Information not recorded	7.22	2.92	0.020	0.016
Kitchen, Other	23.37	11.03	0.064	0.041
Bedroom, Fabric	20.95	25.35	0.060	0.063
Bedroom, Fat or Food	0.01	0.09	0.000	0.000
Bedroom, Flammable or Combustible Liquid	11.97	2.35	0.029	0.007
Bedroom, Polymer	16.27	12.62	0.045	0.041
Bedroom, Finished timber	1.30	1.97	0.004	0.008
Bedroom, Information not recorded	14.08	4.87	0.035	0.016
Bedroom, Other	28.45	17.72	0.076	0.045
Laundry/Bathroom, Fabric	0.04	0.99	0.001	0.005
Laundry/Bathroom, Fat or Food	0.17	0.07	0.000	0.000
Laundry/Bathroom, Flammable or Combustible Liquid	0.28	0.22	0.001	0.001
Laundry/Bathroom, Polymer	0.62	2.11	0.005	0.016
Laundry/Bathroom, Finished timber	0.01	0.23	0.000	0.002
Laundry/Bathroom, Information not recorded	0.02	0.51	0.000	0.003
Laundry/Bathroom, Other	0.39	2.22	0.003	0.010
Living/Dining Room, Fabric	24.19	9.94	0.062	0.034
Living/Dining Room, Fat or Food	0.68	0.82	0.002	0.002
Living/Dining Room, Flammable or Combustible Liquid	1.12	3.43	0.004	0.010
Living/Dining Room, Polymer	12.20	11.18	0.036	0.041
Living/Dining Room, Finished timber	0.80	3.79	0.004	0.025

Living/Dining Room, Information not recorded	34.04	5.12	0.083	0.023
Living/Dining Room, Other	42.11	14.49	0.108	0.058
Internal Pathways, Fabric	1.87	0.64	0.005	0.002
Internal Pathways, Fat or Food	0.01	0.01	0.000	0.000
Internal Pathways, Flammable or Combustible Liquid	0.16	0.33	0.001	0.001
Internal Pathways, Polymer	0.24	1.20	0.002	0.009
Internal Pathways, Finished timber	0.02	0.62	0.000	0.003
Internal Pathways, Information not recorded	0.93	0.53	0.003	0.002
Internal Pathways, Other	0.40	0.86	0.003	0.006
Information not recorded, Fabric	0.00	0.04	0.000	0.000
Information not recorded, Fat or Food	0.17	0.19	0.001	0.001
Information not recorded, Flammable or Combustible Liquid	0.00	0.06	0.000	0.000
Information not recorded, Polymer	0.00	0.20	0.000	0.001
Information not recorded, Finished timber	0.00	0.10	0.000	0.001
Information not recorded, Information not recorded	0.45	1.08	0.001	0.007
Information not recorded, Other	0.00	0.34	0.000	0.002
Other, Fabric	0.60	2.38	0.003	0.011
Other, Fat or Food	0.00	0.20	0.000	0.001
Other, Flammable or Combustible Liquid	0.19	2.57	0.001	0.007
Other, Polymer	0.83	6.21	0.009	0.039
Other, Finished timber	0.46	5.70	0.005	0.039
Other, Information not recorded	6.24	1.73	0.016	0.009
Other, Other	2.16	10.02	0.015	0.059

Table 42: A summary of the effective importance values for selection of highest values across the combinations of scenarios considered

Scenario Description	Importance Value for Apartments	Importance Value for Residential	Normalised Importance Value for Apartments	Normalised Importance Value for Residential
Kitchen, Unattended or careless cooking fire	163	142	0.41	0.30
Bedroom, Electric blanket or heater fire involving fabrics	28	36	0.07	0.08
Bedroom, Careless disposal of cigarettes, ashes, etc	35	89	0.09	0.19
Bedroom, Play or recklessness	29	51	0.07	0.11
Bedroom, Deliberate, suspicious or unlawful	48	50	0.12	0.10
Laundry/Bathroom, Electrical failure of clothes washing machine or dryer	3	3	0.01	0.01
Living/Dining Room, Electrical failure of entertainment equipment or power transfer equipment	24	15	0.06	0.03
Living/Dining Room, Play, recklessness or carelessness	33	56	0.08	0.12
Living/Dining Room, Deliberate, suspicious or unlawful	34	34	0.09	0.07
Internal Pathways, Electrical failure	1	5	0.003	0.01