Fire Research Report

Cost of Repair to Fire Damaged Buildings

BRANZ

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One of the roles of the New Zealand Fire Service is to limit the extent of damage to buildings from fire. To measure its effectiveness in this task the Fire Service records a significant amount of information at the site to help assess its firefighting effectiveness. One of the main measures used is the ratio of area damaged or destroyed to the total building area. However, it is suspected this may not be an adequate measure in many cases because of localised damage can result in major costs or even total replacement of the building. This research investigated the real costs of recovery following a fire, the criteria used by insurance assessors to write-off a partially damaged building, with the aim of developing a more realistic measure of response effectiveness, preferably using data already collected by the Fire Service.
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The cost of repair to fire damaged buildings

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2. INTRODUCTION

The NZ Fire Service uses a number of methods to monitor its effectiveness in limiting the damage caused by fire to life and property. One of these measures applies to individual buildings and is the ratio of the building area damaged by flame to the total building area. A low ratio implies that the fire service intervention has been relatively successful, as most of the building is saved. However it is suspected that fire reinstatement costs are not a linear function of the area damaged, and that other measures of effectiveness may be more useful.

The Fire Service records a significant amount of information in their Station Management System (SMS). For each fire it attends there are typically a hundred items recorded in the database, describing the damage, location, building, response times, etc. Using a single item recorded at the fire is a simplistic measure, and this project investigated whether combinations of some of the SMS fields of data might yield better measures of effectiveness.

Discussions were held with assessors to understand what factors affect repair costs, and their criteria for write-offs. The aim is to develop a more realistic measure of response effectiveness, preferably using data already collected by the Fire Service.

3. SUMMARY

Costs of repairs as assessed by the Fire Service often bear little relation to the actual cost of repairs as disclosed through building consent data and surveys of builders involved in the repairs. SMS had a significant number of fires in which the property was said to be substantial saved (more than 75% of the floor area), but subsequently a new house building consent was issued for that address, presumably because total replacement was cheaper than repair.

For partially damaged houses almost 300 matches were found between SMS and consents for two years of data. While the average repair cost was similar for both datasets, there was a considerable discrepancy for most houses. For properties which SMS recorded as 50% or less saved the repair cost estimate was about 25% above the average consent values. For properties with 51% or more of the area saved the SMS dataset underestimated repair costs by about 35%, on average, but there was a considerable range, with some being under-costed by a factor of 3 or more.

A further source of discrepancy is that building consents tend to under-estimate actual building costs, for a variety of reasons discussed later. A survey of builders who undertook reinstatement work found that on average costs were 14% higher than the

values used in the consent applications. However, the correlation of builder survey repair costs and consent values was a lot closer than the correlation between the SMS repair costs and the consent values.

Various combinations of data from SMS was trialled to see if a better fit could be obtained with the actual repair costs as obtained from the survey. It was found that area damaged by smoke, as well as flame, was a significant factor, and this aligns with comments from insurance assessors.

The recommended adjustment is to apply a set of factors to the flame damaged area for cases where more than 50% of the building is saved. These factors will bring estimated costs into line with actual costs as disclosed from building consents and the builders survey.

4. METHOD

Three main processes were carried out

- A comparison of the SMS data for individual houses compared to building consent data and responses from builders for the same houses repaired.
- Trials on the SMS dataset to see if good correlations could be obtained between the data, and the actual repair cost as obtained either from the builders survey or from building consents.
- Discussions with insurance assessors to better understand the factors affecting cost of repair.

The NZ Fire Service provided data on every building fire they attended in New Zealand between January 2006 to April 2008, consisting of over 4400 residential addresses, excluding repeats, and null or incomplete site addresses. For each incidence a number of fields were provided including the site address, date of fire, and the area of the structure damaged by flame, smoke, water and fire control, each separately.

Statistics New Zealand collect all building consents issued, but do not publish individual records. Instead, the Whats-On company[1] dataset of building consents was used. This company obtain consents lists, which are public documents, from territorial authorities, and assemble the lists in one database. It covers all building consents, for all territorial authorities, except those issued by private building certifiers, and excludes owner builders. The dataset has the type of building, description of work, site address, builders address, date of consent issue, and the estimated value of the work. When the work relates to fire repairs the work descriptor usually, but not always, has “fire re-instatement”, or “fire repairs”, or “fire damage” in the wording. These words are used in searches to identify appropriate consents. In a parallel activity the site address is matched to that in the SMS dataset. Some address matches do not have “fire“ in the consent descriptor and hence may not necessarily relate to fire repairs. As a final check for valid matches, the dates were checked to ensure the work occurred after the fire incident date, and not before, as occurred for some records. SMS repair costs are compared to the values on the building consents.

[1] Whats-On Report, T F Stevens & Co Ltd, Penrose Auckland.

The final repair costs are not always as stated on the consent for a number of reasons such as additional work is uncovered after the repairs are started, and cost escalation due to general inflation.

The SMS-building consent matches were all surveyed, by writing to the builder on the consent. The survey form is in the appendix, and asks about the cost of the work and any non-fire related work so that can be omitted from the repairs cost.

Surveyed repair costs were compared to the SMS repair cost. Generally the correlation was not good, and other data fields in the SMS were trialled to see if between correlations could be obtained with the survey costs.

Interviews were carried out with two insurance assessors to understand why partly damaged houses are demolished, and what factors affect repair costs and the decision to repair rather than re-build.

5. RESULTS

5.1 The SMS dataset

The sample from the SMS dataset is summarised in Table 2. Most of the residential fires related to detached houses and according to the Fire Service assessment about 75% of these properties were saved, on average. The property saved percentage is calculated from the area of flame damage, as a percentage of the total building floor area. The flame damage area is an assessment by the assessors of the floor area of the room(s) or part room affected by the fire. On average houses are substantially saved but domestic out-buildings are substantially damaged and would probably be totally replaced.

Table 1 SMS dataset records sample

SMS dataset for residential buildings Jan 2006 to April 2008			
	Number	Average property saved percent	Number Repairs <$10,000
Single house	3220	75%	1,681
Flats, Apartments, Units 1 to 2	413	80%	231
Flats, Apartments, Units 3 to 10	78	88%	49
Flats, Apartments, Units 11 to 20	7	99%	7
Flats, Apartments, Units 21 to 30	4	100%	3
Flats, Apartments, Units 31 to 40	1	100%	1
Flats, Apartments, Units over 40	19	94%	16
Garage	407	37%	164
Garden shed, Other shed	258	28%	233
Residential property - not classified above	26	67%	20
	4433		2,405

5.2 Comparing SMS with building consents

The SMS site addresses were matched with building consent data. A total of 526 matches were found, see Table 2, and this is a quite low number. As explained in the appendix the reasons for this low rate include; minor repairs not requiring a building consent, recent SMS entries that have not yet appeared as consents, and address errors in either dataset.

Two types of building consents were examined, the new house consents, and the alterations and addition (A&A) consents. The former covers 100% write-offs, while the latter are partly damaged houses that have been repaired. More details of the two datasets are in the appendix.

Table 2 SMS and consent matches summary

Summary of matches SMS with Residential Building Consents	
	Matches
New house consents	109
Alterations and additions consents	
Single hse consents with "fire" descriptor	223
Single hse consents with no "fire" descriptor	82
Multi-unit consents with "fire" descriptor	23
Multi-unit consents with no "fire" descriptor	7
Garage consents with "fire" descriptor	32
Garage consents with no "fire" descriptor	38
Shed consents with "fire" descriptor	4
Shed consents with no "fire" descriptor	8
	526
The descriptor refers to the type of work entered on the building consent application.	

5.2.1 New house replacements

For new house consents there were 109 matches, shown in Table 3. A significant number of matches (41) were found where SMS said less than 26% of the property was saved and this is not surprising since often it is easier to completely replace a house that is extensively damaged, rather that repair it. In contrast there were a number of total replacements for houses that SMS said were substantial saved, e.g. 27 houses that were over 75% undamaged. These latter appear to be spurious matches, particularly given the small lag time (36 days) between the fire and the consent issue. The other property saved percentage groups have a lag of at least 160 days, which is the period expected for a new consent issue. The middle two groups (26% to 75% saved) are significant because of the difference between the fire service assessment of partial damage and the eventual outcome which was total replacement.

Table 3 New houses matches SMS v Consents

New house consent matches with SMS		
SMS Property saved %	Number of matches	Average days from fire to consent issue
0 to 25%	41	215
26 to 50%	35	163
51 to 75%	6	248
76 to 100%	27	36
Total	109	156

5.2.2 Repaired houses (A&A consents)

The A&A consents include all types of work on existing dwellings that involve structural alterations and additions, including fire repair of framing, floors, claddings and linings. The consents cover two types of work, repairs to houses, and repairs to outbuildings (garages, sheds, etc), which are reported separately.

The consents have a work descriptor which may or may not have reference to fire repairs or reinstatement. The address matches for house repairs are shown in Table 4 (for fire damage in the description) and Table 5 (no reference to fire damage).

Table 4 Repaired house matches SMS v Consents (fire damage description)

Alterations and additions single house consents matches Has fire damage in the consent description				
SMS Property saved %	Number of matches	Average days from fire to consent issue	Average SMS repair cost of matches $	Average consent value of matches $
0 to 25%	29	129	145,722	80,599
26 to 50%	43	128	160,741	111,239
51 to 75%	54	124	79,333	97,826
76 to 100%	97	116	36,342	70,382
Total	223	122	84,964	86,235
For the period Jan06 to April 08				

Figure 1 Repaired house matches SMS v Consents (fire damage description)

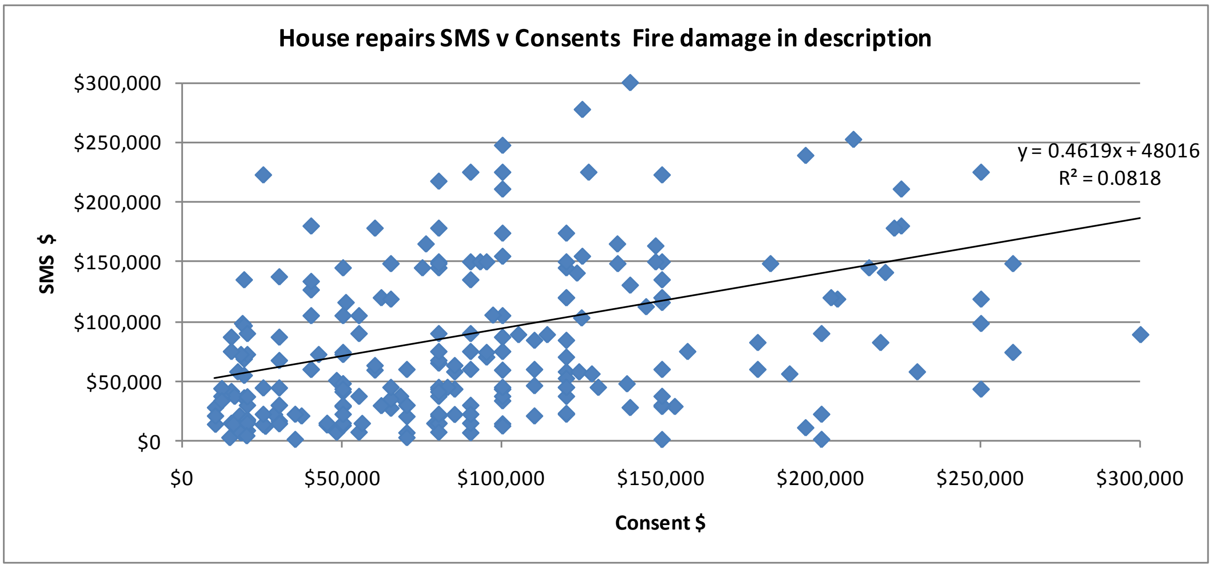


Table 4 and Figure 1 show work that has in the consent description the words "fire damage" or "fire replacement". The average repair cost for all houses in the two datasets is similar at about $86,000 but there is wide variation for individual houses. The chart indicates a large amount of scatter. If both datasets were in agreement we would expect to see the points on a line, with a high correlation, instead we have low correlation of Rsq = 0.08. The SMS data in Table 4 over-estimates the costs for the low property saved percentages, and under-estimates costs where SMS says a high percentage of the property was saved.

Table 5 is for address matches without the fire repair descriptor, so we cannot be certain that the consent does in fact relate directly to fire repairs/ reinstatement. Although the consent is for the same site as the fire it could be totally unrelated to the repair of fire damage. Comparison of the average values in the two table suggest this is the case for some of the matches, as the average values in Table 5 are lower than in Table 4. Also, the lags in Table 5 are almost twice as long as in Table 4 suggesting some unrelated work. On the other hand Table 5 may represent fairly minor fire damage work which is not as urgent as the more costly repairs in Table 4, and which may have had other non-fire related work included at the same time hence the extra delay.

Table 5 Repaired house matches SMS v Consents (no fire damage description)

Alterations and additions single house consents matches **Does not have fire damage in the consent description**				
SMS Property saved %	Number of matches	Average days from fire to consent issue	Average SMS repair cost of matches $	Average consent value of matches $
0 to 25%	21	248	109,456	48,549
26 to 50%	6	432	94,890	45,750
51 to 75%	11	190	60,043	45,318
76 to 100%	44	199	13,379	45,521
Total	82	228	50,208	46,286
For the period Jan06 to April 08				

The above tables show the matches with detached houses, and there were other matches with multi-unit dwellings, garages, and sheds. These are shown in Figure 2 and Figure 3, where there is a quite large scatter, as occurred for detached housing.

Figure 2 Multi-units SMS v Consents

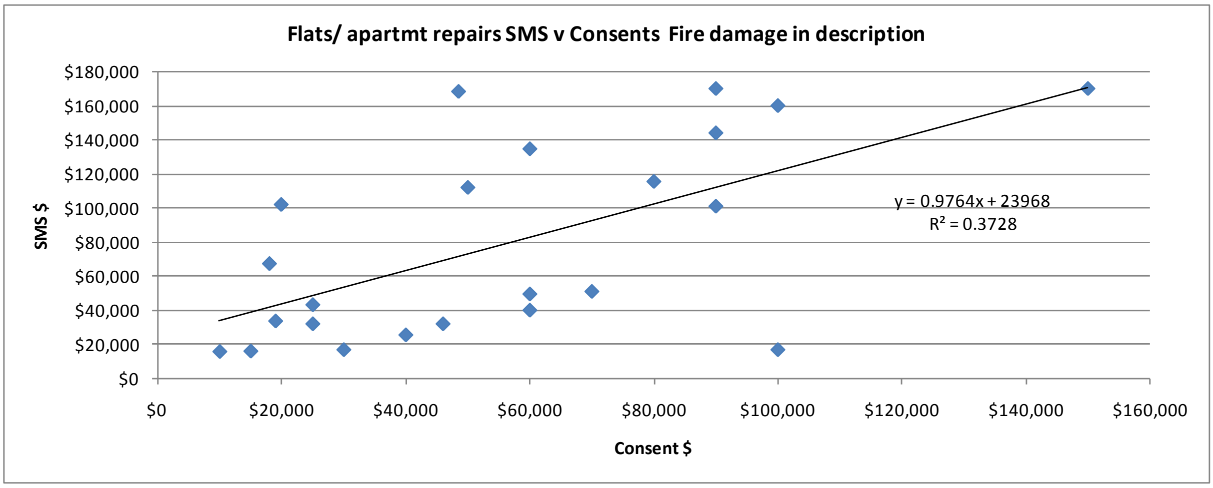
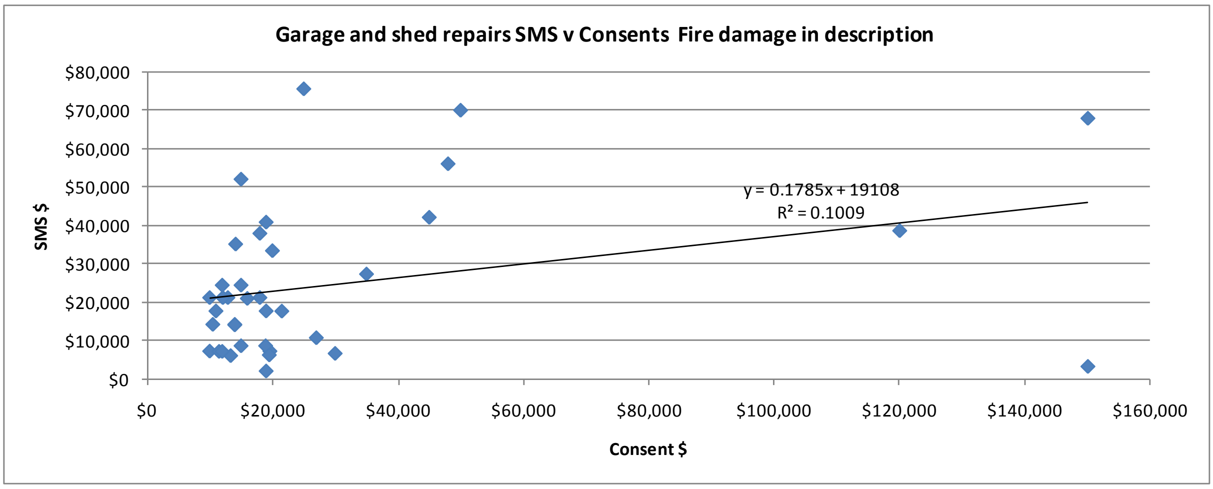


Figure 3 Outbuildings SMS v Consents



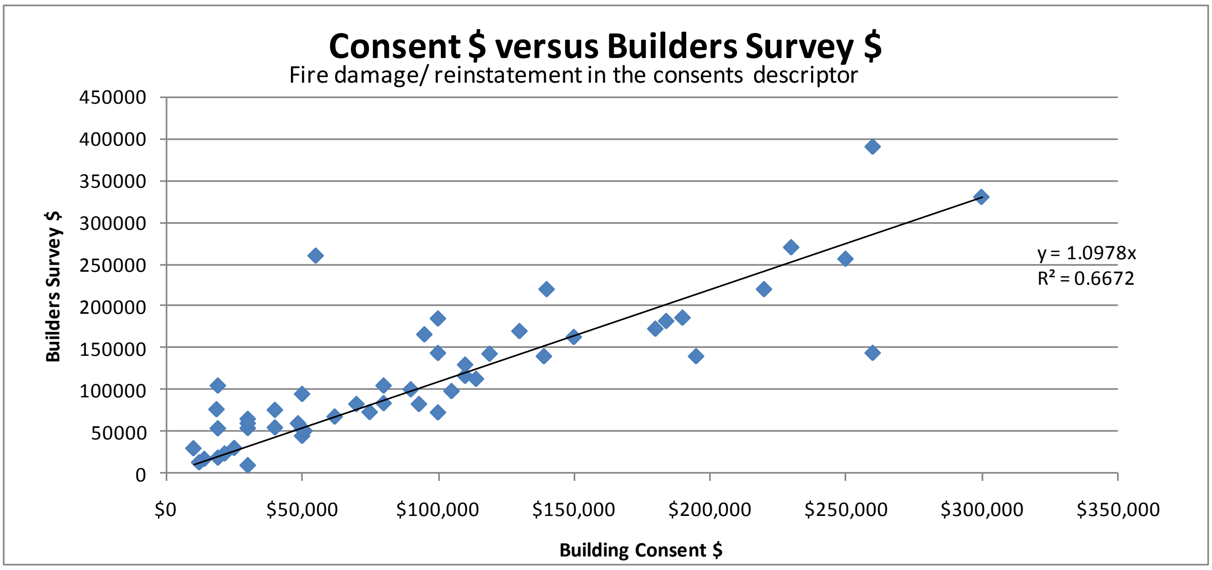
It is concluded that the SMS cost data does not relate at all closely to the cost of repairs as disclosed by building consents. Reasons for this are discussed later, but the next question is - How reliable are building consent costs? Builders were surveyed to find this out.

5.3 Costs from the builders survey

Builders able to be identified in the 526 SMS - building consent matches were surveyed and 106 replies were received, of which 92 were useable (i.e. the respondent was able to answer most questions). The survey form is in the appendix.

Most of the replies were for houses rather than multi-units and out-buildings. Figure 4 shows consent values plotted against the values from the builder's survey, for house repairs. The chart indicates that the consent values are fairly close to the final repair costs for that building as given by the builder involved. This result of a close agreement is to be expected because builders and insurance assessors have inspected the fire damage and estimated the amount of repair and the cost before applying for the consent. There is some scatter because it is often difficult to foresee the complete scope of work until after the repairs are started. However, in general the consent values are fairly close to the final repair costs.

Figure 4 Consent values versus survey values



5.4 Builders survey v SMS costs

The survey responses were also plotted against the SMS values, see Figure 5 to Figure 7. Each point represents one house. The survey asked if additional work was done apart from fire repairs (e.g. an addition to the house), and the value of this work was subtracted so that a direct comparison is possible between the SMS estimate and the final repair costs. The first chart shows the responses for consents with the words "fire damage" or "fire reinstatement" in the consent application descriptor. The second chart is for consents that do not have fire as a descriptor but are believed to be for fire repairs because the addresses match with an appropriate time lag. The third chart is for total replacement, i.e. a new dwelling was constructed at the SMS site address.

For all three charts the scatter is quite wide indicating SMS does not reliably predict the actual repair cost.

In Table 6 the survey values ($/sqm) are compared to average SMS and consent values, by the property saved percentage groups. The $/sqm measure was used instead of values to allow for the different building sizes in the four groups. The main finding from this table is that the SMS repair cost estimates are well below the builders survey costs, particularly where SMS says the major part of the building is saved. In other words, the actual repairs costs are much higher than estimated by SMS for those situations where less than half the building is damaged.

Figure 5 SMS $ versus Survey $ - Fire damage in alterations & additions (A&A) consent descriptor

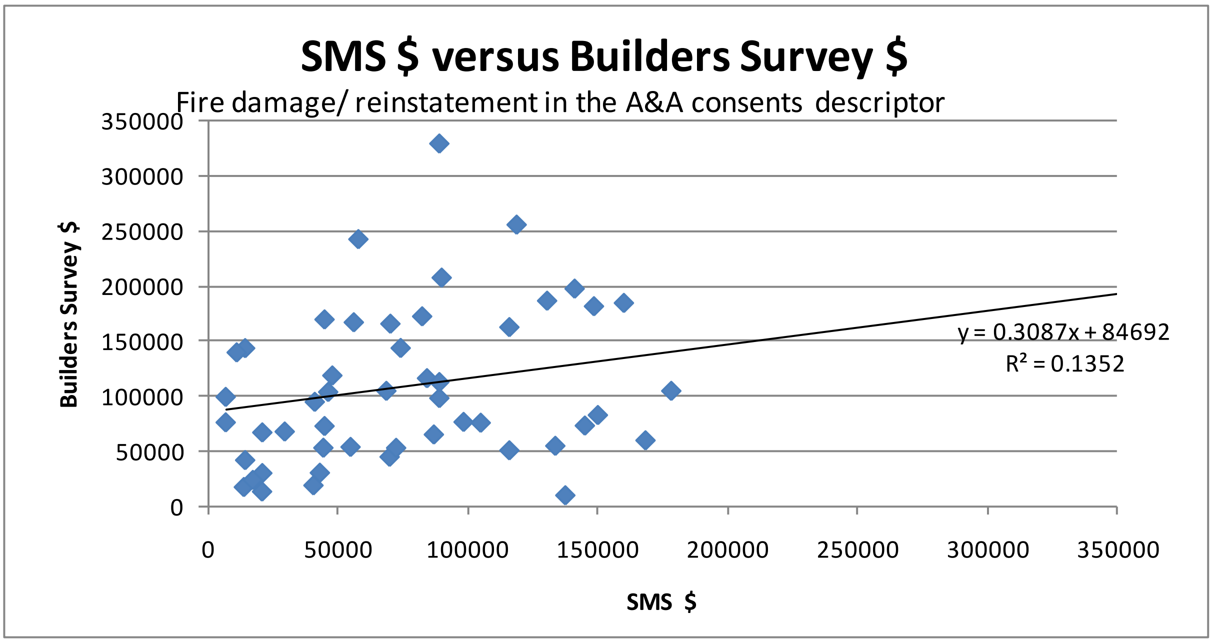


Figure 6 SMS $ versus Survey $ - No reference to fire damage in A&A descriptor

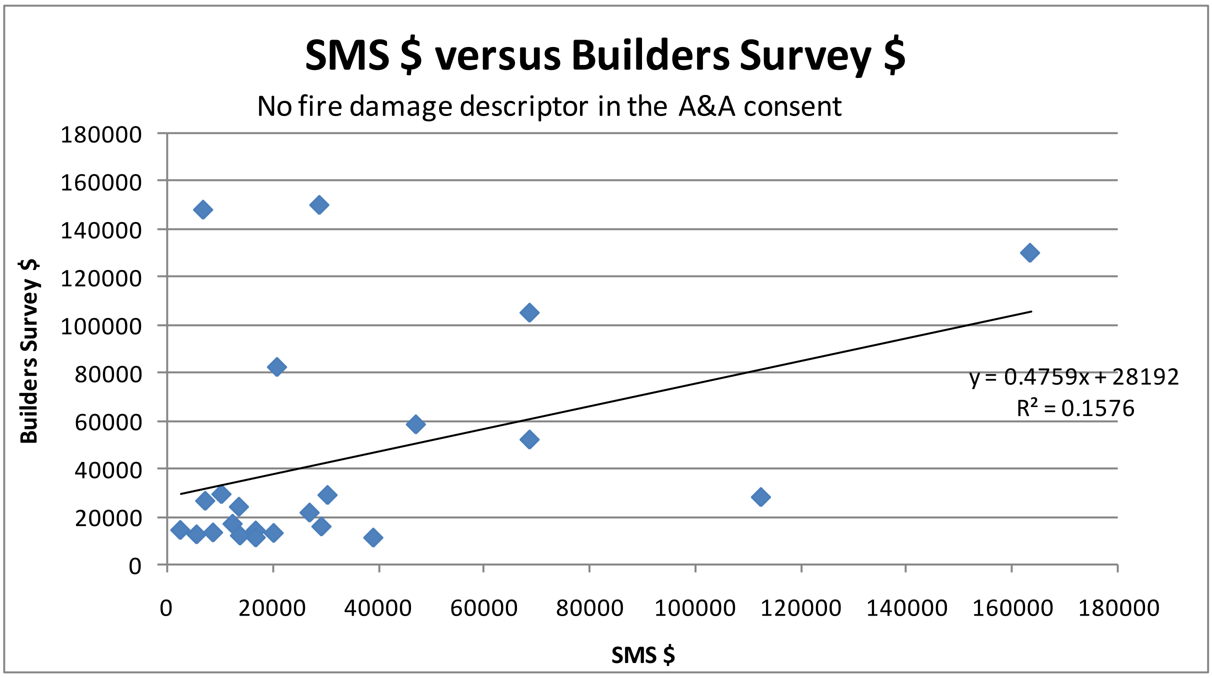


Figure 7 SMS $ versus Survey $ - New house replacement

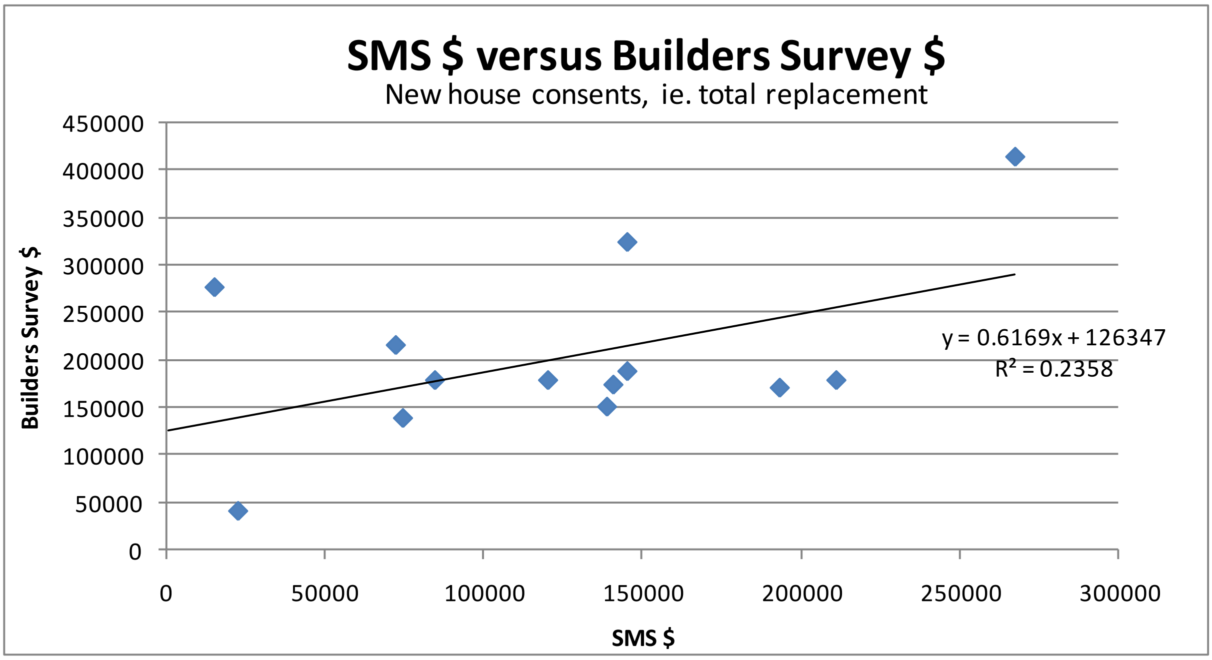
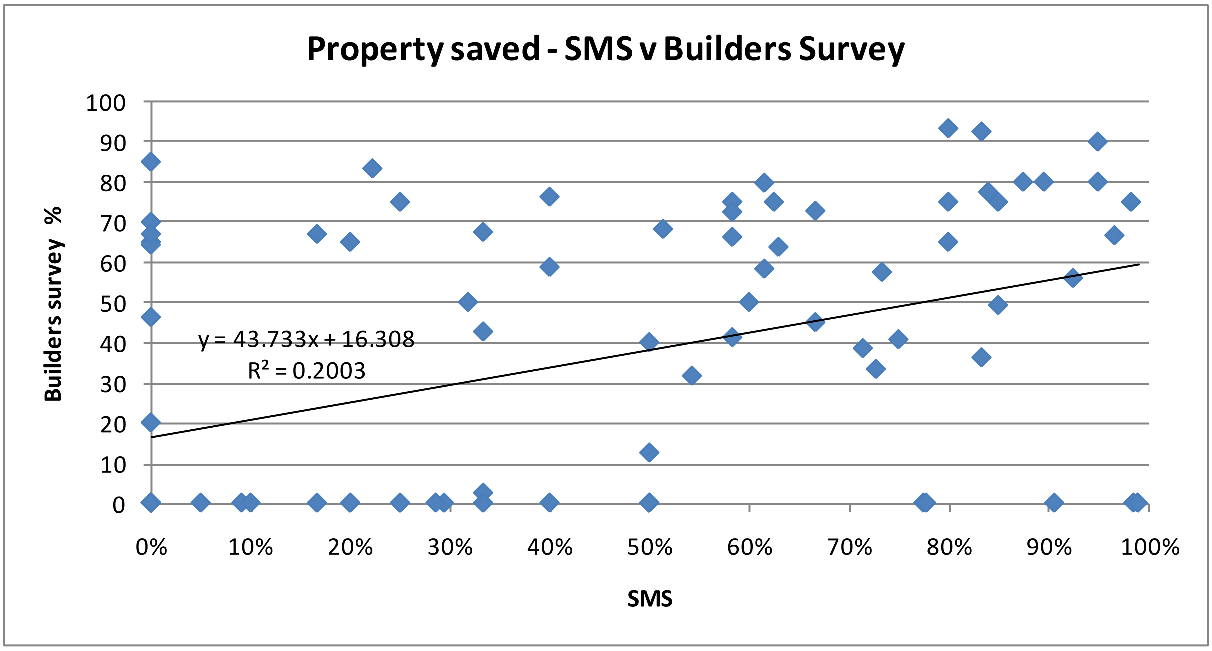


Table 6 Builders survey values compared to SMS and consents

Builders survey repair values compared to SMS and Consents Includes detached house rpairs, multi-units, new houses and out-buildings.					
SMS Property saved %	Number of survey returns	Average days from fire to consent issue	Average SMS repair cost for matches $/sqm	Ave consent repair cost for matches $/sqm	Ave survey repair cost for matches $/sqm
0 to 25%	39	131	1,173	1,244	1,383
26 to 50%	15	160	846	787	868
51 to 75%	17	140	532	579	686
76 to 100%	16	169	182	530	649
Total	87	145	680	792	906
For the period Jan06 to April08					
$/sqm is the repair cost divided by the total building area.					

The builder's survey asked questions about the amount of repair required as a percentage of each building component (roof, walls and floor). The components were averaged and subtracted from 100, to give a defacto property saved percentage for comparison with the similar measure in the SMS. The results are in Figure 8, each point representing one house, and indicate low agreement between the two datasets. The best that can be said is that there is positive correlation but the R sq value, at 0.20 is low.

Figure 8 Property saved – SMS v Builders survey



5.5 Other SMS Indicators

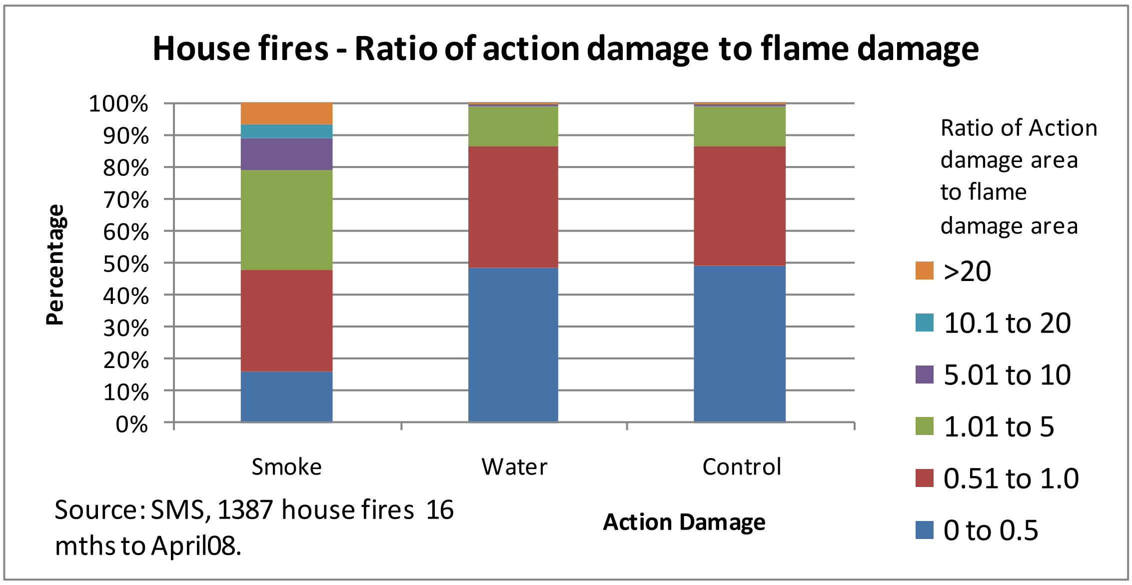
This section examines whether combinations of the data fields collected in SMS might provide a better correlation with the repair costs as given by the builders survey and the consent values.

The work above shows that the Fire Service estimate of repair costs, based on the area of flame damage, tends to underestimate the actual repair costs, on average for the sample, as obtained directly from the builder involved in the repairs for the particular building, or more broadly, from consents.

The SMS database records the areas damaged by flame, smoke, water and fire control, but only uses the first to estimate damage, based on various $ per sq metre rates for different buildings. Analysis of the database shows that areas affected by smoke are very much larger, on average than flame damaged areas, see Figure 9.

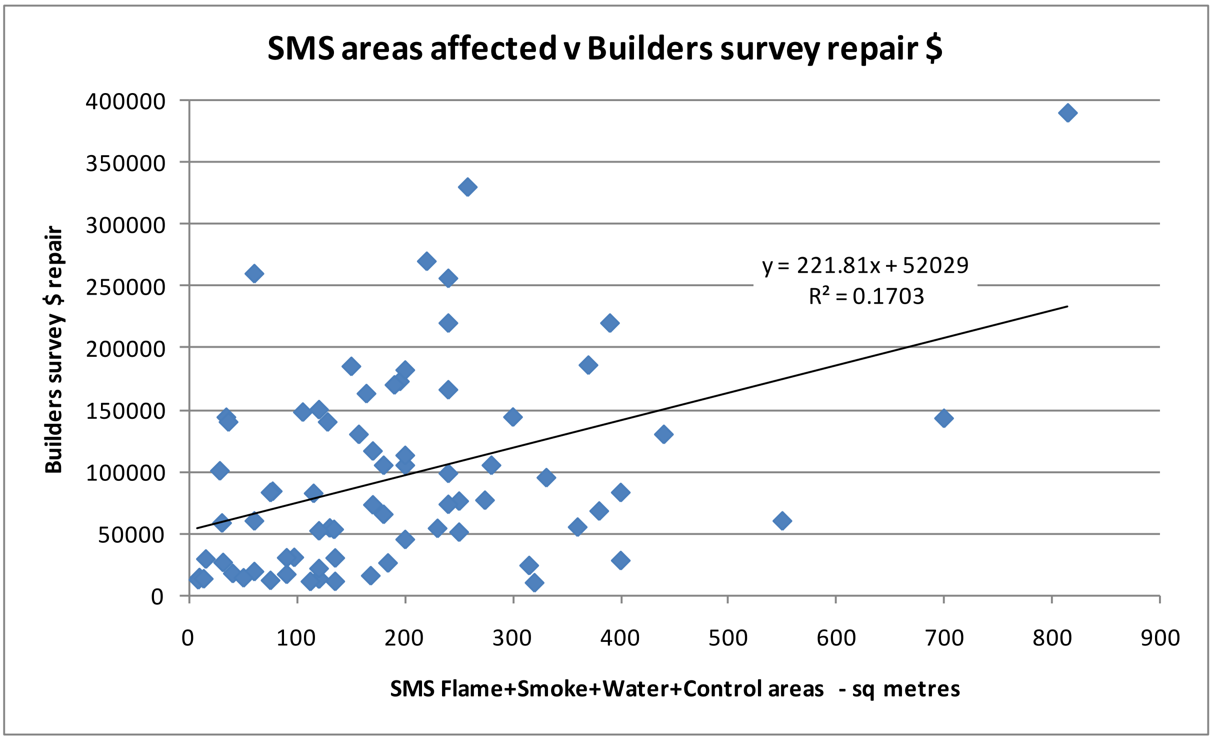
This corresponds with the views of the fire assessors, discussed later. Water and control damage areas, in Figure 9 are less than flame damage areas in 85% of the incidents, but for smoke damage in about 53% of cases the damage covers an area larger than the flame damage area. There are a significant proportion of fires, about 20%, where smoke damage is more than 5 times the area of flame damage. This leads to the inference that repair cost is influenced both by flame and smoke areas.

Figure 9 SMS data on house fires damage areas by damage type



The first trial in this section was to add the four damage areas from SMS and plot these against the survey repair cost. The results are in Figure 10 which shows that the sum of the four damage actions does not correlate very well with cost.

Figure 10 Builders survey repair costs v SMS area affected



A possible alternative is to allow for each of the four damage actions separately in a regression analysis. The costs were obtained from the builders survey and 43 observations for fire damaged dwellings (garages and outbuildings were omitted) were used. These all have fire reinstatement in their consent descriptor.

The regression equation models the builders survey repair costs against the areas of damage recorded in the SMS database for flame, smoke, water and control damaged areas. Four combinations were tried, represented by four equations, as below:

Repair cost $ = c1 + c2 Flame area + c3 Lag Equation 1

Repair cost $ = c1 + c2xFlame area+ c3xSmoke area+ c4Lag. Equation 2

Repair cost $ = c1 + c2xFlame area+ c3xSmoke area+ c4xWater area+ c5xControl area + c6Lag. Equation 3

Repair cost $ =c1+ c2xFlame area+ c3xSmoke area+ c4Lag. Equation 4 (Reduced dataset.)

Where the c1 to c6 are constant terms, and the areas are from the SMS dataset. The lag is the number of days between the fire and the consent issue date. It was introduced to allow for cost inflation, which has been significant in recent years. The fourth equation is as for Equation 2 but outliers have been removed, reducing the sample from 43 observations to 29. These are records where the SMS :Survey cost ratio is either less than 0.33 or larger than 3.0.

The results were:
Eqn 1 Repair cost $ = 37933 + 354 Flame area + 495 Lag.
(2.0) (2.5) (4.5)
And the Rsq =0.40, n=43 obs.

Eqn 2 Repair cost $= 19434 + 257Flame area + 314Smoke area + 465Lag.
(0.9) (1.7) (1.8) (4.3)
And the R sq= 0.45, n=43 obs.

Eqn 3 Repair cost = $24894 + 217Flame + 262Smoke + 326Water - 543xControl
(1.2) (1.3) (1.5) (1.2) (2.1)

+ 503Lag.
(4.7)
And the R sq = 0.51, n=43 obs..

Eqn 4 Repair cost = 11758+1046Flame area + 91Smoke area + 114 Lag
(0.5) (3.6) (0.4) (2.5)
And R sq = 0.60, n=29 obs.

The Rsq for the equations were between 0.40 and 0.60, which indicates the equations explain part of the variation in repair costs, but are not a particularly close fit. An exact fit would have an Rsq of 1.0. The values in brackets are the t statistic and a value over 2.0 indicates the coefficient is significant with 95% certainty.

Equation 1 is the simplest and all coefficients are significant with the t value 2 or over. It is effectively the current method used by the fire service to measure their effectiveness. The flame damage area explains about 40% of the variation between the SMS repair estimate and the surveyed cost, (as shown by the Rsq=0.40 value).

Equation 2 has smoke area added and the result indicates both smoke and flame together in the same equation are approaching 95% significance level, with the t just under 2. It improves the data fit slightly with an Rsq=0.45.

Equation 3 has all the action damage areas and further improves the data fit, but is a complex equation to use. The Control coefficient is negative suggesting that the greater the area affected by action taken to access the fire (i.e. breaking open wall claddings) the less the repair damage. This could be logically correct provided the repair of control damage is small compared to the amount of flame and smoke damage saved by that control action.

In equation 4 the dataset size has been reduced by removing records which appear to be anomalies because their SMS :Survey cost ratio appears to be extreme (i.e. outside the range 0.33 to 3). Hence the equation fit improves, as denoted by the Rsq value. But does this reduced range of matches accurately omit records with errors in the data (e.g. incorrect measurement by the builder or fire-fighter)? We note that in equation 2 the smoke coefficient has a quite high t value, i.e. it is almost at the 95% confidence level, whereas in equation 4 its coefficient has a low t value (and low coefficient value). Inspection of the omitted records shows over half have high smoke damage areas.

Hence these omitted records probably have accurate survey costs in which a significant proportion of the total cost is due to smoke, which is not included in the SMS cost estimate.

Are these relationships a good measure to use in assessing fire service effectiveness? Probably not, because the equations explain only part of the repair cost, as measured by the R sq value. This is also seen graphically in Figure 11 and Figure 12, for equations 2 and 4, which shows a scatter for each pair of modelled $ and actual repair $ for each house, where the model values are from the equations above. If the models were 100% accurate the points would lie on a straight line.

Figure 11 Repair costs modelled as a function of the damage areas – outliers included

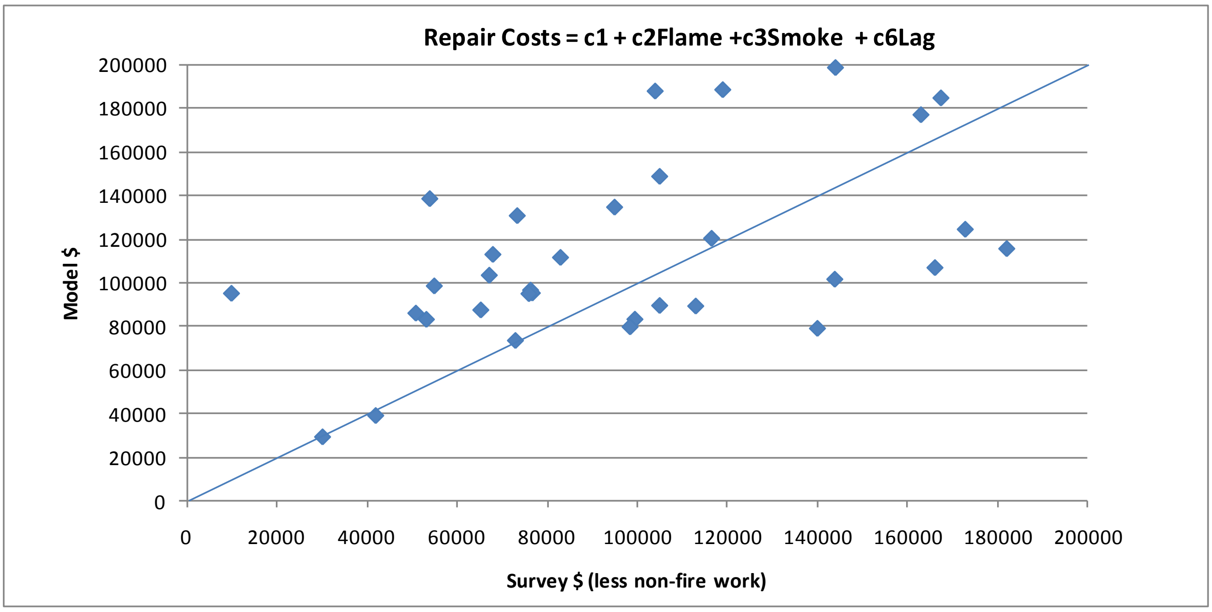
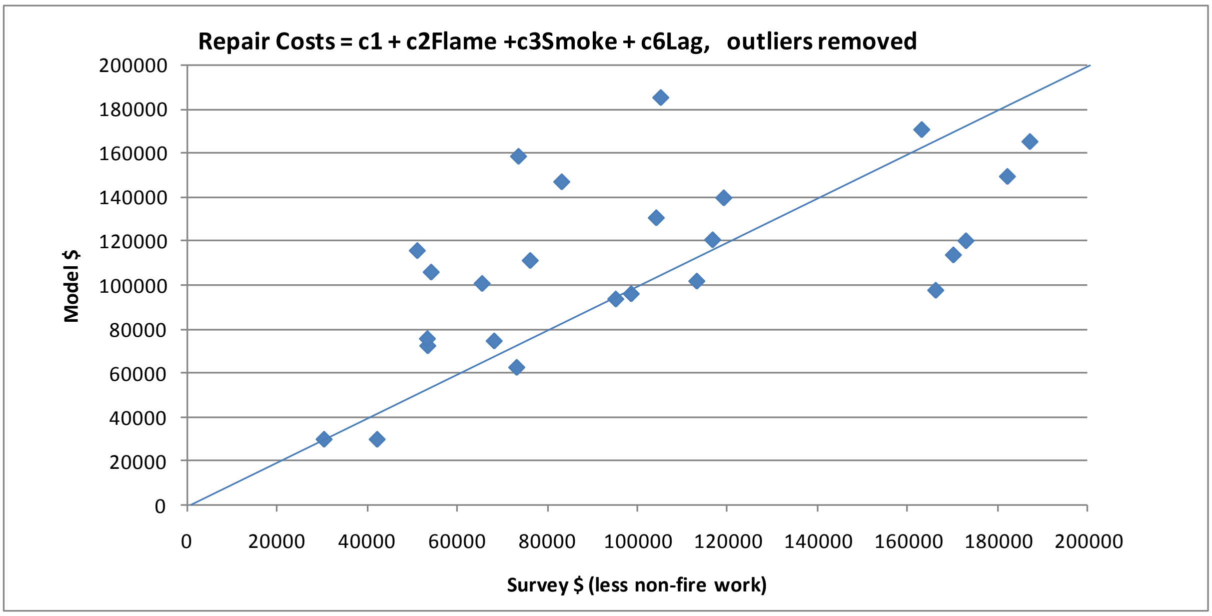


Figure 12 Repair costs modelled as a function of the damage areas – outliers removed



The sample size is larger when building consents are used instead of the survey $ results. We know from Figure 4 that consents are a good proxy for the survey values, so the larger sample may enable a better fit using consents values instead of survey values in equation 2.

The result is below, equation 5, and is equivalent to equation 3 which uses survey values instead of consent values:

Consent value$ = $51767+ 354xFlame- 49xSmoke+ 132xWater- 228xControl-237lag.
(6.1) (3.2) (-0.9) (1.1) (-1.9) (4.7)
Equation 5 Rsq =0.17, n=246 obs.

The consents used were those with "fire re-instatement" in the work descriptor. The fit, as denoted by the Rsq, is poor.

The above equations all have quite low R sq values, so a completely different set of SMS data was trialled, using the SMS fields on the extent of damage spread, see Table 7, instead of the damage areas. The SMS descriptions for spread of each action damage have been given a score, of increasing severity, as shown. The score for each damage action are used as the explanatory variables for the survey values in a regression. The results are below:

Survey$/sqm= $259+ 31xFlames+ 200xSmoke+ 193xWater - 389xControl +8.2Lag.
(0.1) (0.1) (0.7) (0.9) (-1.9) (1.8)
Equation 6 Rsq = 0.14, n=42.

For this analysis none of the spread descriptors have significance. The Rsq for the equation was low, at Rsq = 0.14, so this equation is virtually useless for predicting repair costs.

Table 7 Damage spread scoring

FIRMS damage spread descriptors	Score
No damage of this type	1
Confined to part of room or area of origin	2
Confined to object of origin	2
Confined to room of origin	3
Confined to fire cell of origin	4
Confined to floor of origin	5
Confined to structure of origin	6
Extended beyond structure of origin	7

5.6 SMS regression summary

A variety of methods have been tried to better indicate repair costs, as follows:

- NZFS method using flame damage area only, compared to the building consent costs (Figure 1). This gives an Rsq of about 0.08 for detached house repairs.
- NZFS data using the sum of the four damage areas (flame, smoke, water, control) compared to the builders survey costs. (Figure 10). This gives an Rsq of about 0.17 for detached house repairs.
- NZFS method using flame damage area only, and a lag variable compared to the builders survey costs. This gives an Rsq of about 0.40 for detached house repairs.
- NZFS two damage areas (flame and smoke,) and the lag between the fire and the consent issue date, used as the explanatory variables in a regression equation to explain the builder's survey costs. This gives an Rsq of about 0.45 for detached house repairs.
- NZFS four damage areas (flame, smoke, water, control), and a lag variable used as the explanatory variables in a regression equation to explain the builder's survey costs (Figure 11). This gives an Rsq of about 0.51 for detached house repairs.
- NZFS two damage areas (flame and smoke,) and the lag between the fire and the consent issue date, used as the explanatory variables in a regression equation to explain the builder's survey costs. A reduced dataset is used with "outlier" records removed. This gives an Rsq of about 0.60 for detached house repairs.
- NZFS four damage areas (flame, smoke, water, control) and a lag variable used as the explanatory variables in a regression equation to explain the building consents costs. This gives an Rsq of about 0.17 for detached house repairs.
- NZFS four damage spread scores (for flame, smoke, water, control, scored as per Table 7) used as the explanatory variables, with a lag variable, in a regression equation to explain the survey cost/sqm floor area. This gives an Rsq of about 0.14 for detached house repairs.

None of these methods is particularly accurate at predicting costs. The most accurate is the two damage areas (Flame and smoke) regression equation with an Rsq of 0.60, from the reduced dataset. The coefficients are 1046 (flame) and 91 (smoke), which implies that the flame repair cost, at $1046/sqm is about 10 times that for the smoke damaged area at $91/sqm, which seems reasonable. The constant term ($11,758) can be interpreted as the average site establishment cost for repairs. So one method for more accurately assessing costs is to continue with the current method of a $/sqm rate applied to the flame damage area, and to add on the smoke damage area times one tenth of the S/sqm rate.

The regression approach is inaccurate, for several reasons:

- The fire-fighters are likely to find it hard to accurately measure damage areas, as discussed later.

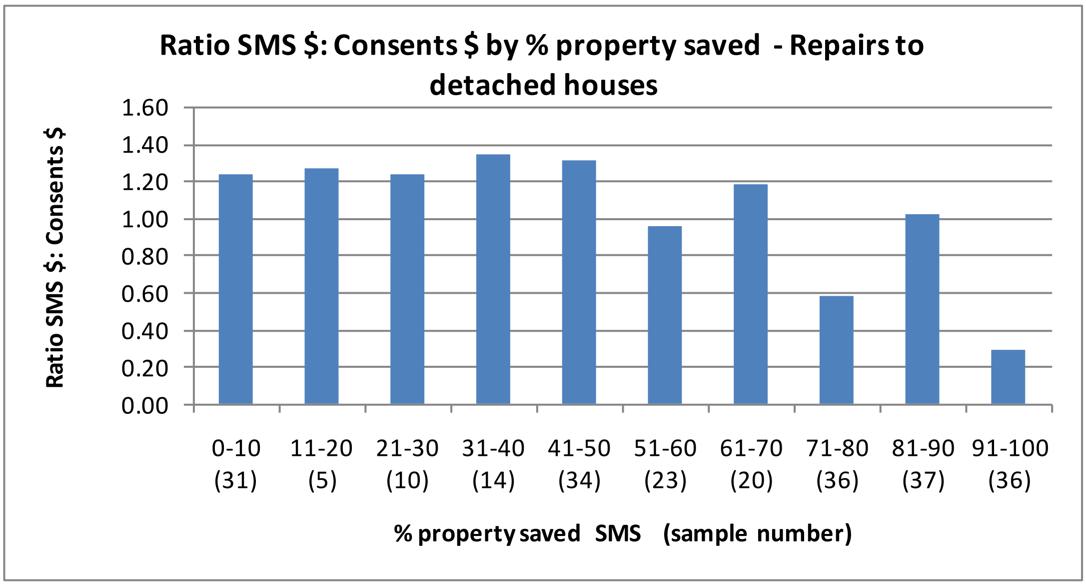
- Cost of repair is unlikely to be a linear relationship of the flame damage area because there are establishment and overhead costs which are a significant proportion of the total cost, particularly for small projects.
- Despite attempts to “cleanse” the datasets some of the data will have errors (e.g. incorrect building areas).
- The repairs may include quality upgrades and additional floor area, though we have attempted to subtract the latter. Conversely, owners may be under-insured, or decide to replace on a lesser scale.

In these cases the SMS estimate will differ from the consent and survey values.

5.7 Recommended method

The recommended method for assessing performance is derived from an examination of Table 4 to Table 6 and Figure 13. These show that SMS underestimate costs by a significant amount when the property saved percentage is high. Figure 13 shows the ratio of SMS costs to consent costs for different property saved percentages. Consent data has been used rather than builders survey data because the sample is much larger. The sample size in each percentage saved group is shown on the chart. It indicates that at low property saved percentages SMS over-estimates costs by about 20%, but above 50% property saved, the ratio trends down quite sharply.

Figure 13 Ratio of SMS to consent costs by property saved percentage



It is suggested that repair cost estimates continue to be based on the flame damage area but above 50% property saved percentage the repair costs be multiplied by a factor of 1.05 (51 to 60% saved), 1.2 (61 to 70% saved), 1.4 (71 to 80% saved), 1.8 (81 to 90% saved) and 2.6 for above 90% saved. For less than 50% property saved there is no adjustment.

In choosing these factors the main consideration was that the relative ratios between the different % saved groups in the chart was retained. For example, between zero to 50% property saved the $/sqm replacement cost, as obtained by the fire service, are used as before. For 71 to 80% the chart line has the ratio SMS:Consents =0.9, and to preserve its relative position with the 0 to 50% group there is a scaling of 1.25 so the net factor is 1.25/0.9 = 1.4. Similarly for the other groups above 50%.

Table 8 Multiplier for SMS repair costs

Scaling multiplier	
SMS	
% property saved	Multiplier
0 to 50%	1
51 to 60%	1.05
61 to70%	1.2
71 to 80%	1.4
81 to 90%	1.8
>90%	2.6
Multiplier is applied to the SMS repair cost estimate.	

The multiplication factors in Table 8 will bring the repair costs close to the typical repair costs for the majority of fires where more than half the building is saved, as measured by the flame damage area.

5.8 Discussions with insurance assessors

This section has findings from discussions with insurance assessors on how the repair work is specified and the procedures for costing this repair work. The main finding is that repairs often extend beyond the area of the building immediately damaged by flame and that repairing this damage adds to costs. As stated previously one measure of effectiveness used by the Fire Service is the percentage of the total building saved from flame damage. So when smoke damage extends beyond the flame damaged areas the latter underestimates the cost of repairs.

The assessors interviewed thought that councils are becoming more risk adverse in interpretation of the building code, leading to upgrading of repairs to new E2, E3 and H1 NZBC requirements rather than replacement of “like-with-like”. There is more emphasis by the Fire Service on people rather than property safety, causing an increase in fire control damage. These factors add to repair costs.

Two assessors were interviewed:

Interview of Assessor One.
The remedial process after a fire is the Assessor inspects the site, and in about 60% of cases a building consent is required. In more complex repairs a registered architect or engineer prepares the drawings and contract documents for the consent, otherwise architectural draught-persons do the contract preparation and consent application. The Assessor calls tenders, or for smaller jobs use a pool of builders for the work on a cost

plus basis. Very little supervision is undertaken by the assessor as they rely on the council inspections and/or the owner to ensure re-instatement is achieved.

In many fires the smoke damage is the main determinant of repair cost, rather than flame damage. It is important to locate all smoke damaged areas, which can be quite widespread, away from the flame area, due to pressurisation. Sometimes this extends from the roof space, around the eaves soffit and into the wall cavity, bleeding through the weatherboard joints. This may require stripping of weatherboards, and replacing of building paper to remove smoke smells. On some projects all the linings need to be stripped to locate smoke damaged framing, in order to ensure there is no lingering smell. The sealing paint for smoke damaged areas is expensive ($120/ 4 litres) due to its limited coverage on timber.

In older homes the matai/rimu floors, doors and architraves are replaced, especially where they are a feature(i.e. unpainted), and this replacement is expensive. Generally insulation is installed in uninsulated houses as a routine item. About 60% of repairs require a building consent. Some councils require the repair work to current standards, when issuing consents, including installation of cavities and wraps in window and door openings, and double glazed window replacements. Linings replacements may also require a bracing check. All this adds on to the final repair bill.

In newer homes, such as monolithic clad homes on a concrete slab with sheet cladding materials, it is quite common for a total replacement to occur when the fire damage area is only about 30% to 50% of the house. In these cases the smoke damage has spread throughout the house and into the roof space and repainting linings and roof timbers is quite expensive, it may not get rid of the smoke smell, and a total replacement, i.e. a new building on the existing slab, is more economic.

The assessor thought the Fire Service change in emphasis from property protection to personnel protection, of recent times, may have lead to a slight increase in fire control damage. For water damage the assessor was of the opinion that the Fire Service has improved in terms of collateral damage, and that they actively try to minimise water damage in general.

The above suggests that the area of flame damage, smoke damage and control damage are the relevant parameters that influence the repair cost.

Interview of Assessor Two.
This assessor tends to be involved in commercial repair jobs rather than domestic. The remedial process is the Assessor inspects the site and provides detailed lists of work to be done to the architect. The architect prepares the documents for the consent application, the assessor calls tenders, and often the insurers will employ a builder supervisor (or clerk of works on larger jobs). Most repairs need a building consent unless it involves only a few sheets of plasterboard. Most fires require a check by an electrician and often the re-wire involves most of the building even though flame damage is limited to part of the building.

Smoke repairs can be quite extensive, involving paint sealing (to eliminate the smoke smell) of linings and roof timbers. It is a judgement call whether to replace smoke damaged linings or to repaint over the damaged area
.

His view is that assessor experience is being lost through retirements, and demand from other areas (e.g. building surveyors for weather-tightness). New assessors were being ultra-cautious due to limited experience and replacing more than is needed.

6. DISCUSSION

The comparison between the SMS estimated repair costs and the costs as disclosed in the builders survey is not very close, as shown in Figure 5 to Figure 7, for detached house repairs and replacement. This indicates that using the flame damage area as a measure of the total cost of repairs is not very accurate. Table 4 and Table 5 show that SMS over-estimate the repair costs, as given by consents, when more than 50% of the building is damaged, and underestimates the repair costs when less than 50% is damaged.

Discussion with the assessors indicate that smoke damage can be widespread, usually several times the spread of flame damage, and that it can be quite difficult and costly to repair. However, using combinations of the action damage areas does not improve the prediction of actual costs very much. The best fit was found using the flame and smoke damage areas as the predictors, but even then a large amount of unexplained deviation from the actual repair cost still remains.

The fire-fighters need to record the extent of action damage after a fire into the SMS database. The data entry spreadsheet has four boxes for the damage areas, one each for fire, smoke water and control. It is not clear how the numbers for entry are calculated. One possibility is they assess how much of the floor area is adjacent to the damage areas and this floor area is the metric used. Another possibility is that they enter the surface areas affected by the action. For smoke damage to linings, the wall and ceiling areas could exceed the total floor area of the building. However, there are constraints in the data entry to ensure each action damage area does not exceed the total building floor area (which is entered separately).

What seems to be intended in the data entry is for a judgement to be made on the extent of damage to the surfaces as a proportion of all surfaces. However, this is a difficult task, because what surfaces are to be included? For flame damage occurring say, at one wall and extending up and across most of the roof, is the flame damage area the total roof area (i.e. 100% coverage over the floor), implying that the whole house is replaced, when only the roof might be repaired. Similarly for smoke damage which may spread to all ceilings but only some walls, is the percentage damage area 100% or some lesser amount? It seems that different interpretations are likely to arise with different recorders. This makes the action damage areas unreliable as a cost indicator. It is probably the reason why the regressions, using the action damage areas as the explanatory variables for actual repair costs are not very accurate.

It was hoped that the use of the fire spread measures might enable a correlation with the consent costs. The spread description is fairly general, see Table 7, and unfortunately the correlation with survey $ damage per sq metre of floor area was very low. So this approach is also of little use.

It was decided that the best that could be done was to adjust costs for where more than 50% of the house is saved. The adjustments ranges from a factor of 1.05 in the 51 to 60% saved group up to 2.6 for the above 90% saved group. The full set of adjustments are in Section 5.7 and the application of these is expected to bring costs into line with actual repair costs, on average, though it will not necessarily apply to individual houses.

7. APPENDIX

This appendix consists of :

- Why a significant number of fire incidences do not appear in the consent data.
- Data source for building consents.
- The survey form sent to builders.

7.1 SMS and building consent comparison

The period covered by the SMS dataset is from January 2006 to April 2008 consisting of 4433 address, excluding repeats and null or incomplete site addresses.

The SMS data was compared to building consents between April 2006 and April 2008, allowing a lag period of about 3 months between the fire incident and the consent issue.

For new house consents there were 109 matches. For A&A consents there were 417 matches. This totals 526 consents and we scale these up by 33% to allow for the incomplete Whats-On coverage, as discussed later, giving about 700 matches. This leaves about 3733 SMS incidences which do not appear as building consents. These include:

- Repairs less than $10,000, which do not appear in consent data.
- Repairs over $10,000 in value, but not involving the structure so that a building consent is not required.
- Recent entries in the SMS dataset that have not yet appeared as consents.
- Errors in the addresses of either dataset.

Approximately 2,405 of the SMS entries were below $10,000 in estimated repair cost, leaving about 1,328 entries not picked up in consents. There were about 385 SMS entries between $10,000 and $15,000 and most of these are likely to be non-structural and not requiring a consent. This leaves about 943 SMS entries not appearing in consents and this may be due to lag effects or database error.

A significant number of matches were obtained between the SMS and consents datasets. The matches included some spurious matches where the consent issue date was before the date of the fire incident. In these cases the consent was for work totally unrelated to the fire repairs, and these matches were deleted..

7.2 Building consent data source

The Whats-on dataset (published monthly by TF Stevens and Co Ltd, Auckland and Wellington) is not a complete record of all building consents for three reasons:

- Consents under $10,000 in value are omitted.
- Some territorial authorities use private certifiers to issue consents and the Whats-On dataset does not collect these.
- The Whats-On dataset also omits owner builders.

In total the Whats-On dataset covers about 75% of all consent issued.

To achieve a match the site address and territorial authority identifiers in both datasets were compared. A considerable amount of time was spent in adjusting for incorrect addresses, usually the site number, for example, 15 B instead of 15 A, or 1/9 instead of 9A. It was also necessary to check that the building consent was issued after the date of the fire, as discussed above.

The building consent values relating to repair work are expected to be fairly accurate. The reasons are:

- Territorial authorities, who issue the consents, are strict on correctly valuing many cases the consent fee is based on the value of the work.
- The funding for the repairs is usually from insurance companies who undertake an assessment of damage and the repair cost, before approving the start of work.
- However, after work beings further damage may be uncovered, in which case the consent value could be an under-estimate of the final repair cost.

7.3 Fire damage repairs survey

This postal survey was sent to builders identified from building consents lists obtained from territorial authorities. The address in SMS matched the address for the consent. A small incentive was offered (a $10 lotto ticket or book voucher), and the response rate of about 20% was achieved. The survey form is below.

Could you please fill out this survey for the building that was damaged by fire at the address given over the page.

Q 1 What was the total cost of the repairs $................

Q 2 What percentage of the building required repair/ replacement?
Roof ....%
Exterior Walls .... %
Interior Walls ....%
Floor ....%

Q 3 Does the cost in Q1 include other work not caused by the fire, e.g. adding on a new room? Yes/ No (circle one).

If Yes, What percent of the cost in Q1 was new work not fire damage repair/replacement. ....%

Thank you. Please indicate your preferred reward over page and place this survey in the enclosed reply paid envelope.