

Fire Research Report

**Changes in community
self-reliance and
implications for fire
safety messages and
emergency response**

**McDermott Miller
Strategies**

November 2011

New Zealand Fire Service (NZFS) incident statistics indicate that campaigns to encourage people to call 111, and other fire safety education initiatives, can lead to increases in false alarm callouts. Such calls can have adverse consequences for the Fire Service, most seriously the potential for demotivation of volunteer fire-fighters if they are called too frequently from their normal activities to attend inconsequential “emergency” events. The aims of this research include gaining insights for refining NZFS’s fire safety educational activities to increase “Fire Efficacy” in the community. The research programme involves: initial consultation and literature review, development of an “Index of Fire Efficacy”; development of a market research methodology to generate this Index; and, conducting an initial survey to act as a baseline for ongoing monitoring. The report concludes with recommendations on how NZFS can increase “Fire Efficacy” with respect to fire safety in the community.

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FINAL REPORT

Changes in community self-reliance and implications for fire safety messages and emergency response

**Report by McDermott Miller *Strategies*
to New Zealand Fire Service**

30 November 2011

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ABSTRACT:

New Zealand Fire Service (NZFS) incident statistics indicate that campaigns to encourage people to call 111, and other fire safety education initiatives, can lead to increases in false alarm callouts. Such calls can have adverse consequences for the Fire Service, most seriously the potential for demotivation of volunteer fire-fighters if they are called too frequently from their normal activities to attend inconsequential “emergency” events. The aims of this research include gaining insights for refining NZFS’s fire safety educational activities to increase “Fire Efficacy” in the community. The research programme involves: initial consultation and literature review, development of an “Index of Fire Efficacy”; development of a market research methodology to generate this Index; and, conducting an initial survey to act as a baseline for ongoing monitoring. The report concludes with recommendations on how NZFS can increase “Fire Efficacy” with respect to fire safety in the community.

1. SCOPE OF THE RESEARCH

1.1 INTRODUCTION

McDermott Miller was commissioned by the New Zealand Fire Service (NZFS) in March 2011 to assess *Changes in Community Self-Reliance and Implications for Fire Safety Messages and Emergency Response* as part of NZFS's 2010-2011 Contestable Research Fund.

The purpose of this research, the methodology used to achieve its purpose, results obtained and implications for fire safety messages and emergency response are contained in the following sections of this report.

1.2 DEFINITIONS

The following definitions of "fire preparedness" and "self-efficacy" have been adopted for the purposes of this research:

FIRE PREPAREDNESS

Individual knowledge about and experience in dealing with fire incidents coupled with a person's fire fighting equipment available in the home (refer Section 2.1).

SELF-EFFICACY

The belief in one's capability to organise and execute the courses of action required to manage prospective [fire] situations (Source: Bandura, refer Section 2.1).

"Fires" were classified into three groups for the purpose of the research, these are defined as:

- **Minor:** a fire incident which causes no damage to your home.
- **Medium:** a fire incident which has damaged the walls, ceilings, floors of your home, but not to the point where it needs to be replaced

- **Major:** A fire incident which has damaged the walls, ceilings or floors of your home to the point where it needs to be replaced.

1.3 RESEARCH AIMS

The aim of the research is to achieve:

- a baseline “Index of Fire Efficacy” to measure existing self-efficacy and actual efficacy;
- clarification of the relationship between New Zealand Fire Service (NZFS) educational activities and unnecessary call outs ;
- insights for refining NZFS’s fire safety educational activities to increase both self-efficacy and actual efficacy in the community; and,
- a scoped and costed Fire Efficacy monitoring research programme.

1.4 RESEARCH OBJECTIVES

The research objectives of the project are to:

- develop an “Index of Fire Efficacy” to measure competence in dealing with minor incidents and recognising when the NZFS is needed.
- develop a research methodology that underpins the “Index of Fire Efficacy”.
- measure the current level of this Index, at the national and sub-national level, as a baseline for on-going monitoring.

1.5 BACKGROUND

NZFS incident statistics indicate that campaigns to encourage people to call 111, and other fire safety education initiatives both at the national and urban and rural community levels, lead to increases in call-outs. It appears some members of the community are

motivated by these campaigns to call the NZFS to relatively minor incidents which they could have dealt with themselves; by the time the NZFS arrives the incident may have been successfully dealt with. False alarms and other unnecessary calls-outs have adverse consequences for the NZFS, including the resource cost of the call-out and potential for de-motivation of volunteer fire-fighters (with possible consequential retention and recruitment problems) if they are called too frequently from their normal activities to attend inconsequential “emergency” events. This problem might be particularly acute in rural communities, due to the NZFS’s reliance on volunteer fire-fighters and the increased response times and distances involved.

Ideally, the NZFS’s fire safety education should lead to a reduction in incidents and resultant call-outs, or at least no increase. This means fire safety education should aim at supporting efficacy in the community in handling minor incidents. Individuals and households would acquire the capacity to recognise when NZFS really is required, and hence the confidence to deal with minor matters themselves. Supporting “self-efficacy” (self-confidence in handling minor matters) is not sufficient to achieve the NZFS’s mission of reducing the consequence of fire. The NZFS must also aim for improvement in actual efficacy (real competence in dealing with minor incidents) – particularly in rural areas where response times can be substantially longer than in cities. At the same time it needs to avoid an increase in ill-founded or mistaken self-efficacy that could have serious consequences – such as injuries and delays in calling 111 when the NZFS really is required.

The National Fire Risk Management Plan (June 2010) states (p 19) “From our Fire Knowledge Survey we know that New Zealand Fire Service only attends 7% (2011 figure) of all fires. We are attending a greater percentage of all fires whilst still minimising the extent of the damage. This means more people are calling the NZFS to fires.”

The New Zealand Fire Service Commission Statement of Intent 2010/2013 states (p 29) under the heading "Value for Money":

"The marginal financial cost to NZFS of responding to another incident is very low relative to the cost already incurred in standing ready to respond."

However, it then notes that this view is incomplete:

"This approach has its limitations as the marginal cost to a volunteer (or an employer of a volunteer) of responding to another incident may be significant in terms of loss of family/leisure time (or productivity)."

This marginal cost that the trained, experienced volunteer and/or his family and employer bear will become a real cost to NZFS if s/he leaves the Service due to the significant "marginal costs" they are expected to bear – a replacement must be recruited and trained, and if a replacement cannot be found (or until one is trained and comparably experienced) there is a danger that achievement of the NZFS's goals may be compromised.

1.6

SUMMARY DESCRIPTION OF METHOD

Six core tasks are covered in McDermott Miller's research programme. These tasks are designed to achieve the aims and objectives set out above, as follows:

Task 1. Literature review of relevant texts:

We reviewed NZFS reports, other relevant New Zealand and overseas literature, including both theory and case-studies on:

- how "self-efficacy" has been measured in other countries as a guide to our research design;
- actions that have been taken by other fire services to improve "self-efficacy"; and,
- how effective these actions have been.

Task 2. Consultation on “self-efficacy”:

The second research task involved consultation with Senior NZFS Managers and Executive Officers to discuss the evidence for declining “self-efficacy”, where it has been observed, and how severe a challenge it is for NZFS.

This was followed by a series of focus groups with ‘Urban’, ‘Rural’ and ‘Maori and Pacific Island’ communities. The focus groups helped clarify community perceptions and guide design of the survey instrument for the quantitative research.

Task 3. Statistical Analysis of “self-efficacy” effects:

In this task we worked with Fire Service Information Analysts to quantify the challenges posed by changes in “self-efficacy”, including drawing on the existing SMS Incident Database and market research survey data, to identify communities most “at risk”.

Task 4. Develop Index of Fire Efficacy:

Here we developed a “**Fire Efficacy Index**”, which measures household competence in dealing with fire emergencies appropriately, whether or not this involves a 111 call. This index facilitates:

- cross-sectional comparisons between regions and communities (including comparisons between urban and rural communities); and,
- longitudinal comparisons, i.e. monitoring of changes over time, from the benchmarks established the research proposed here.

Task 5. Conduct an initial survey to act as a baseline for ongoing monitoring.

We undertook an email survey of our “**Fire Efficacy Index**” with the General Population and certain ‘at-risk’ groups. We then analysed the data and calculated the Index of Fire Efficacy and its constituent Indices.

Task 6. Interpretation and Reporting

The research culminates with findings and recommendations from the consultation, review and survey results.

1.7

OUTLINE OF REPORT

Section 2 of this report discusses the research that underpins the conceptual development of McDermott Miller's Fire Efficacy Index. The research involved a literature review, stakeholder consultation and statistical analysis of NZFS incident data.

Section 3 discusses the conceptual development of McDermott Miller's Fire Efficacy Index;

Section 4 shows the underlying calibration of respective indices ('Self-Efficacy' and 'Fire Preparedness' Indices); and, contains the Index results of McDermott Miller's survey of the general population and "at risk" household segments;

Section 5 outlines the implications for the NZFS current and future fire safety educational activities to improve self-efficacy and fire preparedness by households.

Section 6 reports McDermott Miller's findings and recommendations.

This report should be read in conjunction with its companion *Technical Report on Changes in community self-reliance and implications for fire safety message and emergency response* dated November 2011 which covers:

- methodology used in the literature review;
- methodology used in the stakeholder research;
- analysis of existing Fire Service data relevant to the study;
- tabulated survey results;
- bibliography;

- attributes of the Fire Preparedness and Self-Efficacy indices; and,
- survey specifications.

2. RESEARCH UNDERPINNING THE INDEX

2.1 LITERATURE REVIEW OF RELEVANT TEXTS

McDermott Miller reviewed NZFS reports, other relevant New Zealand and overseas literature, including both theory and case-studies. The review clarified:

- the definition of “self-efficacy” and its recognised drivers;
- how “self-efficacy” is measured in other countries;
- actions that have been taken by other fire services to improve “self-efficacy”; and,
- how effective these actions have been.

The themes are discussed below.

SELF-EFFICACY AND ITS DRIVERS

“Self-efficacy” is a construct derived from social cognitive theory, which posits that behaviour, cognition and the environment all influence each other in a dynamic fashion (Bandura, 1977; 1986). “self-efficacy” is defined as the ‘belief in one’s capabilities to organise and execute the courses of action required to manage prospective situations’ (Bandura, 1995 p2). The “self-efficacy” construct is considered to have generative capabilities where it is capable of influencing thought patterns, emotional reactions, and orchestration of performance through the adroit use of sub skills, ingenuity, and resourcefulness (Gist et al, 1992). “Self-efficacy” is a dynamic construct, where efficacy judgement changes over time as a result of acquiring new experiences and information (Gist et al, 1992).

“Self-efficacy” is considered an important motivational construct. It influences individual choices, goals, emotional reactions, effort, coping and persistence. There is an accepted way to measure the self efficacy construct (Bruner, 2009) but a person’s level of “self-efficacy” can also be influenced or change as a result of learning, experience and feedback (Gist et al, 1992).

An accepted scale of “self-efficacy” has been adopted by the marketing fraternity (Bruner, 2009). This scale has been used to measure self efficacy in education, sport and organisational research (Gist et al, 1992). Other studies (Bandura, 2006; Lee & Bobko, 1994) have found that using this accepted scale, but also scoring the strength of each item, strengthens the overall reliability of the “self-efficacy” rating.

IMPROVING SELF-EFFICACY: INTERNATIONAL FIRE SERVICE EXAMPLES

There is a trend in Australia and the USA towards increased community involvement in fire education and safety as a way to increase a community’s fire preparedness (Beatson et al, 2010; Rohrmann, 1999; RMIT University, 2009). A past example is the Country Fire Authority of Victoria which introduced the “Community Fireguard” program, which is based on community involvement and aimed at enhancing individual responsibility for fire safety and survival strategies (Rohrmann, 1999).

Recently, CRC Australia commissioned RMIT University to complete a five year project to evaluate Bushfire Community Education Programs (Project C7). The objective of this project was to develop and test a comprehensive framework and methodology for evaluating the broad range of bushfire community safety policy and programs in Australia, highlighting (i) an approach that has the potential to lead to a comprehensive and sound evidence base for identifying which policies and programs work best, for whom and in what settings; and (ii) the provision of a consultative and collaborative approach to working with end-users and community members (RMIT University, 2009). The outcomes of the C7 project highlighted the importance of a community safety approach. It advised the approach to be embedded in the policy and planning for bushfire community safety across Australia (RMIT University, 2009).

2.2

CONSULTATION ON “SELF-EFFICACY”

The second research task involved consultation with Senior NZFS Managers and Executive Officers. Here we

discussed the evidence for declining “self-efficacy”, where it has been observed, and how severe a challenge it is for NZFS.

This consultation process revealed:

SENIOR NZFS MANAGERS AND EXECUTIVE OFFICERS:

- There is an internal NZFS debate about the extent to which the fire service should educate communities about recognising and dealing with fire incidents on their own.
- Some Managers and Executive Officers believe there is a risk of increasing dependence on the fire service through the provision of safety advice and equipment. A stated example of this is fire stations/fire-fighters installing smoke alarms in peoples homes. This action is considered to lead to an increased expectation by residents that the fire service will continue to maintain their smoke alarms.
- Some communities/householders appear to react to this support by taking the view that they need do nothing for themselves and rely entirely on the fire service.
- “Self-efficacy” in urban areas is unlikely to be as high as in rural areas because of shorter NZFS response times in urban areas and greater knowledge and experience of fires in rural areas.
- However, the increasing numbers of city-originated “lifestylers” who buy small parcels of land and build houses on them have a much lower knowledge of fire hazards on the land and therefore do not build precautions against fire into their houses or acquire suitable equipment to help contain fire.
- Moreover, they often assume access to and availability of the fire service is the same in rural areas as it is in the city they came from.
- “Lifestylers” slip through the training/information loop about rural fire hazards because there are no comprehensive networks to catch them for this purpose.

- As a result “lifestylers” often inadvertently and unknowingly raise the risk of structural damage from fire to their own and other properties and are not good at making the appropriate “stay/go” decision when faced with a rural fire.

Consultation with NZFS Managers and Executive Officers was followed by a series of focus groups with ‘Urban’, ‘Rural’ and ‘Maori and Pacific Island’ communities. The focus groups were used to clarify community perceptions and to obtain guidance for design of the survey instrument for the quantitative research.

Below is a summary of the findings for each group:

‘URBAN’ DWELLERS:

- No one in this group had ever called the fire service and no one had been personally involved with fire.
- The most common form of interaction with fire safety is work-related fire drills. Many of the group are fire wardens at their place of work. Although, this does not necessarily correlate to experience with the NZFS.
- The majority of the group do not have fire equipment in their home, but they all recognise that they should have smoke alarms.
- Some were in the process of installing smoke alarms in their homes. For others, awareness of the need for smoke alarms is not incentive enough to install smoke alarms in their own homes, this tends to be because they do not believe they are ‘at risk’ of house fires.
- Some respondents admitted being more fire safety conscious when they had young families.
- The respondent who was most fire safety conscious had a rural background (grew up on a farm) but also had a young family.
- The group recognises that a major fire in their home was something they would not have the capability to deal with.

- If faced with a major fire, they would get everyone out of the house and call the fire service.
- A medium level fire (e.g. cooking fire), or a minor fire (e.g. smoking light bulb) are fire incidents respondents recognise as something they could deal with and indicated they would try to put out the fire themselves first before calling the NZFS.
- The group recalled many of NZFS's promoted messages. Their main understanding of these messages was to never leave fire/cooking unattended and if fire starts to leave the house and call the NZFS.
- The group expressed a desire for an education campaign that taught people more about how to deal with fire and fire equipment in certain situations.
- This suggestion was made after respondents admitted to dealing with minor (and in some cases medium) fire incidents in their homes, but also admitting their knowledge about how to deal with these situations safely was limited.

'RURAL' DWELLERS:

- There seems to be little relationship between NZFS educational/communication campaigns and unnecessary callouts for this group.
- Less likely to experience unattended cooking fires, fires caused by cigarettes or kitchen fires.
- They tend to be some distance from the fire station, and are aware that most of firemen are volunteers; as a result they are less likely to call NZFS for minor incidents.
- Generally well-equipped with fire extinguishers and smoke alarms. Most know how to use a fire extinguisher.
- However, if there was smoke billowing under the door, there was awareness that the fire must therefore have become so major that it was beyond putting out independently and assistance was needed.

- Saving one's own life and then those of any others in the home in the event of a major fire would become the first priority.
- This group tended to deal with minor and medium fires on their own.
- Suggestions made that the NZFS could do more public speaking, demonstrations of use of fire extinguishers, advice on smoke alarms, safety measures, to various groups in the Wairarapa rural area.

'MAORI AND PACIFIC ISLANDERS':

- NZFS educational/communication messages conveyed the following messages:
 - Caution with home cooking
 - Speed with which fire spreads
 - NZFS is available when you need the service and friendly.
- Aware that, if it is a major fire, all you can do is call the NZFS.
- If it is a medium or minor fire it needs to be put out very quickly and respondents will take whatever reasonable measures they can to put out these types of fires.
- A significant number of respondents reported that they would be 'too shy' to ring the Fire Service for a minor incident. Fire officers are held in high esteem and respondents did not want to seem "stupid" or that they might have made a mistake calling the Fire Service.
- This community is less likely to have fire extinguishers and working smoke alarms than higher socio-economic groups.
- The group felt NZFS TV advertisements are effective in providing education about precautionary measures, i.e. how to avoid a fire, rather than how to put a fire out.
- Believe that more NZFS staff with a Maori and Pacific Island cultural understanding would be helpful for the

Fire Service to be more pro-active in those communities.

2.3

STATISTICAL ANALYSIS OF "SELF-EFFICACY" EFFECTS

For this task we worked with Fire Service Information Analysts to quantify the challenges posed by changes in "self-efficacy", including drawing on existing SMS Incident Database to identify trends in fire incidents.

NEW ZEALAND FIRE SERVICE INCIDENT DATA

In the year ending 30 June 2011, NZFS attended 59,140 "incidents". This was around 4.2% fewer incidents than attended in 1999.

Up until the 2011 financial year, all incidents attended by the New Zealand Fire Service had been growing by around 1.5% per annum. However 2011 year incident data shows the smallest number of incidents in the whole twelve year period, and a reversal of trend across all regions, other than Region 4, since 1999.

This is because **XXX**

Table 2.1 below summarises these incident numbers for each of the twelve years 1999-2011 for each of the current five fire regions.

Table 2.1: Incident Data by Fire Region 1999-2011

FIRE REGION	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Annual Growth Rate
Region 1	19,649	19,494	19,408	20,027	19,766	20,201	20,758	21,436	22,436	22,516	20,938	21,872	17,447	-1.00%
Region 2	9,190	8,895	9,119	9,857	9,718	9,682	10,301	10,353	11,253	11,585	10,813	11,270	9,000	-0.02%
Region 3	17,823	17,319	18,907	17,360	18,462	19,505	17,854	19,713	20,445	20,120	18,266	18,691	15,054	-1.40%
Region 4	9,275	9,886	10,941	10,239	11,116	10,958	10,959	11,708	12,328	12,387	11,745	15,178	12,712	2.66%
Region 5	5,797	5,133	5,293	5,429	5,623	5,653	5,978	6,331	6,992	6,121	5,870	6,503	4,927	-1.35%
NZFS	61,734	60,727	63,668	62,912	64,685	65,999	65,850	69,541	73,454	72,729	67,632	73,514	59,140	-1.36%

Source: New Zealand Fire Service

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The following **Table 2.2** shows the average number of incidents over the 2006-2010 year period (please note 2009 has incomplete data for that year as a result of industrial action by fire-fighters).

Table 2.2: Incident Data by Incident Type 2006-2010

Incident Types	Average Annual Incidents 2006-2010	SHARE
All Fires	24,143	33%
Hazardous Emergencies	5,101	7%
Overpressure, Rupture, Explosives, Over Heating	570	1%
Rescue, Emergency, Medical Call	10,238	14%
Special Service Calls	4,657	6%
Natural Disasters	2,492	3%
False Alarms	26,696	36%
Not Recorded	35	0%
TOTALS	73,932	100%

Source: New Zealand Fire Service
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The data underlying **Table 2.2** revealed fires and false alarms continue to be the largest share of annual incidents, and that rescue, emergency and medical calls are the fastest growing group of incidents.

NZFS ATTENDANCE AND TOTAL FIRE OCCURRENCE

Table 2.3 below shows: NZFS is notified about fewer than half the unwanted fires of any type that occur in New Zealand; attends on average around 20% of the fires in residential property that are reported to the NZFS; and, attends on average around 35% of rural fires that are reported, and puts out only a proportion of the fires that are attended.

Table 2.3: Percentage of unwanted fires reported and subsequently attended to by NZFS

Year	FIRE	
	In Home	Outside
1999	17%	38%
2000	19%	19%
2001	11%	40%
2002	9%	29%
2003	10%	34%
2004	14%	35%
2005	16%	44%
2006	25%	40%
2007	21%	48%
2008	18%	38%
2009	12%	32%
2010	11%	39%

Source: NZFS, May 2011
 ©McDermott Miller Limited, August 2011

2.4

SUMMARY

The literature review and the stakeholder consultation revealed a need to not only measure 'self efficacy' but also to measure other factors which affect a person's ability and confidence to deal with fire incidents.

We have used Bandura's (2006) and Bruner's (2009) accepted scale of self-efficacy to measure New Zealander's level of self efficacy in relation to fire incidents. This scale makes up the "Self-efficacy" component of McDermott Miller's 'Fire Efficacy Index' (refer **Section 3** for further explanation).

The literature review and stakeholder consultation indicates a need also to measure a person's level of knowledge, experience and other environmental factors pertinent to fire behaviour.

To measure these factors a second measurement scale is required ("Fire-preparedness Index"). This scale measures the respondent's amount of fire experience and their level of prior knowledge about fire and the amount of fire equipment they have in their home. Some of these constructs have been measured in previous studies by: Srinivasan & Ratchford (1991) re.

experience; and, Beatty & Smith (1987), Bettman & Park (1980), Brucks (1985) re. prior knowledge. These studies have helped inform the design of our fire-preparedness index. We also used the NZFS Fire Knowledge Survey and findings from our consultation with NZFS officials to aid the design of the “Fire-preparedness Index”.

3. DEVELOPMENT OF FIRE EFFICACY INDEX

3.1 SCOPE

This section defines the scope of the research, fire preparedness and “self-efficacy”, which are the qualities we are seeking to test in this study and outlines the approach adopted to establishing indices to measure changes in their individual and combined values over time.

This research and the resulting indices relate to fires in household structures only. They do not relate to bush fires; ‘outside’ fires; or other property damaged as a result of fire (e.g. cars, sheds, barns).

Fires or fire risk in commercial, industrial and other public structures as well as wildfires, grass fires or other open air fire or fire risk situations are excluded from the research.

The research tests a person’s level of fire knowledge and belief in their own capabilities of handling a fire event in their own household. Additionally, the research measures the amount of working fire equipment a person has in their household. Throughout the report we refer to this as a ‘household’s’ level of Fire Efficacy.

3.2 BACKGROUND

The “**Index of Fire Efficacy**” is a function of two constituent indices; these are:

- The “**Index of Fire Preparedness**” – is an indicator of households’ actual competence to deal with incidents appropriately. It is constructed from responses to questions on household fire safety preparations, fire alarms and extinguishers, evacuation plans, routines for checking fire alarms, and knowledge about how to use equipment.

Experience with household fires and awareness of when NZFS should be called, and what to do after calling (especially in rural areas), also enter this Index.

- The “**Index of Fire Self-Efficacy**” - has been constructed from a series of questions on respondent’s belief that they can deal with a fire incident appropriately, whether or not this involves a call to the fire service.

Sections 3.4-3.7 below show how the indices are built up from valuing attributes relevant to fire preparedness and self-efficacy respectively, weighting the attributes according to their relative significance, and using the resulting values to establish baseline index levels.

3.3

INDEX OF FIRE PREPAREDNESS

For the purposes of this study “fire preparedness” is defined in terms of three attributes which are:

- an individual’s fire knowledge;
- the fire prevention/control equipment and set-up at their residence (or workplace); and,
- their experience (if any) in actual fire incidents.

These attributes are described in greater detail in the attached **Technical Report: Annex II – Index Attributes**.

Each attribute has a value, which is expressed as:

$$f(FK \text{ or } E \text{ or } XP)_t = \left(\sum_{SA=1}^k (\mu.V(SA) + \epsilon)_k \right)_t$$

where:

FK = Fire Knowledge attribute.

E = Equipment attribute

XP = Experience attribute

μ_k =weighting coefficient for sub-attribute k=1...K

$V(SA)_{kt}$ = value of sub-attribute $k=1...K$ at time t revealed by the research results.

ϵ_{kt} = error factor for sub-attribute k at time t

t = time periods $1...N$.

These attribute values are combined to determine a **fire preparedness value** ("PV" below) as:

$$fPV_t = a.f(FK)_t + b.f(E)_t + c.f(XP)_t + \epsilon_t$$

where:

a , b and c are weighting coefficients

$f(FK)_t$ is the Fire Knowledge value at time $t=1...N$

$f(E)_t$ is the Equipment and set-up value at time $t=1...N$

$f(XP)_t$ is the Experience value at time $t=1...N$

ϵ_t is the error factor at time $t=1...N$

Initial baseline value is when time $t=1$

Subsequent measurements of Fire Preparedness values will take place at time $t=2,3,4...N$

The **Fire Preparedness Index** ("PI" below) compares changes in the Fire Preparedness Value over time and is determined as:

$$fPI_t = [fPV_t / fPV_{t-1}] * 100$$

where:

PV is the Fire Preparedness Value at time, $t=1...N$

Initial baseline index level determined when time=1 is 100.

Subsequent measurements of Self-Efficacy will take place at times=2, 3, 4...N

3.4

INDEX OF FIRE SELF-EFFICACY

As noted earlier we are using Bandura's definition of "self-efficacy" for the purposes of this study, being *the belief in one's capabilities to organise and execute the courses of action required to manage prospective [fire] situations.*

The fire self-efficacy index developed as a result is determined in terms of three principal attributes which are:

- Risk perception or the ability to recognise and assess fire danger
- Self-confidence
- The ability to act under pressure.

These attributes are described in greater detail in the attached **Technical Annexe II**.

Each of these attributes has a value, expressed as:

$$f(RP \text{ or } SC \text{ or } AA)_t = \left(\sum_{SA=1}^m (\delta \cdot V(SA) + \epsilon)_m \right)_t$$

where:

RP = Risk Perception attribute.

SC = Self-Confidence attribute

AA = Ability to Act attribute

δ_m = weighting coefficient for each sub-attribute $m=1...M$

$V(SA)_{mt}$ = value of each sub-attribute $m=1...M$ derived from research results at time $t=1...N$

These attributes are combined to determine a Self-Efficacy Value ("SV") expressed as:

$$fSV_t = v \cdot f(RP)_t + w \cdot f(SC)_t + x \cdot f(AA)_t + \epsilon$$

where:

v , w , and x are weighting coefficients

$f(RP)_t$ is the value of the Risk Perception attribute at time $t=1...N$

$f(SC)_t$ is the value of the Self-Confidence attribute at time $t=1...N$

$f(AA)_t$ is the value of the Ability to Act attribute at time $t=1...N$

ϵ_t is the error factor at time $t=1...N$

The Self-Efficacy Index ("SI" below) compares changes in Self-Efficacy values over time and is expressed as:

$$fSI_t = [fSV_t / fSV_{t-1}] * 100$$

where:

SV_t is the Self-Efficacy Value at time $t=1...N$.

Initial baseline index level determined when time $t=1$ is 100.

Subsequent measurements of Self-Efficacy will take place at times=2, 3, 4...N.

3.5

INDEX OF FIRE EFFICACY

The Index of Fire Efficacy combines the values underlying the Indices of Fire Preparedness and Self-Efficacy to give a single overall value.

This overall index can be expressed as:

$$FE_t = y.PI_t + z.SI_t$$

where:

PI_t and SI_t are values determined in **Sections 3.3** and **3.4** respectively, and y and z are weighting coefficients.

3.6

WEIGHTING

The initial starting point in estimating values in this study is to assume all attributes rank equally, that is, all the weighting coefficients in the value formulae above have a value of 1.

But the attributes in the “Fire Preparedness” and the “Self-Efficacy” Indices and the combination of the two to obtain an overall Index of Efficacy could be weighted to reflect the relative significance of each attribute within the respective indices.

These possible weightings need to be derived either from on-going research or from the perception of relative significance from NZFS’s professional evaluation.

4. INDEX CALIBRATION

4.1 OUTLINE

The literature review and stakeholder consultation informed the conceptual design of the "Fire Efficacy Index". But the critical stage of research comes from a nation-wide survey of the general population, 'at-risk' segments and rural residents. This survey provides the data input to McDermott Miller's conceptual "Fire Efficacy Index".

4.2 SURVEY INPUT

A nation-wide email survey of the general population and selected "at risk" segments was undertaken over the May-June 2011 period. The survey obtained respondents' assessments of their preparedness for a fire, their experience of fires, their knowledge of fire safety messages and other fire safe practices and their likely behaviour when faced with a fire.

The populations surveyed included the nation-wide general population (all households) together with a number of "at risk" households as summarised below.

The full sample size was 1990 persons. Valid responses received for the selected segments, (final quotas for segments are interlocking, i.e. respondents can belong to more than one segment), are noted below:

Segment:	Valid Responses Received (n=)
General population:	1007
Rural population:	534
Low income: (below \$30K per annum)	493
Maori and Pacific Islanders:	272
Renters:	689
People with disabilities:	464
Older people (age 70yrs+):	211

The survey methodology and specifications are described more fully in the attached **Technical Report: Annexe III – Survey Specifications**.

4.3

METHOD OF INDEX CALIBRATION

The values underlying Fire Efficacy, Self-Efficacy and Fire Preparedness indices are estimated by:

- Applying scores to the results of the survey to determine values for the underlying attributes of each index. This has been done by assigning scores ranging from +1 to -1 to each survey respondent's answers to each question in the survey that underlies the various attributes defined in **Sections 3.4-3.6** above.
- These individual scores are then summed to obtain an overall estimated attribute value.
- Assuming the weighting of attributes is 1 (as noted in **Section 3.7** above), the resulting attribute values are summed to obtain the respective Fire Preparedness and Self-Efficacy value estimates.
- Again, assuming Fire Preparedness and Fire Efficacy values are equally important (i.e. weighting between these index values is 1 as noted in **Section 3.7** above), their index values are summed to obtain the overall estimated Fire Efficacy Value.
- This process is undertaken to estimate Fire Preparedness, Self-Efficacy and Fire Efficacy values for:
 - the general household population;
 - rural and urban segments of the population; and,
 - at risk segments of lower income (<\$30,000 annual income), aged (70+ years), Maori and Pacific Islanders, disabled and renter households.

- The resulting index values are tested for sensitivity to changes in weighting assumptions.
- Finally, initial index values are assigned a nominal index rating of 100 as the starting point for each of them.

All initial index values developed from this research are set at a value of 100 as the starting point. Changes in the underlying efficacy and preparedness values of the surveyed populations will be reflected in movements of the index values above (as efficacy rises) or below (as efficacy falls) the starting point index value of 100.

The initial baseline index values are set as at June 2011.

For example, the general population fire efficacy value of 8.80 as shown in **Table 4.5** below is the value underlying the fire efficacy index rating of 100 as at 30 June 2011.

The following **Sections 4.3-4.5** summarise the Index Values derived from the survey results following the process outlined above.

Please note: a higher index figure indicates a higher level of Fire Efficacy (including a person's level of "self-efficacy" and "fire preparedness"). Conversely, a lower index figure indicates a lower level of Fire Efficacy. This research identifies a baseline index result, the final index result is not necessarily the ideal figure but merely the general population at "at risk" segments Fire Efficacy level at this point in time.

4.4

FIRE PREPAREDNESS VALUES: BASELINE DATA

Table 4.1 below shows the baseline values for fire preparedness derived from the survey results for the Urban and Rural segments compared to the general (household) population.

Table 4.1: Fire Preparedness: Rural/Urban Segments compared to General Population

	City	Town	Rural area	Urban (City + Town)	General Population
Indice value	5.16	5.36	7.55	5.26	5.70
N=	428	367	212	795	1007

Source: McDermott Miller Survey
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This table shows rural households having significantly higher fire preparedness than any other geographic segment. Further analysis of the data shows their fire knowledge is not materially greater than that of urban households, but the extent and scale of the equipment available to them is almost twice as much (on this scoring system) as for any urban segment. The level of fire preparedness could be correlated to the increased risk of wildfire in rural areas and the likelihood rural households are located further from local fire stations thereby requiring action on the part of householders to deal with fire incidents before the fire service responds to a call.

Table 4.2 shows the baseline values for at risk groups for fire preparedness compared to the general population.

Table 4.2: Fire Preparedness: At Risk Group Segments compared to General Population

	Low income	Maori & PI	Renter	70 yrs+	Disability	Gen pop
Indice value	5.40	6.00	4.9	6.10	6.3	5.70
N=	493	272	689	211	464	1007

Source: McDermott Miller Survey
 ©McDermott Miller Limited, 2011

Table 4.2 shows “at risk” groups, with the exception of low income households and renters, are more prepared for fire incidents than is the general population. Renters and low income households are less likely to own fire safety equipment.

With the exception of aged households, all other ‘at risk’ groups have had greater fire experience than the

general population, which increases their overall fire preparedness. Whereas, the aged and the disabled are better equipped to deal with fires than are the other 'at risk' segments and the general population.

4.5

SELF-EFFICACY VALUES: BASELINE DATA

Table 4.3 below shows the baseline self-efficacy values derived from the survey results for the Urban and Rural segments compared to the general (household) population.

Table 4.3: Self-Efficacy: Rural/Urban Segments compared to General Population

	City	Town	Rural area	Urban (City + Town)	General Population
Indice value	3.13	3.11	2.87	3.12	3.10
N=	428	367	212	795	1007

Source: McDermott Miller survey
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Table 4.4 shows the baseline self-efficacy values derived from the survey results for "at risk" groups compared to the general population.

Table 4.4: Self-Efficacy: At Risk Group Segments compared to General Population

	Low income	Maori & PI	Renter	70 yrs+	Disability	Gen pop
Indice value	3.20	3.20	3.2	3.20	3.3	3.10
N=	493	272	689	211	464	1007

Source: McDermott Miller survey
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A person's level of "self efficacy" is relatively consistent across all segments.

4.6

FIRE EFFICACY VALUES: BASELINE DATA

Fire Efficacy values are a combination of the Fire Preparedness and Self-Efficacy values.

Table 4.5 below shows the baseline Fire Efficacy values derived from the survey results for the Urban and Rural

segments compared to the general (household) population.

Table 4.5: Fire Efficacy: Rural/Urban Segments compared to General Population

Segment	City	Town	Rural area	Urban (City + Town)	General Population
Index value	8.29	8.47	10.42	8.38	8.80
N=	428	367	212	795	1007

Source: McDermott Miller survey
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- It is clear that fire preparedness (availability of equipment to fight fires, etc) is a much greater contributor to fire efficacy than confidence of householders in dealing with fires.
- This is shown by comparing the respective values of fire preparedness (5.70 for the general population) and self-efficacy (3.10) in **Tables 4.1 and 4.3** above.
- These values suggest the relationship is almost 2:1 in favour of fire preparedness.
- It is also clear that rural households have a greater fire efficacy than do urban households (10.42 in rural households compared to 8.38 in urban areas)

Table 4.6: Fire Efficacy: At Risk Group Segments compared to General Population

Segment	Low income	Maori & PI	Renter	70 yrs+	Disability	Gen pop
Index value	8.60	9.30	8.1	9.30	9.6	8.80
N=	493	272	689	211	464	1007

Source: McDermott Miller survey
 ©McDermott Miller Limited, 2011

Table 4.6 shows the baseline Fire Efficacy values derived from the survey results for “at risk” groups compared to the general population.

- Fire efficacy is higher for disabled people, aged people (over the age of 70) and Maori and Pacific Islanders than it is for the general population. The research results show this because these groups

are better prepared for fire than the population as a whole.

- This may be because Fire Service messages are reaching these “at risk” segments more than the rest of the population and they are more aware of fire risk.
- If so, this appears to have been a successful Fire Service initiative.
- In contrast, the experience of fires by disabled and aged people and their fire knowledge (gained from publication of fire safety information) is lower than that of the general population. So these groups could be said to be prepared for fire, but are not confident about dealing with fire if it occurs.

4.7

SENSITIVITY

As this is a baseline study and data from the research is only available at one time point, relative sensitivity to changes in the underlying attribute values over time can not be tested.

However, the absolute attribute values derived from the research show the “Fire Preparedness Index” is currently most influenced by fire knowledge and, second, by fire fighting equipment, whereas fire experience is almost insignificant as an influence.

Similarly, the absolute attribute values derived from the research also show the “Self-efficacy Index” is currently most influenced by self confidence and least influenced by ability to act.

The relative insignificance of fire experience and ability to act attributes reflects the extremely limited experience of the population with real fire incidents.

As the “Fire Efficacy Index” combines the other two indices, their influences affect it. However the “Fire Preparedness” value, as noted in **Section 4.4** above,

represents almost two-thirds of the “Fire Efficacy” value, using equal weighting of the six underlying attributes.

Therefore, on the basis of the present research, a change in the value of fire preparedness (especially fire knowledge and fire fighting equipment) will have a much greater impact on fire efficacy than changes in self-confidence and risk perception.

4.8

ESTIMATED INDICES

Sections 4.2-4.4 above show a total of thirty index values in three categories of Fire Preparedness, Self Efficacy and Fire Efficacy over the general population, five at risk segments and four location segments.

The overriding index values are those for Fire Efficacy. The other values help elucidate and interpret the Fire Efficacy Index values.

Table 4.7 below summarises the General Population values as at 30 June 2011 for the “Fire Efficacy Index” developed as part of this study, and its component “Fire Preparedness” and “Self-Efficacy” indices.

These values are set as the base values for an index rating for “Fire Efficacy” and each of its components. This base index rating is 100 for the “Fire Efficacy” value of 8.80, estimated on the basis carried out in this study.

	General Population Value	Initial Index Rating Number
Fire Preparedness	5.70	100
Self-Efficacy	3.10	100
Fire Efficacy	8.80	100

Source: McDermott Miller survey
 ©McDermott Miller Limited, November 2011

As changes in the underlying “self-efficacy” and “fire preparedness” values of the surveyed populations occur over time, from 5.70 and 3.10 respectively, the index rating will move above 100 (as “Fire efficacy” rises) or below the starting point of 100 (as “Fire efficacy” falls).

5. IMPLICATIONS

5.1 INDEX RESULTS

As noted in **Section 1.1**, the New Zealand Fire Service is interested in the implications this research has for its current and future fire safety educational activities. The NZFS is also interested in whether there is a link between its fire safety initiatives and an increasing tendency for people to call the NZFS for minor fire incidents.

This study is a baseline study. We are unable to rigorously test whether there is any correlation between the NZFS's fire safety educational activities and "Fire Efficacy" over time. However, such testing will be possible if household surveys are carried out to assess "Fire Efficacy" in future. Changes in "Fire Efficacy" over time can then be compared to NZFS's on-going fire safety educational activities (and its operational budget) over time.

In the meantime, there are a number of inferences and implications that can be drawn from the research results. These include:

- No evidence was found of unnecessary callouts for minor fire incidents in either the urban or rural segment or the 'at risk' segments. Findings from the focus groups and the survey showed most people try to deal with minor fire incidents on their own, at least initially.
- However, this finding needs to be tracked over time to identify if it is an increasing trend.
- Current levels of "self-efficacy" and "fire preparedness" already lead to householders fighting fires without reference to the NZFS.
- This similar level of "self-efficacy" across all segments could be a result of fire being a regular part of people's lives (e.g. BBQs, campfires, hangis,

fireworks, etc), which means, regardless of a person's capability to deal with fire, they have an innate confidence in their own ability to deal with fire incidents.

- "Fire Efficacy" appears to result in few calls to the fire service for minor fires and for medium fires as a proportion of the total number of fire incidents.
- This finding, coupled with fire incident statistics, suggests that most people (general population and 'at risk' groups) will continue to deal with medium and minor fire incidents on their own, and will only call the NZFS when they believe they can no longer deal with the situation.
- To some extent, improving self-efficacy and fire preparedness (other than facilitating exit from the property) work against the current fire safety messages of call the fire service and get out and stay out for any fire scenario.
- The situation, identified in focus groups, where participants were looking for improved knowledge of how to use their fire extinguishers and other fire equipment also works against the current fire safety message.

5.2

OTHER SURVEY FINDINGS

The results of the survey have been incorporated in the development of index values as described in **Section 4** above. However, the survey also yielded a series of other interesting results which are summarised below.

FIRE EXPERIENCE

- The vast majority of the population have had very little or no experience of household fires. Only 1.5% have experienced a major household fire, 1.6% a medium fire and 12.3% have experienced a minor fire.
- There is a much higher incidence of fire experience by Maori and Pacific Islanders for all types of household fire (18.4% experienced minor household fires, 4.4% experienced medium fires and 5.1% had

experienced major household fires). This is greater than the experience of all other segments and the general population for all household fire types.

- On the other hand, people aged 70 years and over have a much lower experience of major (1.4%) and minor (7.6%) fires than other at risk segments.

Table 4.1 below shows around 1.5% of the population in general have personally experienced a major fire, 1.6% a medium fire and 12.3% a minor fire (as defined in **Section 1**).

Table 4.1: Incidence of Fire in Residential Property by Fire Type

SEGMENT	FIRE TYPE		
	Major	Medium	Minor
General Population	1.5%	1.6%	12.3%
Maori & Pacific Islands	5.1%	4.4%	18.4%
Older (70+age group)	1.4%	2.4%	7.6%
Disabled	2.2%	1.5%	11.9%
Household income<30K	3.0%	2.2%	13.6%
Renter	2.6%	2.8%	15.4%

Source: McDermott Miller email survey, June 2011
 ©McDermott Miller Limited, 2011

FIRE RESPONSE

- No more than 50% of any segment calls 111 as its first action when fire occurs for any fire type. In other words, the majority of people do other things before calling 111 when a fire occurs, irrespective of fire type, or the prevailing NZFS fire safety message.

Table 4.2 below shows what people first do when a fire occurs, classified by fire type for the general population and selected "at risk" population segments.

Table 4.2: What People Do When a Fire Occurs

	MAJOR					FIRE TYPE MEDIUM INITIAL RESPONSE					MINOR				
	Call 111 %	get everyone out %	use a hose %	use fire extinguishing %	put fire out %	Call 111 %	get everyone out %	use a hose %	use fire extinguishing %	put fire out %	Call 111 %	get everyone out %	use a hose %	use fire extinguishing %	put fire out %
	General Population	33.3	26.7	13.3	6.7	6.7	25.0	18.8	0.0	6.3	18.8	1.6	4.8	4.0	13.7
Maori & Pacific Islands	50.0	35.7	0.0	0.0	7.1	16.7	25.0	8.3	8.3	25.0	2.0	8.0	4.0	10.0	62.0
Older (70+ age group)	33.3	33.3	33.3	0.0	0.0	40.0	0.0	0.0	0.0	20.0	6.3	6.3	0.0	12.5	56.3
Disabled	40.0	40.0	0.0	10.0	10.0	28.6	14.3	0.0	0.0	42.9	3.6	5.5	0.0	16.4	52.7
Household income <30K	33.3	46.7	13.3	0.0	6.7	18.2	18.2	0.0	0.0	36.4	1.5	7.5	4.5	17.9	49.3
Renter	44.4	44.4	0.0	0.0	11.1	15.8	31.6	5.3	10.5	21.1	2.8	9.4	2.8	13.2	57.5

Source: McDermott Miller email survey, June 2011

Note: Small sample sizes mean many of these results can only be indicative and may not be statistically reliable

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FIRE SAFETY MESSAGES

- The survey results show fire safety messages are received by households.
- However, the survey results also show:
 - NZFS fire safety messages are not followed (especially for minor and medium fires). More than 50% of the respondents' first step in response to fire was to do something other than follow the NZFS advice.
 - Respondents want to be educated about how to recognise fire risks and how to deal with them, whether they live in cities, towns or rural areas.
 - Rural people expect to look after themselves. As fire response time is so long (40-60 minutes), they try to deal with fires themselves even when the fire service has been called.

6. FINDINGS AND RECOMMENDATIONS

6.1 RESEARCH AIMS AND OBJECTIVES

This project was guided by a series of research aims and objectives. These included:

- Developing an “Index of Fire Efficacy” to measure competence in dealing with minor incidents and recognising when NZFS is needed.
- Developing a research methodology that underpins the “Index of Fire Efficacy”.
- Measuring the current level of this Index, at the national and sub-national level, as a baseline for on-going monitoring.
- Clarifying the relationship between NZFS educational activities and unnecessary call outs ;
- Refining NZFS’s fire safety educational activities to increase both self-efficacy and actual efficacy in the community; and,

Sections 3 to 5 of this report have discussed and answered the research aims and objectives for this project.

Future research topics uncovered by the research, and a research and development programme for the “Fire Efficacy Index” that will allow the NZFS to monitor “Fire Efficacy” over time, are outlined below.

6.2 SIGNIFICANCE FOR FIRE RISK MANAGEMENT

- The research results reinforce previous knowledge that householders fight fires, irrespective of Fire Service safety messages;
- The majority of minor fires are fought by householders without recourse to the Fire Service.
- Householders, therefore, already have a level of fire efficacy supported by fire preventative systems within some households, and fire fighting equipment available to them.

- The consequence of improving householders' fire efficacy will be to increase their fire fighting behaviour, mostly for small fires and to some extent for medium fires.
- In turn, this will affect the extent of risk householders take in dealing with fires, and, consequently, the risk faced by the Fire Service when it is called to a household fire.
- The key risk issue then becomes the householder's ability (or not) to recognise the state of a fire in their household, its potential development and the speed of development, and if and when to call the emergency services.
- To the extent that improved fire efficacy results in greater fire fighting by householders before calling for the fire brigade, risks will rise for both the householders and the Fire Service (as it could be called to much more developed fire incidents than has been the case in the past).
- But this risk could be offset by NZFS placing more emphasis on community fire education to try and increase the fire-fighting and fire recognition capability of the population.

6.3

POTENTIAL IMPACT ON DEMAND FOR NZFS RESOURCES

- The stakeholder research indicates Fire Efficacy will be improved as a result of educating householders to better recognise fire risk situations, and if the fire preventative and containment equipment available to them is improved, and they learn how to use the equipment safely.
- Extending the Fire Service's present safety education programmes to teach householders to use the fire fighting equipment available to them (eg fire extinguishers), coupled with fire risk recognition, might require greater resource in terms of people and funding for these programmes.
- Extending fire safety education programmes to improve "Fire Efficacy" simply would require moderation of the current policy of concentrating

on the prime fire safety messages of *call the fire service* and *get out and stay out*, to include recognising fire situations where containment equipment can be used safely.

6.4

FUTURE RESEARCH TOPICS

- Evaluating the weighting of attributes in the index values and consequently in the indices themselves.
- Testing fire efficacy in public, commercial, industrial and rural (wild fire) situations.
- Testing the strength of the correlation indicated by the stakeholder (focus groups) research, but not tested in the household survey, of the Fire Service's fire safety educational activities with fire efficacy over time by undertaking further surveys of households' self-efficacy and fire preparedness.
- And, most challenging of all, researching effective ways of educating households to recognise fire situations where fire containment equipment can be used safely.

6.5

FUTURE RESEARCH PROGRAMME

- Monitoring "Fire Efficacy" over time can be achieved by:
 - Replicating the nation-wide household survey used in this study by adapting it for delivery by email link to a Fire Service website;
 - For maximum effect the Fire Efficacy survey should be repeated in two to three years time in order to accurately evaluate the weightings of the index values and their attributes
 - Once the Index weightings have been determined the Fire Efficacy survey should be replicated every five to seven years thereafter. It is our opinion that Fire Efficacy will remain relatively stable over the short term.
- Running the Fire Efficacy survey on a time series basis will allow the results of the survey to estimate new values for fire preparedness and self-efficacy

at the selected time period;; and, determine new index ratings for new time periods in accordance with the method set out in **Sections 3.4 to 3.7** and **4.2** above.

- Consistency of results will be reached by using the same questions as used in the survey underlying this study, and securing similarly representative samples.

6.6

RECOMMENDATIONS

Given people's propensity to deal with medium and minor fire incidents on their own and their expressed desire to improve their fire knowledge, NZFS could choose to 'go with the flow' and follow the example of Australia and USA by increasing community involvement in fire prevention, containment and safety education as a way to increase a community's "Fire Efficacy".

We must conclude, however, with a note of caution. This research has not indentified a causal link between NZFS's fire safety campaigns and a household's level of "Fire Efficacy". But, if NZFS were to change their fire safety messages by also emphasising community education, safe use of fire equipment and recognition of the seriousness of different types of fire incidents, over an exclusive message of '*get out and stay out*', and then track levels of "Fire Efficacy" across the population over time, a casual link (or alternatively no causal link) might be identified.

FINAL REPORT

Changes in community self-reliance and implications for fire safety messages and emergency response

**Report by McDermott Miller *Strategies*
to New Zealand Fire Service**

30 November 2011

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ABSTRACT:

New Zealand Fire Service (NZFS) incident statistics indicate that campaigns to encourage people to call 111, and other fire safety education initiatives, can lead to increases in false alarm callouts. Such calls can have adverse consequences for the Fire Service, most seriously the potential for demotivation of volunteer fire-fighters if they are called too frequently from their normal activities to attend inconsequential “emergency” events. The aims of this research include gaining insights for refining NZFS’s fire safety educational activities to increase “Fire Efficacy” in the community. The research programme involves: initial consultation and literature review, development of an “Index of Fire Efficacy”; development of a market research methodology to generate this Index; and, conducting an initial survey to act as a baseline for ongoing monitoring. The report concludes with recommendations on how NZFS can increase “Fire Efficacy” with respect to fire safety in the community.

1. SCOPE OF THE RESEARCH

1.1 INTRODUCTION

McDermott Miller was commissioned by the New Zealand Fire Service (NZFS) in March 2011 to assess *Changes in Community Self-Reliance and Implications for Fire Safety Messages and Emergency Response* as part of NZFS's 2010-2011 Contestable Research Fund.

The purpose of this research, the methodology used to achieve its purpose, results obtained and implications for fire safety messages and emergency response are contained in the following sections of this report.

1.2 DEFINITIONS

The following definitions of "fire preparedness" and "self-efficacy" have been adopted for the purposes of this research:

FIRE PREPAREDNESS

Individual knowledge about and experience in dealing with fire incidents coupled with a person's fire fighting equipment available in the home (refer Section 2.1).

SELF-EFFICACY

The belief in one's capability to organise and execute the courses of action required to manage prospective [fire] situations (Source: Bandura, refer Section 2.1).

"Fires" were classified into three groups for the purpose of the research, these are defined as:

- **Minor:** a fire incident which causes no damage to your home.
- **Medium:** a fire incident which has damaged the walls, ceilings, floors of your home, but not to the point where it needs to be replaced

- **Major:** A fire incident which has damaged the walls, ceilings or floors of your home to the point where it needs to be replaced.

1.3 RESEARCH AIMS

The aim of the research is to achieve:

- a baseline “Index of Fire Efficacy” to measure existing self-efficacy and actual efficacy;
- clarification of the relationship between New Zealand Fire Service (NZFS) educational activities and unnecessary call outs ;
- insights for refining NZFS’s fire safety educational activities to increase both self-efficacy and actual efficacy in the community; and,
- a scoped and costed Fire Efficacy monitoring research programme.

1.4 RESEARCH OBJECTIVES

The research objectives of the project are to:

- develop an “Index of Fire Efficacy” to measure competence in dealing with minor incidents and recognising when the NZFS is needed.
- develop a research methodology that underpins the “Index of Fire Efficacy”.
- measure the current level of this Index, at the national and sub-national level, as a baseline for on-going monitoring.

1.5 BACKGROUND

NZFS incident statistics indicate that campaigns to encourage people to call 111, and other fire safety education initiatives both at the national and urban and rural community levels, lead to increases in call-outs. It appears some members of the community are

motivated by these campaigns to call the NZFS to relatively minor incidents which they could have dealt with themselves; by the time the NZFS arrives the incident may have been successfully dealt with. False alarms and other unnecessary calls-outs have adverse consequences for the NZFS, including the resource cost of the call-out and potential for de-motivation of volunteer fire-fighters (with possible consequential retention and recruitment problems) if they are called too frequently from their normal activities to attend inconsequential “emergency” events. This problem might be particularly acute in rural communities, due to the NZFS’s reliance on volunteer fire-fighters and the increased response times and distances involved.

Ideally, the NZFS’s fire safety education should lead to a reduction in incidents and resultant call-outs, or at least no increase. This means fire safety education should aim at supporting efficacy in the community in handling minor incidents. Individuals and households would acquire the capacity to recognise when NZFS really is required, and hence the confidence to deal with minor matters themselves. Supporting “self-efficacy” (self-confidence in handling minor matters) is not sufficient to achieve the NZFS’s mission of reducing the consequence of fire. The NZFS must also aim for improvement in actual efficacy (real competence in dealing with minor incidents) – particularly in rural areas where response times can be substantially longer than in cities. At the same time it needs to avoid an increase in ill-founded or mistaken self-efficacy that could have serious consequences – such as injuries and delays in calling 111 when the NZFS really is required.

The National Fire Risk Management Plan (June 2010) states (p 19) “From our Fire Knowledge Survey we know that New Zealand Fire Service only attends 7% (2011 figure) of all fires. We are attending a greater percentage of all fires whilst still minimising the extent of the damage. This means more people are calling the NZFS to fires.”

The New Zealand Fire Service Commission Statement of Intent 2010/2013 states (p 29) under the heading "Value for Money":

"The marginal financial cost to NZFS of responding to another incident is very low relative to the cost already incurred in standing ready to respond."

However, it then notes that this view is incomplete:

"This approach has its limitations as the marginal cost to a volunteer (or an employer of a volunteer) of responding to another incident may be significant in terms of loss of family/leisure time (or productivity)."

This marginal cost that the trained, experienced volunteer and/or his family and employer bear will become a real cost to NZFS if s/he leaves the Service due to the significant "marginal costs" they are expected to bear – a replacement must be recruited and trained, and if a replacement cannot be found (or until one is trained and comparably experienced) there is a danger that achievement of the NZFS's goals may be compromised.

1.6

SUMMARY DESCRIPTION OF METHOD

Six core tasks are covered in McDermott Miller's research programme. These tasks are designed to achieve the aims and objectives set out above, as follows:

Task 1. Literature review of relevant texts:

We reviewed NZFS reports, other relevant New Zealand and overseas literature, including both theory and case-studies on:

- how "self-efficacy" has been measured in other countries as a guide to our research design;
- actions that have been taken by other fire services to improve "self-efficacy"; and,
- how effective these actions have been.

Task 2. Consultation on “self-efficacy”:

The second research task involved consultation with Senior NZFS Managers and Executive Officers to discuss the evidence for declining “self-efficacy”, where it has been observed, and how severe a challenge it is for NZFS.

This was followed by a series of focus groups with ‘Urban’, ‘Rural’ and ‘Maori and Pacific Island’ communities. The focus groups helped clarify community perceptions and guide design of the survey instrument for the quantitative research.

Task 3. Statistical Analysis of “self-efficacy” effects:

In this task we worked with Fire Service Information Analysts to quantify the challenges posed by changes in “self-efficacy”, including drawing on the existing SMS Incident Database and market research survey data, to identify communities most “at risk”.

Task 4. Develop Index of Fire Efficacy:

Here we developed a “**Fire Efficacy Index**”, which measures household competence in dealing with fire emergencies appropriately, whether or not this involves a 111 call. This index facilitates:

- cross-sectional comparisons between regions and communities (including comparisons between urban and rural communities); and,
- longitudinal comparisons, i.e. monitoring of changes over time, from the benchmarks established the research proposed here.

Task 5. Conduct an initial survey to act as a baseline for ongoing monitoring.

We undertook an email survey of our “**Fire Efficacy Index**” with the General Population and certain ‘at-risk’ groups. We then analysed the data and calculated the Index of Fire Efficacy and its constituent Indices.

Task 6. Interpretation and Reporting

The research culminates with findings and recommendations from the consultation, review and survey results.

1.7

OUTLINE OF REPORT

Section 2 of this report discusses the research that underpins the conceptual development of McDermott Miller's Fire Efficacy Index. The research involved a literature review, stakeholder consultation and statistical analysis of NZFS incident data.

Section 3 discusses the conceptual development of McDermott Miller's Fire Efficacy Index;

Section 4 shows the underlying calibration of respective indices ('Self-Efficacy' and 'Fire Preparedness' Indices); and, contains the Index results of McDermott Miller's survey of the general population and "at risk" household segments;

Section 5 outlines the implications for the NZFS current and future fire safety educational activities to improve self-efficacy and fire preparedness by households.

Section 6 reports McDermott Miller's findings and recommendations.

This report should be read in conjunction with its companion *Technical Report on Changes in community self-reliance and implications for fire safety message and emergency response* dated November 2011 which covers:

- methodology used in the literature review;
- methodology used in the stakeholder research;
- analysis of existing Fire Service data relevant to the study;
- tabulated survey results;
- bibliography;

- attributes of the Fire Preparedness and Self-Efficacy indices; and,
- survey specifications.

2. RESEARCH UNDERPINNING THE INDEX

2.1 LITERATURE REVIEW OF RELEVANT TEXTS

McDermott Miller reviewed NZFS reports, other relevant New Zealand and overseas literature, including both theory and case-studies. The review clarified:

- the definition of "self-efficacy" and its recognised drivers;
- how "self-efficacy" is measured in other countries;
- actions that have been taken by other fire services to improve "self-efficacy"; and,
- how effective these actions have been.

The themes are discussed below.

SELF-EFFICACY AND ITS DRIVERS

"Self-efficacy" is a construct derived from social cognitive theory, which posits that behaviour, cognition and the environment all influence each other in a dynamic fashion (Bandura, 1977; 1986). "self-efficacy" is defined as the 'belief in one's capabilities to organise and execute the courses of action required to manage prospective situations' (Bandura, 1995 p2). The "self-efficacy" construct is considered to have generative capabilities where it is capable of influencing thought patterns, emotional reactions, and orchestration of performance through the adroit use of sub skills, ingenuity, and resourcefulness (Gist et al, 1992). "Self-efficacy" is a dynamic construct, where efficacy judgement changes over time as a result of acquiring new experiences and information (Gist et al, 1992).

"Self-efficacy" is considered an important motivational construct. It influences individual choices, goals, emotional reactions, effort, coping and persistence. There is an accepted way to measure the self efficacy construct (Bruner, 2009) but a person's level of "self-efficacy" can also be influenced or change as a result of learning, experience and feedback (Gist et al, 1992).

An accepted scale of “self-efficacy” has been adopted by the marketing fraternity (Bruner, 2009). This scale has been used to measure self efficacy in education, sport and organisational research (Gist et al, 1992). Other studies (Bandura, 2006; Lee & Bobko, 1994) have found that using this accepted scale, but also scoring the strength of each item, strengthens the overall reliability of the “self-efficacy” rating.

IMPROVING SELF-EFFICACY: INTERNATIONAL FIRE SERVICE EXAMPLES

There is a trend in Australia and the USA towards increased community involvement in fire education and safety as a way to increase a community’s fire preparedness (Beatson et al, 2010; Rohrmann, 1999; RMIT University, 2009). A past example is the Country Fire Authority of Victoria which introduced the “Community Fireguard” program, which is based on community involvement and aimed at enhancing individual responsibility for fire safety and survival strategies (Rohrmann, 1999).

Recently, CRC Australia commissioned RMIT University to complete a five year project to evaluate Bushfire Community Education Programs (Project C7). The objective of this project was to develop and test a comprehensive framework and methodology for evaluating the broad range of bushfire community safety policy and programs in Australia, highlighting (i) an approach that has the potential to lead to a comprehensive and sound evidence base for identifying which policies and programs work best, for whom and in what settings; and (ii) the provision of a consultative and collaborative approach to working with end-users and community members (RMIT University, 2009). The outcomes of the C7 project highlighted the importance of a community safety approach. It advised the approach to be embedded in the policy and planning for bushfire community safety across Australia (RMIT University, 2009).

2.2

CONSULTATION ON “SELF-EFFICACY”

The second research task involved consultation with Senior NZFS Managers and Executive Officers. Here we

discussed the evidence for declining “self-efficacy”, where it has been observed, and how severe a challenge it is for NZFS.

This consultation process revealed:

SENIOR NZFS MANAGERS AND EXECUTIVE OFFICERS:

- There is an internal NZFS debate about the extent to which the fire service should educate communities about recognising and dealing with fire incidents on their own.
- Some Managers and Executive Officers believe there is a risk of increasing dependence on the fire service through the provision of safety advice and equipment. A stated example of this is fire stations/fire-fighters installing smoke alarms in peoples homes. This action is considered to lead to an increased expectation by residents that the fire service will continue to maintain their smoke alarms.
- Some communities/householders appear to react to this support by taking the view that they need do nothing for themselves and rely entirely on the fire service.
- “Self-efficacy” in urban areas is unlikely to be as high as in rural areas because of shorter NZFS response times in urban areas and greater knowledge and experience of fires in rural areas.
- However, the increasing numbers of city-originated “lifestylers” who buy small parcels of land and build houses on them have a much lower knowledge of fire hazards on the land and therefore do not build precautions against fire into their houses or acquire suitable equipment to help contain fire.
- Moreover, they often assume access to and availability of the fire service is the same in rural areas as it is in the city they came from.
- “Lifestylers” slip through the training/information loop about rural fire hazards because there are no comprehensive networks to catch them for this purpose.

- As a result “lifestylers” often inadvertently and unknowingly raise the risk of structural damage from fire to their own and other properties and are not good at making the appropriate “stay/go” decision when faced with a rural fire.

Consultation with NZFS Managers and Executive Officers was followed by a series of focus groups with ‘Urban’, ‘Rural’ and ‘Maori and Pacific Island’ communities. The focus groups were used to clarify community perceptions and to obtain guidance for design of the survey instrument for the quantitative research.

Below is a summary of the findings for each group:

‘URBAN’ DWELLERS:

- No one in this group had ever called the fire service and no one had been personally involved with fire.
- The most common form of interaction with fire safety is work-related fire drills. Many of the group are fire wardens at their place of work. Although, this does not necessarily correlate to experience with the NZFS.
- The majority of the group do not have fire equipment in their home, but they all recognise that they should have smoke alarms.
- Some were in the process of installing smoke alarms in their homes. For others, awareness of the need for smoke alarms is not incentive enough to install smoke alarms in their own homes, this tends to be because they do not believe they are ‘at risk’ of house fires.
- Some respondents admitted being more fire safety conscious when they had young families.
- The respondent who was most fire safety conscious had a rural background (grew up on a farm) but also had a young family.
- The group recognises that a major fire in their home was something they would not have the capability to deal with.

- If faced with a major fire, they would get everyone out of the house and call the fire service.
- A medium level fire (e.g. cooking fire), or a minor fire (e.g. smoking light bulb) are fire incidents respondents recognise as something they could deal with and indicated they would try to put out the fire themselves first before calling the NZFS.
- The group recalled many of NZFS's promoted messages. Their main understanding of these messages was to never leave fire/cooking unattended and if fire starts to leave the house and call the NZFS.
- The group expressed a desire for an education campaign that taught people more about how to deal with fire and fire equipment in certain situations.
- This suggestion was made after respondents admitted to dealing with minor (and in some cases medium) fire incidents in their homes, but also admitting their knowledge about how to deal with these situations safely was limited.

'RURAL' DWELLERS:

- There seems to be little relationship between NZFS educational/communication campaigns and unnecessary callouts for this group.
- Less likely to experience unattended cooking fires, fires caused by cigarettes or kitchen fires.
- They tend to be some distance from the fire station, and are aware that most of firemen are volunteers; as a result they are less likely to call NZFS for minor incidents.
- Generally well-equipped with fire extinguishers and smoke alarms. Most know how to use a fire extinguisher.
- However, if there was smoke billowing under the door, there was awareness that the fire must therefore have become so major that it was beyond putting out independently and assistance was needed.

- Saving one's own life and then those of any others in the home in the event of a major fire would become the first priority.
- This group tended to deal with minor and medium fires on their own.
- Suggestions made that the NZFS could do more public speaking, demonstrations of use of fire extinguishers, advice on smoke alarms, safety measures, to various groups in the Wairarapa rural area.

'MAORI AND PACIFIC ISLANDERS':

- NZFS educational/communication messages conveyed the following messages:
 - Caution with home cooking
 - Speed with which fire spreads
 - NZFS is available when you need the service and friendly.
- Aware that, if it is a major fire, all you can do is call the NZFS.
- If it is a medium or minor fire it needs to be put out very quickly and respondents will take whatever reasonable measures they can to put out these types of fires.
- A significant number of respondents reported that they would be 'too shy' to ring the Fire Service for a minor incident. Fire officers are held in high esteem and respondents did not want to seem "stupid" or that they might have made a mistake calling the Fire Service.
- This community is less likely to have fire extinguishers and working smoke alarms than higher socio-economic groups.
- The group felt NZFS TV advertisements are effective in providing education about precautionary measures, i.e. how to avoid a fire, rather than how to put a fire out.
- Believe that more NZFS staff with a Maori and Pacific Island cultural understanding would be helpful for the

Fire Service to be more pro-active in those communities.

2.3

STATISTICAL ANALYSIS OF "SELF-EFFICACY" EFFECTS

For this task we worked with Fire Service Information Analysts to quantify the challenges posed by changes in "self-efficacy", including drawing on existing SMS Incident Database to identify trends in fire incidents.

NEW ZEALAND FIRE SERVICE INCIDENT DATA

In the year ending 30 June 2011, NZFS attended 59,140 "incidents". This was around 4.2% fewer incidents than attended in 1999.

Up until the 2011 financial year, all incidents attended by the New Zealand Fire Service had been growing by around 1.5% per annum. However 2011 year incident data shows the smallest number of incidents in the whole twelve year period, and a reversal of trend across all regions, other than Region 4, since 1999.

This is because **XXX**

Table 2.1 below summarises these incident numbers for each of the twelve years 1999-2011 for each of the current five fire regions.

Table 2.1: Incident Data by Fire Region 1999-2011

FIRE REGION	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Annual Growth Rate
Region 1	19,649	19,494	19,408	20,027	19,766	20,201	20,758	21,436	22,436	22,516	20,938	21,872	17,447	-1.00%
Region 2	9,190	8,895	9,119	9,857	9,718	9,682	10,301	10,353	11,253	11,585	10,813	11,270	9,000	-0.02%
Region 3	17,823	17,319	18,907	17,360	18,462	19,505	17,854	19,713	20,445	20,120	18,266	18,691	15,054	-1.40%
Region 4	9,275	9,886	10,941	10,239	11,116	10,958	10,959	11,708	12,328	12,387	11,745	15,178	12,712	2.66%
Region 5	5,797	5,133	5,293	5,429	5,623	5,653	5,978	6,331	6,992	6,121	5,870	6,503	4,927	-1.35%
NZFS	61,734	60,727	63,668	62,912	64,685	65,999	65,850	69,541	73,454	72,729	67,632	73,514	59,140	-1.36%

Source: New Zealand Fire Service

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The following **Table 2.2** shows the average number of incidents over the 2006-2010 year period (please note 2009 has incomplete data for that year as a result of industrial action by fire-fighters).

Table 2.2: Incident Data by Incident Type 2006-2010

Incident Types	Average Annual Incidents 2006-2010	SHARE
All Fires	24,143	33%
Hazardous Emergencies	5,101	7%
Overpressure, Rupture, Explosives, Over Heating	570	1%
Rescue, Emergency, Medical Call	10,238	14%
Special Service Calls	4,657	6%
Natural Disasters	2,492	3%
False Alarms	26,696	36%
Not Recorded	35	0%
TOTALS	73,932	100%

Source: New Zealand Fire Service
 ©McDermott Miller Limited, August 2011

The data underlying **Table 2.2** revealed fires and false alarms continue to be the largest share of annual incidents, and that rescue, emergency and medical calls are the fastest growing group of incidents.

NZFS ATTENDANCE AND TOTAL FIRE OCCURRENCE

Table 2.3 below shows: NZFS is notified about fewer than half the unwanted fires of any type that occur in New Zealand; attends on average around 20% of the fires in residential property that are reported to the NZFS; and, attends on average around 35% of rural fires that are reported, and puts out only a proportion of the fires that are attended.

Table 2.3: Percentage of unwanted fires reported and subsequently attended to by NZFS

Year	FIRE	
	In Home	Outside
1999	17%	38%
2000	19%	19%
2001	11%	40%
2002	9%	29%
2003	10%	34%
2004	14%	35%
2005	16%	44%
2006	25%	40%
2007	21%	48%
2008	18%	38%
2009	12%	32%
2010	11%	39%

Source: NZFS, May 2011
 ©McDermott Miller Limited, August 2011

2.4

SUMMARY

The literature review and the stakeholder consultation revealed a need to not only measure 'self efficacy' but also to measure other factors which affect a person's ability and confidence to deal with fire incidents.

We have used Bandura's (2006) and Bruner's (2009) accepted scale of self-efficacy to measure New Zealander's level of self efficacy in relation to fire incidents. This scale makes up the "Self-efficacy" component of McDermott Miller's 'Fire Efficacy Index' (refer **Section 3** for further explanation).

The literature review and stakeholder consultation indicates a need also to measure a person's level of knowledge, experience and other environmental factors pertinent to fire behaviour.

To measure these factors a second measurement scale is required ("Fire-preparedness Index"). This scale measures the respondent's amount of fire experience and their level of prior knowledge about fire and the amount of fire equipment they have in their home. Some of these constructs have been measured in previous studies by: Srinivasan & Ratchford (1991) re.

experience; and, Beatty & Smith (1987), Bettman & Park (1980), Brucks (1985) re. prior knowledge. These studies have helped inform the design of our fire-preparedness index. We also used the NZFS Fire Knowledge Survey and findings from our consultation with NZFS officials to aid the design of the “Fire-preparedness Index”.

3. DEVELOPMENT OF FIRE EFFICACY INDEX

3.1 SCOPE

This section defines the scope of the research, fire preparedness and “self-efficacy”, which are the qualities we are seeking to test in this study and outlines the approach adopted to establishing indices to measure changes in their individual and combined values over time.

This research and the resulting indices relate to fires in household structures only. They do not relate to bush fires; ‘outside’ fires; or other property damaged as a result of fire (e.g. cars, sheds, barns).

Fires or fire risk in commercial, industrial and other public structures as well as wildfires, grass fires or other open air fire or fire risk situations are excluded from the research.

The research tests a person’s level of fire knowledge and belief in their own capabilities of handling a fire event in their own household. Additionally, the research measures the amount of working fire equipment a person has in their household. Throughout the report we refer to this as a ‘household’s’ level of Fire Efficacy.

3.2 BACKGROUND

The “**Index of Fire Efficacy**” is a function of two constituent indices; these are:

- The “**Index of Fire Preparedness**” – is an indicator of households’ actual competence to deal with incidents appropriately. It is constructed from responses to questions on household fire safety preparations, fire alarms and extinguishers, evacuation plans, routines for checking fire alarms, and knowledge about how to use equipment.

Experience with household fires and awareness of when NZFS should be called, and what to do after calling (especially in rural areas), also enter this Index.

- The “**Index of Fire Self-Efficacy**” - has been constructed from a series of questions on respondent’s belief that they can deal with a fire incident appropriately, whether or not this involves a call to the fire service.

Sections 3.4-3.7 below show how the indices are built up from valuing attributes relevant to fire preparedness and self-efficacy respectively, weighting the attributes according to their relative significance, and using the resulting values to establish baseline index levels.

3.3

INDEX OF FIRE PREPAREDNESS

For the purposes of this study “fire preparedness” is defined in terms of three attributes which are:

- an individual’s fire knowledge;
- the fire prevention/control equipment and set-up at their residence (or workplace); and,
- their experience (if any) in actual fire incidents.

These attributes are described in greater detail in the attached **Technical Report: Annex II – Index Attributes**.

Each attribute has a value, which is expressed as:

$$f(FK \text{ or } E \text{ or } XP)_t = \left(\sum_{SA=1}^k (\mu.V(SA) + \epsilon)_k \right)_t$$

where:

FK = Fire Knowledge attribute.

E = Equipment attribute

XP = Experience attribute

μ_k =weighting coefficient for sub-attribute k=1...K

$V(SA)_{kt}$ = value of sub-attribute $k=1...K$ at time t revealed by the research results.

ϵ_{kt} = error factor for sub-attribute k at time t

t = time periods $1...N$.

These attribute values are combined to determine a **fire preparedness value** ("PV" below) as:

$$fPV_t = a.f(FK)_t + b.f(E)_t + c.f(XP)_t + \epsilon_t$$

where:

a , b and c are weighting coefficients

$f(FK)_t$ is the Fire Knowledge value at time $t=1...N$

$f(E)_t$ is the Equipment and set-up value at time $t=1...N$

$f(XP)_t$ is the Experience value at time $t=1...N$

ϵ_t is the error factor at time $t=1...N$

Initial baseline value is when time $t=1$

Subsequent measurements of Fire Preparedness values will take place at time $t=2,3,4...N$

The **Fire Preparedness Index** ("PI" below) compares changes in the Fire Preparedness Value over time and is determined as:

$$fPI_t = [fPV_t / fPV_{t-1}] * 100$$

where:

PV is the Fire Preparedness Value at time, $t=1...N$

Initial baseline index level determined when time=1 is 100.

Subsequent measurements of Self-Efficacy will take place at times=2, 3, 4...N

3.4

INDEX OF FIRE SELF-EFFICACY

As noted earlier we are using Bandura's definition of "self-efficacy" for the purposes of this study, being *the belief in one's capabilities to organise and execute the courses of action required to manage prospective [fire] situations.*

The fire self-efficacy index developed as a result is determined in terms of three principal attributes which are:

- Risk perception or the ability to recognise and assess fire danger
- Self-confidence
- The ability to act under pressure.

These attributes are described in greater detail in the attached **Technical Annexe II**.

Each of these attributes has a value, expressed as:

$$f(RP \text{ or } SC \text{ or } AA)_t = \left(\sum_{SA=1}^m (\delta \cdot V(SA) + \epsilon)_m \right)_t$$

where:

RP = Risk Perception attribute.

SC = Self-Confidence attribute

AA = Ability to Act attribute

δ_m = weighting coefficient for each sub-attribute $m=1...M$

$V(SA)_{mt}$ = value of each sub-attribute $m=1...M$ derived from research results at time $t=1...N$

These attributes are combined to determine a Self-Efficacy Value ("SV") expressed as:

$$fSV_t = v \cdot f(RP)_t + w \cdot f(SC)_t + x \cdot f(AA)_t + \epsilon$$

where:

v , w , and x are weighting coefficients

$f(RP)_t$ is the value of the Risk Perception attribute at time $t=1...N$

$f(SC)_t$ is the value of the Self-Confidence attribute at time $t=1...N$

$f(AA)_t$ is the value of the Ability to Act attribute at time $t=1...N$

ϵ_t is the error factor at time $t=1...N$

The Self-Efficacy Index ("SI" below) compares changes in Self-Efficacy values over time and is expressed as:

$$fSI_t = [fSV_t / fSV_{t-1}] * 100$$

where:

SV_t is the Self-Efficacy Value at time $t=1...N$.

Initial baseline index level determined when time $t=1$ is 100.

Subsequent measurements of Self-Efficacy will take place at times=2, 3, 4...N.

3.5

INDEX OF FIRE EFFICACY

The Index of Fire Efficacy combines the values underlying the Indices of Fire Preparedness and Self-Efficacy to give a single overall value.

This overall index can be expressed as:

$$FE_t = y.PI_t + z.SI_t$$

where:

PI_t and SI_t are values determined in **Sections 3.3** and **3.4** respectively, and y and z are weighting coefficients.

3.6

WEIGHTING

The initial starting point in estimating values in this study is to assume all attributes rank equally, that is, all the weighting coefficients in the value formulae above have a value of 1.

But the attributes in the "Fire Preparedness" and the "Self-Efficacy" Indices and the combination of the two to obtain an overall Index of Efficacy could be weighted to reflect the relative significance of each attribute within the respective indices.

These possible weightings need to be derived either from on-going research or from the perception of relative significance from NZFS's professional evaluation.

4. INDEX CALIBRATION

4.1 OUTLINE

The literature review and stakeholder consultation informed the conceptual design of the "Fire Efficacy Index". But the critical stage of research comes from a nation-wide survey of the general population, 'at-risk' segments and rural residents. This survey provides the data input to McDermott Miller's conceptual "Fire Efficacy Index".

4.2 SURVEY INPUT

A nation-wide email survey of the general population and selected "at risk" segments was undertaken over the May-June 2011 period. The survey obtained respondents' assessments of their preparedness for a fire, their experience of fires, their knowledge of fire safety messages and other fire safe practices and their likely behaviour when faced with a fire.

The populations surveyed included the nation-wide general population (all households) together with a number of "at risk" households as summarised below.

The full sample size was 1990 persons. Valid responses received for the selected segments, (final quotas for segments are interlocking, i.e. respondents can belong to more than one segment), are noted below:

Segment:	Valid Responses Received (n=)
General population:	1007
Rural population:	534
Low income: (below \$30K per annum)	493
Maori and Pacific Islanders:	272
Renters:	689
People with disabilities:	464
Older people (age 70yrs+):	211

The survey methodology and specifications are described more fully in the attached **Technical Report: Annexe III – Survey Specifications**.

4.3

METHOD OF INDEX CALIBRATION

The values underlying Fire Efficacy, Self-Efficacy and Fire Preparedness indices are estimated by:

- Applying scores to the results of the survey to determine values for the underlying attributes of each index. This has been done by assigning scores ranging from +1 to -1 to each survey respondent's answers to each question in the survey that underlies the various attributes defined in **Sections 3.4-3.6** above.
- These individual scores are then summed to obtain an overall estimated attribute value.
- Assuming the weighting of attributes is 1 (as noted in **Section 3.7** above), the resulting attribute values are summed to obtain the respective Fire Preparedness and Self-Efficacy value estimates.
- Again, assuming Fire Preparedness and Fire Efficacy values are equally important (i.e. weighting between these index values is 1 as noted in **Section 3.7** above), their index values are summed to obtain the overall estimated Fire Efficacy Value.
- This process is undertaken to estimate Fire Preparedness, Self-Efficacy and Fire Efficacy values for:
 - the general household population;
 - rural and urban segments of the population; and,
 - at risk segments of lower income (<\$30,000 annual income), aged (70+ years), Maori and Pacific Islanders, disabled and renter households.

- The resulting index values are tested for sensitivity to changes in weighting assumptions.
- Finally, initial index values are assigned a nominal index rating of 100 as the starting point for each of them.

All initial index values developed from this research are set at a value of 100 as the starting point. Changes in the underlying efficacy and preparedness values of the surveyed populations will be reflected in movements of the index values above (as efficacy rises) or below (as efficacy falls) the starting point index value of 100.

The initial baseline index values are set as at June 2011.

For example, the general population fire efficacy value of 8.80 as shown in **Table 4.5** below is the value underlying the fire efficacy index rating of 100 as at 30 June 2011.

The following **Sections 4.3-4.5** summarise the Index Values derived from the survey results following the process outlined above.

Please note: a higher index figure indicates a higher level of Fire Efficacy (including a person's level of "self-efficacy" and "fire preparedness"). Conversely, a lower index figure indicates a lower level of Fire Efficacy. This research identifies a baseline index result, the final index result is not necessarily the ideal figure but merely the general population at "at risk" segments Fire Efficacy level at this point in time.

4.4

FIRE PREPAREDNESS VALUES: BASELINE DATA

Table 4.1 below shows the baseline values for fire preparedness derived from the survey results for the Urban and Rural segments compared to the general (household) population.

Table 4.1: Fire Preparedness: Rural/Urban Segments compared to General Population

	City	Town	Rural area	Urban (City + Town)	General Population
Indice value	5.16	5.36	7.55	5.26	5.70
N=	428	367	212	795	1007

Source: McDermott Miller Survey
 ©McDermott Miller Limited, 2011

This table shows rural households having significantly higher fire preparedness than any other geographic segment. Further analysis of the data shows their fire knowledge is not materially greater than that of urban households, but the extent and scale of the equipment available to them is almost twice as much (on this scoring system) as for any urban segment. The level of fire preparedness could be correlated to the increased risk of wildfire in rural areas and the likelihood rural households are located further from local fire stations thereby requiring action on the part of householders to deal with fire incidents before the fire service responds to a call.

Table 4.2 shows the baseline values for at risk groups for fire preparedness compared to the general population.

Table 4.2: Fire Preparedness: At Risk Group Segments compared to General Population

	Low income	Maori & PI	Renter	70 yrs+	Disability	Gen pop
Indice value	5.40	6.00	4.9	6.10	6.3	5.70
N=	493	272	689	211	464	1007

Source: McDermott Miller Survey
 ©McDermott Miller Limited, 2011

Table 4.2 shows “at risk” groups, with the exception of low income households and renters, are more prepared for fire incidents than is the general population. Renters and low income households are less likely to own fire safety equipment.

With the exception of aged households, all other ‘at risk’ groups have had greater fire experience than the

general population, which increases their overall fire preparedness. Whereas, the aged and the disabled are better equipped to deal with fires than are the other 'at risk' segments and the general population.

4.5

SELF-EFFICACY VALUES: BASELINE DATA

Table 4.3 below shows the baseline self-efficacy values derived from the survey results for the Urban and Rural segments compared to the general (household) population.

Table 4.3: Self-Efficacy: Rural/Urban Segments compared to General Population

	City	Town	Rural area	Urban (City + Town)	General Population
Indice value	3.13	3.11	2.87	3.12	3.10
N=	428	367	212	795	1007

Source: McDermott Miller survey
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Table 4.4 shows the baseline self-efficacy values derived from the survey results for "at risk" groups compared to the general population.

Table 4.4: Self-Efficacy: At Risk Group Segments compared to General Population

	Low income	Maori & PI	Renter	70 yrs+	Disability	Gen pop
Indice value	3.20	3.20	3.2	3.20	3.3	3.10
N=	493	272	689	211	464	1007

Source: McDermott Miller survey
©McDermott Miller Limited, 2011

A person's level of "self efficacy" is relatively consistent across all segments.

4.6

FIRE EFFICACY VALUES: BASELINE DATA

Fire Efficacy values are a combination of the Fire Preparedness and Self-Efficacy values.

Table 4.5 below shows the baseline Fire Efficacy values derived from the survey results for the Urban and Rural

segments compared to the general (household) population.

Table 4.5: Fire Efficacy: Rural/Urban Segments compared to General Population

Segment	City	Town	Rural area	Urban (City + Town)	General Population
Index value	8.29	8.47	10.42	8.38	8.80
N=	428	367	212	795	1007

Source: McDermott Miller survey
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- It is clear that fire preparedness (availability of equipment to fight fires, etc) is a much greater contributor to fire efficacy than confidence of householders in dealing with fires.
- This is shown by comparing the respective values of fire preparedness (5.70 for the general population) and self-efficacy (3.10) in **Tables 4.1 and 4.3** above.
- These values suggest the relationship is almost 2:1 in favour of fire preparedness.
- It is also clear that rural households have a greater fire efficacy than do urban households (10.42 in rural households compared to 8.38 in urban areas)

Table 4.6: Fire Efficacy: At Risk Group Segments compared to General Population

Segment	Low income	Maori & PI	Renter	70 yrs+	Disability	Gen pop
Index value	8.60	9.30	8.1	9.30	9.6	8.80
N=	493	272	689	211	464	1007

Source: McDermott Miller survey
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Table 4.6 shows the baseline Fire Efficacy values derived from the survey results for “at risk” groups compared to the general population.

- Fire efficacy is higher for disabled people, aged people (over the age of 70) and Maori and Pacific Islanders than it is for the general population. The research results show this because these groups

are better prepared for fire than the population as a whole.

- This may be because Fire Service messages are reaching these “at risk” segments more than the rest of the population and they are more aware of fire risk.
- If so, this appears to have been a successful Fire Service initiative.
- In contrast, the experience of fires by disabled and aged people and their fire knowledge (gained from publication of fire safety information) is lower than that of the general population. So these groups could be said to be prepared for fire, but are not confident about dealing with fire if it occurs.

4.7

SENSITIVITY

As this is a baseline study and data from the research is only available at one time point, relative sensitivity to changes in the underlying attribute values over time can not be tested.

However, the absolute attribute values derived from the research show the “Fire Preparedness Index” is currently most influenced by fire knowledge and, second, by fire fighting equipment, whereas fire experience is almost insignificant as an influence.

Similarly, the absolute attribute values derived from the research also show the “Self-efficacy Index” is currently most influenced by self confidence and least influenced by ability to act.

The relative insignificance of fire experience and ability to act attributes reflects the extremely limited experience of the population with real fire incidents.

As the “Fire Efficacy Index” combines the other two indices, their influences affect it. However the “Fire Preparedness” value, as noted in **Section 4.4** above,

represents almost two-thirds of the “Fire Efficacy” value, using equal weighting of the six underlying attributes.

Therefore, on the basis of the present research, a change in the value of fire preparedness (especially fire knowledge and fire fighting equipment) will have a much greater impact on fire efficacy than changes in self-confidence and risk perception.

4.8

ESTIMATED INDICES

Sections 4.2-4.4 above show a total of thirty index values in three categories of Fire Preparedness, Self Efficacy and Fire Efficacy over the general population, five at risk segments and four location segments.

The overriding index values are those for Fire Efficacy. The other values help elucidate and interpret the Fire Efficacy Index values.

Table 4.7 below summarises the General Population values as at 30 June 2011 for the “Fire Efficacy Index” developed as part of this study, and its component “Fire Preparedness” and “Self-Efficacy” indices.

These values are set as the base values for an index rating for “Fire Efficacy” and each of its components. This base index rating is 100 for the “Fire Efficacy” value of 8.80, estimated on the basis carried out in this study.

	General Population Value	Initial Index Rating Number
Fire Preparedness	5.70	100
Self-Efficacy	3.10	100
Fire Efficacy	8.80	100

Source: McDermott Miller survey
 ©McDermott Miller Limited, November 2011

As changes in the underlying “self-efficacy” and “fire preparedness” values of the surveyed populations occur over time, from 5.70 and 3.10 respectively, the index rating will move above 100 (as “Fire efficacy” rises) or below the starting point of 100 (as “Fire efficacy” falls).

5. IMPLICATIONS

5.1 INDEX RESULTS

As noted in **Section 1.1**, the New Zealand Fire Service is interested in the implications this research has for its current and future fire safety educational activities. The NZFS is also interested in whether there is a link between its fire safety initiatives and an increasing tendency for people to call the NZFS for minor fire incidents.

This study is a baseline study. We are unable to rigorously test whether there is any correlation between the NZFS's fire safety educational activities and "Fire Efficacy" over time. However, such testing will be possible if household surveys are carried out to assess "Fire Efficacy" in future. Changes in "Fire Efficacy" over time can then be compared to NZFS's on-going fire safety educational activities (and its operational budget) over time.

In the meantime, there are a number of inferences and implications that can be drawn from the research results. These include:

- No evidence was found of unnecessary callouts for minor fire incidents in either the urban or rural segment or the 'at risk' segments. Findings from the focus groups and the survey showed most people try to deal with minor fire incidents on their own, at least initially.
- However, this finding needs to be tracked over time to identify if it is an increasing trend.
- Current levels of "self-efficacy" and "fire preparedness" already lead to householders fighting fires without reference to the NZFS.
- This similar level of "self-efficacy" across all segments could be a result of fire being a regular part of people's lives (e.g. BBQs, campfires, hangis,

fireworks, etc), which means, regardless of a person's capability to deal with fire, they have an innate confidence in their own ability to deal with fire incidents.

- "Fire Efficacy" appears to result in few calls to the fire service for minor fires and for medium fires as a proportion of the total number of fire incidents.
- This finding, coupled with fire incident statistics, suggests that most people (general population and 'at risk' groups) will continue to deal with medium and minor fire incidents on their own, and will only call the NZFS when they believe they can no longer deal with the situation.
- To some extent, improving self-efficacy and fire preparedness (other than facilitating exit from the property) work against the current fire safety messages of call the fire service and get out and stay out for any fire scenario.
- The situation, identified in focus groups, where participants were looking for improved knowledge of how to use their fire extinguishers and other fire equipment also works against the current fire safety message.

5.2

OTHER SURVEY FINDINGS

The results of the survey have been incorporated in the development of index values as described in **Section 4** above. However, the survey also yielded a series of other interesting results which are summarised below.

FIRE EXPERIENCE

- The vast majority of the population have had very little or no experience of household fires. Only 1.5% have experienced a major household fire, 1.6% a medium fire and 12.3% have experienced a minor fire.
- There is a much higher incidence of fire experience by Maori and Pacific Islanders for all types of household fire (18.4% experienced minor household fires, 4.4% experienced medium fires and 5.1% had

experienced major household fires). This is greater than the experience of all other segments and the general population for all household fire types.

- On the other hand, people aged 70 years and over have a much lower experience of major (1.4%) and minor (7.6%) fires than other at risk segments.

Table 4.1 below shows around 1.5% of the population in general have personally experienced a major fire, 1.6% a medium fire and 12.3% a minor fire (as defined in **Section 1**).

Table 4.1: Incidence of Fire in Residential Property by Fire Type

SEGMENT	FIRE TYPE		
	Major	Medium	Minor
General Population	1.5%	1.6%	12.3%
Maori & Pacific Islands	5.1%	4.4%	18.4%
Older (70+age group)	1.4%	2.4%	7.6%
Disabled	2.2%	1.5%	11.9%
Household income<30K	3.0%	2.2%	13.6%
Renter	2.6%	2.8%	15.4%

Source: McDermott Miller email survey, June 2011
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FIRE RESPONSE

- No more than 50% of any segment calls 111 as its first action when fire occurs for any fire type. In other words, the majority of people do other things before calling 111 when a fire occurs, irrespective of fire type, or the prevailing NZFS fire safety message.

Table 4.2 below shows what people first do when a fire occurs, classified by fire type for the general population and selected "at risk" population segments.

Table 4.2: What People Do When a Fire Occurs

	MAJOR					FIRE TYPE MEDIUM					MINOR				
	INITIAL RESPONSE					INITIAL RESPONSE					INITIAL RESPONSE				
	Call 111 %	get everyone out %	use a hose %	use fire extinguishing %	put fire out %	Call 111 %	get everyone out %	use a hose %	use fire extinguishing %	put fire out %	Call 111 %	get everyone out %	use a hose %	use fire extinguishing %	put fire out %
General Population	33.3	26.7	13.3	6.7	6.7	25.0	18.8	0.0	6.3	18.8	1.6	4.8	4.0	13.7	58.9
Maori & Pacific Islands	50.0	35.7	0.0	0.0	7.1	16.7	25.0	8.3	8.3	25.0	2.0	8.0	4.0	10.0	62.0
Older (70+age group)	33.3	33.3	33.3	0.0	0.0	40.0	0.0	0.0	0.0	20.0	6.3	6.3	0.0	12.5	56.3
Disabled	40.0	40.0	0.0	10.0	10.0	28.6	14.3	0.0	0.0	42.9	3.6	5.5	0.0	16.4	52.7
Household income<30K	33.3	46.7	13.3	0.0	6.7	18.2	18.2	0.0	0.0	36.4	1.5	7.5	4.5	17.9	49.3
Renter	44.4	44.4	0.0	0.0	11.1	15.8	31.6	5.3	10.5	21.1	2.8	9.4	2.8	13.2	57.5

Source: McDermott Miller email survey, June 2011

Note: Small sample sizes mean many of these results can only be indicative and may not be statistically reliable

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FIRE SAFETY MESSAGES

- The survey results show fire safety messages are received by households.
- However, the survey results also show:
 - NZFS fire safety messages are not followed (especially for minor and medium fires). More than 50% of the respondents' first step in response to fire was to do something other than follow the NZFS advice.
 - Respondents want to be educated about how to recognise fire risks and how to deal with them, whether they live in cities, towns or rural areas.
 - Rural people expect to look after themselves. As fire response time is so long (40-60 minutes), they try to deal with fires themselves even when the fire service has been called.

6. FINDINGS AND RECOMMENDATIONS

6.1 RESEARCH AIMS AND OBJECTIVES

This project was guided by a series of research aims and objectives. These included:

- Developing an “Index of Fire Efficacy” to measure competence in dealing with minor incidents and recognising when NZFS is needed.
- Developing a research methodology that underpins the “Index of Fire Efficacy”.
- Measuring the current level of this Index, at the national and sub-national level, as a baseline for on-going monitoring.
- Clarifying the relationship between NZFS educational activities and unnecessary call outs ;
- Refining NZFS’s fire safety educational activities to increase both self-efficacy and actual efficacy in the community; and,

Sections 3 to 5 of this report have discussed and answered the research aims and objectives for this project.

Future research topics uncovered by the research, and a research and development programme for the “Fire Efficacy Index” that will allow the NZFS to monitor “Fire Efficacy” over time, are outlined below.

6.2 SIGNIFICANCE FOR FIRE RISK MANAGEMENT

- The research results reinforce previous knowledge that householders fight fires, irrespective of Fire Service safety messages;
- The majority of minor fires are fought by householders without recourse to the Fire Service.
- Householders, therefore, already have a level of fire efficacy supported by fire preventative systems within some households, and fire fighting equipment available to them.

- The consequence of improving householders' fire efficacy will be to increase their fire fighting behaviour, mostly for small fires and to some extent for medium fires.
- In turn, this will affect the extent of risk householders take in dealing with fires, and, consequently, the risk faced by the Fire Service when it is called to a household fire.
- The key risk issue then becomes the householder's ability (or not) to recognise the state of a fire in their household, its potential development and the speed of development, and if and when to call the emergency services.
- To the extent that improved fire efficacy results in greater fire fighting by householders before calling for the fire brigade, risks will rise for both the householders and the Fire Service (as it could be called to much more developed fire incidents than has been the case in the past).
- But this risk could be offset by NZFS placing more emphasis on community fire education to try and increase the fire-fighting and fire recognition capability of the population.

6.3

POTENTIAL IMPACT ON DEMAND FOR NZFS RESOURCES

- The stakeholder research indicates Fire Efficacy will be improved as a result of educating householders to better recognise fire risk situations, and if the fire preventative and containment equipment available to them is improved, and they learn how to use the equipment safely.
- Extending the Fire Service's present safety education programmes to teach householders to use the fire fighting equipment available to them (eg fire extinguishers), coupled with fire risk recognition, might require greater resource in terms of people and funding for these programmes.
- Extending fire safety education programmes to improve "Fire Efficacy" simply would require moderation of the current policy of concentrating

on the prime fire safety messages of *call the fire service* and *get out and stay out*, to include recognising fire situations where containment equipment can be used safely.

6.4

FUTURE RESEARCH TOPICS

- Evaluating the weighting of attributes in the index values and consequently in the indices themselves.
- Testing fire efficacy in public, commercial, industrial and rural (wild fire) situations.
- Testing the strength of the correlation indicated by the stakeholder (focus groups) research, but not tested in the household survey, of the Fire Service's fire safety educational activities with fire efficacy over time by undertaking further surveys of households' self-efficacy and fire preparedness.
- And, most challenging of all, researching effective ways of educating households to recognise fire situations where fire containment equipment can be used safely.

6.5

FUTURE RESEARCH PROGRAMME

- Monitoring "Fire Efficacy" over time can be achieved by:
 - Replicating the nation-wide household survey used in this study by adapting it for delivery by email link to a Fire Service website;
 - For maximum effect the Fire Efficacy survey should be repeated in two to three years time in order to accurately evaluate the weightings of the index values and their attributes
 - Once the Index weightings have been determined the Fire Efficacy survey should be replicated every five to seven years thereafter. It is our opinion that Fire Efficacy will remain relatively stable over the short term.
- Running the Fire Efficacy survey on a time series basis will allow the results of the survey to estimate new values for fire preparedness and self-efficacy

at the selected time period;; and, determine new index ratings for new time periods in accordance with the method set out in **Sections 3.4 to 3.7** and **4.2** above.

- Consistency of results will be reached by using the same questions as used in the survey underlying this study, and securing similarly representative samples.

6.6

RECOMMENDATIONS

Given people's propensity to deal with medium and minor fire incidents on their own and their expressed desire to improve their fire knowledge, NZFS could choose to 'go with the flow' and follow the example of Australia and USA by increasing community involvement in fire prevention, containment and safety education as a way to increase a community's "Fire Efficacy".

We must conclude, however, with a note of caution. This research has not indentified a causal link between NZFS's fire safety campaigns and a household's level of "Fire Efficacy". But, if NZFS were to change their fire safety messages by also emphasising community education, safe use of fire equipment and recognition of the seriousness of different types of fire incidents, over an exclusive message of '*get out and stay out*', and then track levels of "Fire Efficacy" across the population over time, a casual link (or alternatively no causal link) might be identified.