Organisational Resilience and Recovery for Canterbury Organisations after the 4 September 2010 Earthquake

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Abstract

The 4 September 2010 Mw 7.1 Darfield earthquake had major physical, economic and social effects on organisations in Canterbury, New Zealand. This paper presents the results of a survey conducted between November 2010 and February 2011 of organisations based in the Canterbury region. Sampled organisations include those belonging to six industry sectors: fast-moving consumer goods (FMCG), trucking, information and communication technology (ICT), hospitality, building suppliers and critical infrastructure. Also included are organisations from the Christchurch and Kaiapoi central business districts (CBDs) as well as rural organisations proximal to the fault trace.

Organisational recovery after the earthquake will be a major undertaking and the challenges vary for different organisations and industry sectors. This paper analyses the initial effects of the 4 September event across industry sectors and geographic areas. It also highlights possible interdependencies and system characteristics that affect recovery for these organisations and industry sectors. Other factors considered include the specific challenges organisations faced after this major hazard event.

Introduction

On 4 September 2010, the Canterbury region of New Zealand was shaken by a Richter M_w 7.1 earthquake. The epicentre was in Darfield, a town approximately 40km west of Canterbury's largest city, Christchurch. The intensities of the event in different areas ranged from MM3 to MM9[1]. In addition to the impacts of the global recession, organisations across Canterbury were faced with recovery from the earthquake and subsequent aftershocks. However, organisations were also presented with new opportunities in the post-disaster environment.

The Canterbury region is a significant part of the New Zealand economy. Half of all South Island businesses, accounting for 53% of South Island employees, are located in Canterbury (Statistics New Zealand, 2011). This paper presents the results of a survey which forms the first part of a two year study investigating the factors influencing recovery for individual organisations[2] and industry sectors in Canterbury after the 4 September earthquake. The survey explored organisational impacts, challenges, mitigation and preparedness in relation to this event. In addition, this study includes the recovery of both urban and rural organisations. Understanding how post-disaster outcomes manifest for different types of organisations and industry sectors will help stakeholders and decision-makers tailor planning, mitigation, response and recovery strategies that are appropriate for different sectors and for different geographic locations.

Figures from the New Zealand Treasury Department (2010) put the combined loss from the 4 September earthquake at $5 billion NZD. This aggregated amount masks the variations among individual organisations, sectors and geographic locations. In addition, the effects of disaster exceed physical damage to buildings, stock

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1. The Modified Mercalli (MM) scale measures felt shaking intensity on the Earth's surface, and consists of a series of "key responses" such as people awakening, furniture moving, and property damage (USGS, 2009).

2. In this paper, "organisation" refers to businesses, not-for-profit organisations and government agencies of a range of sizes. The terms organisation and business will be used interchangeably throughout the paper.

and infrastructure. Organisations affected by disaster also face disruptions that flow on to the community and other organisations that depend on them (Tierney & Nigg, 1995; Webb, Tierney, & Dahlhamer, 1999). For the purposes of recovery, estimates of disaster impacts should include losses caused by other factors such as business interruption, decreased customer numbers and property devaluation experienced by organisations post-disaster (Rose & Lim, 2002; Wood, 2008).

Recovery from a disaster is a complex and interconnected process, and is not a guaranteed outcome for affected organisations. Recovery is defined here as "longer-term efforts to reconstruct and restore the disaster-stricken area, e.g, through repairing or replacing homes, businesses, public works, and other structures" (Tierney, 1993b, p. 1).

Literature Review

There has been an increasing trend in the communicated cost of natural disasters globally (Munich Re, 1999) and recovery from these disasters can account for a significant proportion of national economies (Benson & Clay, 2004; Munich Re, 1999). Direct losses include damage to premises, infrastructure, equipment and loss of revenue resulting directly from the event (Cochrane, 2004). Indirect losses, which are difficult to measure, include income loss due to supply chain issues or decreased sales caused by customer income losses (National Research Council, 1999). It has been shown that indirect losses can surpass property damage in cost and pervasiveness (National Research Council, 1999). Rose and Lim (2002) state that business interruption losses are possible even without physical or property damage and can result from interdependencies and flow-on effects between organisations, employees, suppliers and customers.

Also, the trajectory of economic trends within business sectors is influenced by disasters (Benson & Clay, 2003). For instance, it is expected that the retail sector suffers loss of revenue while the construction and manufacturing sectors experience a boom in the wake of a disaster (Boarnet, 1997; Tierney & Webb, 2001). According to Registered Master Builders New Zealand, there was a dip in construction sector revenue after the September 2010 event which only started to rise in February 2011 (RMBF, 2011). Tracking the timing and distribution of economic impacts across sectors is important for providing appropriate support for sectors post-disaster.

In the literature, it is recognised that factors such as the type of organisation and industry sector, the size of the organisation and its location contribute to how different organisations and sectors recover from disaster. Other factors that contribute to recovery include the age of the organisation, owning or renting business premises and the level of organisational disaster preparedness (Alesch, Holly, Mittler, & Nagy, 2001; Nigg, 1995; Tierney & Dahlhamer, 1997). For instance, small businesses are more vulnerable to disaster due to restricted access to resources and networks that are available to larger organisations (Alesch et al., 2001; Chang, Seligson, & Eguchi, 1996). It is acknowledged that post-disaster recovery of small business plays a vital role in the economic and social recovery of a community (Pelling, 2003).

Furthermore, there is an emerging body of literature that links an organisation's level of resilience to its recovery (Bruneau et al., 2003; Chang, Rose, Shinozuka, Svekla, & Tierney, 2000). Resilience is an umbrella concept reflecting an organisation's ability to not only survive but to be able to thrive through times of adversity (Seville et al., 2008). More needs to be understood about how different types of organisations are affected by disaster, the factors that influence recovery, and how long after disaster they recover (Galbraith & Stiles, 2006).

Methods

This survey was designed to capture the initial impacts and perceptions of organisations affected by the 4 September earthquake. The survey employed a combination of concepts from qualitative and quantitative research. Data were collected using Dillman's (1978) total design method, adapted to this work. Questionnaires were mailed to organisations. This was followed by a telephone call where organisations were given the option of completing the survey by phone or in a personal visit with a member of the research team, using an online survey tool or returning it by post or e-mail. The multi-media approach was designed to cater for those organisations that might have relocated, closed or were too busy to complete the telephone survey during work hours. The final response rate was greatly improved by the flexible format approach to data collection.

The survey included a shortened form of the Organisational Resilience Measurement Tool (McManus, 2008; Stephenson, 2010) developed by the Resilient

Organisations Research Programme. The shortened version of the Tool was used to obtain a snapshot of the resilience profile of sampled organisations. The full version of the Resilience Measurement Tool will be deployed in later parts of the study.

Sample

A cross-section of industry sectors were strategically selected for this study to reflect various elements of the Canterbury economy. Within each of these sectors, organisations were randomly selected to be invited to take part in the study.

The sectors included were:

*   Information and Communication Technology (ICT) – a high-growth sector identified as a key component of Canterbury's regional economic plan
*   Critical infrastructure (lifelines) – for provision of services vital to recovery
*   Hospitality (cafes, restaurants and bars) – to analyse recovery through consumer discretionary spend
*   Fast moving consumer goods (FMCG) – including product producers, supermarkets, dairies, and petrol stations to analyse recovery through consumer non-discretionary spending
*   Trucking – important part of supply chain for many industry sectors and
*   Building Suppliers – for their involvement in the rebuilding process.
*   Christchurch and Kaiapoi Central Business Districts (CBDs) - because they are retail hubs and represent an aggregation of organisations in one locality.
*   Rural farm - organisations close to the fault trace and also a high-growth sector part of Canterbury's regional economic plan
*   Rural non-farm –rural farm support organisations

Results

The results of this survey highlight the effects of the 4 September earthquake on the Canterbury economy by analysing impacts to particular sectors and the possible interdependencies between them. In the first part of the survey organisations were asked for demographic information. Respondents were then asked whether they had been affected by the 4 September earthquake. Those that responded "no" were directed to complete only the organisational resilience portion of the survey. Eighty per cent of sampled organisations reported having been affected by the earthquake. All results

herein, which describe organisational impact and mitigation information are from organisations that reported being "affected" by the earthquake.

Survey response rate

Of the 869 organisations contacted for the survey, 376 usable responses were returned, giving an overall response rate of 36 per cent. The industry sectors with the highest response rates, by percentage, were ICT and critical infrastructure while that with the lowest was rural farm. Figure 1 shows the response rates for all the sectors sampled.
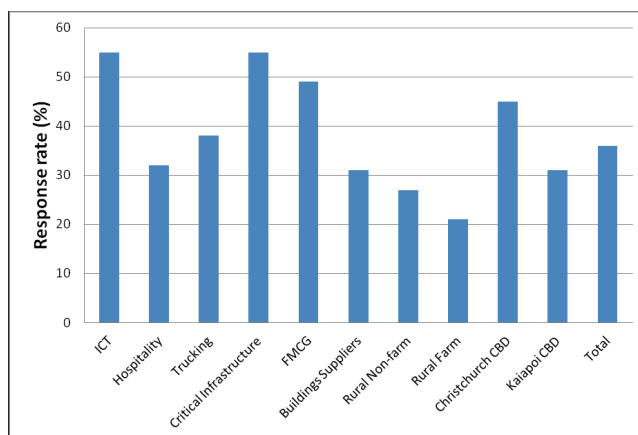

Figure 1: Organisational Resilience and Recovery Survey – response rate by sector

Organisation level information

Table 1 shows the average number of employees and periods of operation of organisations, by sector.

The sample consists primarily of small businesses, reflecting New Zealand's organisational demographic profile (Welch, 2008). Organisations from the critical infrastructure and FMCG sample groups were found to be the oldest organisations and the largest employers in the sample. At the time of the survey, 67 per cent of all organisations had been in operation at least 10 years. Williams (1987) demonstrates that it takes eight years to achieve long-term profitability. Therefore, older organisations are more likely to have additional internal resources to support their recovery.

Affected organisations and duration of closure

The highest proportion of organisations reporting being affected by the earthquake were from the Kaiapoi and Christchurch CBDs, hospitality and critical infrastructure sample groups. Organisations in the Kaiapoi CBD were affected by extensive liquefaction and lateral spread while those in the Christchurch CBD were likely more
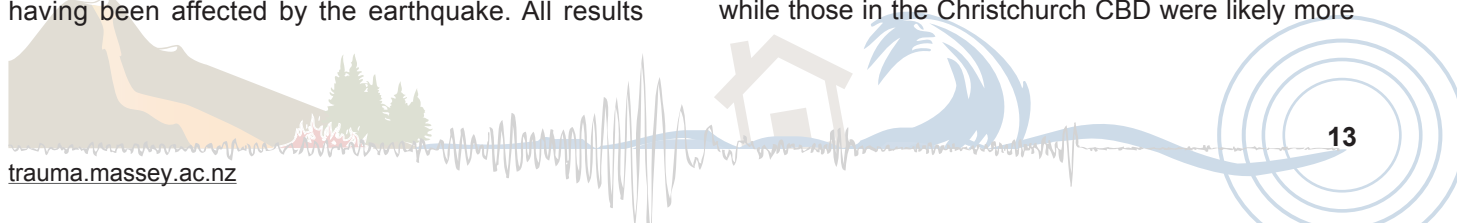
Table 1: Organisation level information

Sector	Number of Employees						Years in operation	
	Full-time		Part-time		Temporary			
	Mean	Median	Mean	Median	Mean	Median	Mean	Median
ICT	18	6	2	2	3	1	15	11
Hospitality	9	5	18	7	1	1	13	10
Trucking	31	10	9	2	1	1	33	24
Critical Infrastructure	233	112	41	13	192	4	80	100
FMCG	154	75	63	52	4	0	38	24
Buildings Suppliers	11	7	2	1	1	1	25	20
Rural Non-farm	9	2	3	2	11	2	25	11
Rural Farm	35	2	2	2	1	1	34	28
Christchurch CBD	15	3	29	3	2	2	35	30
Kaiapoi CBD	5	3	4	2	1	1	35	20
Total	46	5	17	3	26	1	31	19

affected by the official cordons placed around the CBD area in the days and weeks after the earthquake. The high number of organisations affected in the hospitality sector corresponds with their location; a large portion of the hospitality sample was located in or around the Christchurch CBD area. Lastly, the proportion of critical infrastructure organisations affected might be due to the placement of their infrastructure making it especially vulnerable to ground shaking (e.g buried cables or pipes) and because their services were in high demand immediately after the earthquake. The percentage of affected organisations, by sector, is shown in Table 2.

Table 2: Affected organisations and duration of closure

Sector	Affected by 4 September earthquake (%)	Duration of closure (days)	
		Mean	Median
ICT	56%	3	2
Hospitality	94%	8	7
Trucking	71%	11	2
Critical Infrastructure	92%	4	3
FMCG	88%	2	1
Buildings Suppliers	70%	3	2
Rural Non-farm	88%	5	4
Rural Farm	67%	2	2
Christchurch CBD	90%	9	7
Kaiapoi CBD	90%	11	7
Total	80%	7	4

Sixty-three per cent of affected organisations closed for some time following the earthquake. From Table 2, it can be seen that rural farm and FMCG organisations closed for the least amount of time. For rural farm, this is due in part to rural farm organisations not closing in the way organisations in other sectors would. On average,

organisations from the trucking sector and Kaiapoi CBD were closed the longest. The average duration of closure for the entire sample was seven days.

Organisations were presented with a list of reasons that may have contributed to the organisation's closure after the earthquake. The two reasons most cited for closure in the CBDs and the hospitality sector were "building waiting to be structurally assessed" and "damage to immediate locality". Approximately 50 per cent of respondents also cited "clear up damage to interior" as one of the reasons for closure. In addition, closure because of "stock loss or damage" featured prominently for the FMCG and hospitality sectors. Reasons for this include breakage caused by shaking, loss of refrigeration due to power outages and the short shelf life of putrescibles.

Only 25 per cent of trucking organisations reported closing for any period of time following the earthquake. This is likely due to locational flexibility (e.g. many can operate to some extent even with limited access to their building) and also because of the minimal earthquake damage to road networks they use.

The closure of some organisations had supply- and demand-side effects on other organisations. The trucking industry reported that one of their challenges was the lack of warehousing. First, they could not deliver goods because receiving organisations were closed, and then there was increased demand for trucking and supply services when organisations were ready to re-stock. Lastly, there was the additional challenge of decreased warehousing space caused by damage to racking and shelving units.

Table 3: Capability of new and regular supplier

	Capability of regular suppliers			Need to use new suppliers		How well new suppliers met needs		
	Completely capable	Somewhat capable	Completely incapable	No	Yes	Completely capable	Somewhat capable	Completely incapable
ICT	40%	13%	2%	53%	4%	2%	2%	0%
Hospitality	47%	38%	6%	78%	13%	3%	9%	0%
Trucking	42%	21%	5%	63%	5%	3%	3%	0%
Critical Infrastructure	58%	33%	0%	75%	17%	17%	0%	0%
FMCG	29%	57%	2%	62%	26%	10%	17%	0%
Buildings Suppliers	53%	17%	3%	70%	3%	0%	0%	3%
Rural Non-farm	55%	21%	5%	74%	12%	0%	10%	0%
Rural Farm	50%	13%	3%	63%	3%	3%	0%	0%
Christchurch CBD	52%	27%	6%	85%	3%	3%	0%	0%
Kaiapoi CBD	50%	25%	3%	80%	10%	3%	8%	0%
Total	46%	26%	4%	69%	10%	4%	5%	0%

When organisations were asked about the ability of their regular suppliers to meet their needs, 46 per cent of affected organisations reported their regular suppliers were "completely capable" while 26 percent reported that they were "somewhat capable". For FMCG however, close to 57 per cent of respondents reported their suppliers as being "somewhat capable" and only 28 per cent thought their suppliers "completely capable". Twenty-six per cent of FMCG and 17 per cent of critical infrastructure organisations reported the need to use new suppliers. For critical infrastructure, this might be a result the sharp increase for products used for repair and replacement after the earthquake. Information about supplier capability for each sector is presented in Table 3.

Insurance

Insurance against hazard events can be used by organisations to mitigate loss. However, deciding the financial value for insurance of low probability events such as earthquakes can be difficult (Kunreuther, 2002). Sampled organisations were presented with a list of insurance options. Across the sample, the most common types of insurance were "public liability" (60%) and "organisation assets and equipment" (59%), as seen in Table 4.

Sectoral differences in insurance may reflect differing organisational requirements as well as varying perceptions of risk. The two most cited types of insurance for ICT organisations were "public liability" and "assets and equipment". This is likely because ICT organisations want to protect themselves against

Table 4: Percentage of organisations with the different insurance types

Sector	Cash flow, income protection and organisation interruption	Property and buildings	Organisation assets and equipment	Motor Vehicles	Public liability	Commodities and goods	Other
ICT	24%	27%	49%	31%	44%	20%	15%
Hospitality	78%	47%	75%	44%	69%	63%	0%
Trucking	37%	45%	50%	47%	50%	24%	16%
Critical Infrastructure	38%	54%	50%	54%	67%	33%	42%
FMCG	62%	57%	62%	62%	64%	60%	21%
Buildings Suppliers	43%	43%	57%	57%	63%	50%	10%
Rural Non-farm	43%	76%	69%	57%	69%	50%	2%
Rural Farm	23%	63%	33%	63%	47%	33%	7%
Christchurch CBD	70%	48%	73%	55%	64%	70%	12%
Kaiapoi CBD	45%	40%	68%	38%	68%	35%	13%
Total	45%	49%	59%	49%	60%	43%	13%
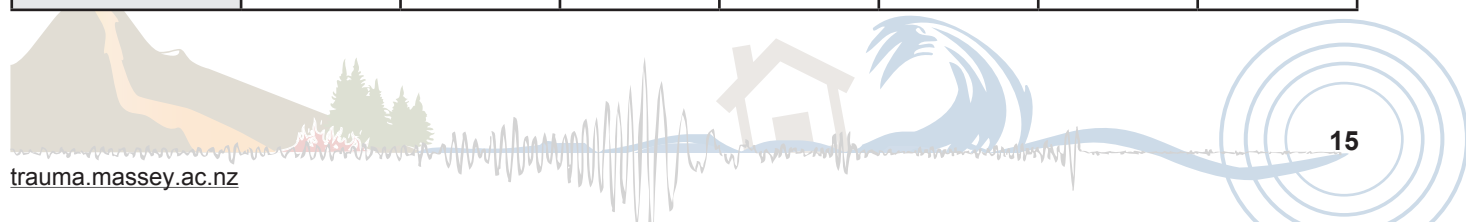
claims should their clients suffer loss and seek recompense and also because they rely heavily on their equipment for the operation of their organisation. Critical infrastructure organisations were also more like to have "public liability" insurance than any other. The ICT and rural farms were the least likely to have "cash flow, income protection and organisation interruption" insurance, while the hospitality sector and organisations in the Christchurch CBD sample were most likely to have it. This may reflect the varying nature and importance of cash transactions for the different sectors.

In the "other" insurance category, some of the building suppliers and critical infrastructure reported being self-insured. Self-insurance is often opted for when organisational wealth is higher and risk perception is relatively low (Ganderton, Brookshire, McKee, Stewart, & Thurston, 2000). In the case of critical infrastructure, following several hazard events in Canterbury in the early 2000s, private insurance costs had increased dramatically, making insuring assets uneconomical. Therefore, some organisations opted for self-insurance and adopted mitigation measures such as seismically reinforcing structures housing important assets and upgrading equipment to decrease the risk of loss (Eidinger, Tang, & O'Rourke, 2011).

Organisations were also asked about their relationships with their insurer, their banker and also how satisfied they were with their insurance package on a scale from "very dissatisfied" to "very satisfied". From the overall sample, 18 percent of organisations reported feeling "very satisfied" with their insurer while 29 per cent were "satisfied". Twenty-four per cent of all sampled organisations were "very satisfied" with their banker and 25 per cent were "satisfied." More organisations from FMCG than from any other sector reported being "very satisfied" with their insurer, insurance package and banker at 36 per cent, 33 per cent and 38 per cent respectively. Pre-disaster, banks may require compliance with building codes before providing mortgages and loans, and insurers can finance mitigation measures which may reduce future losses (Kunreuther, 1996). Having a good relationship with the banking and insurance sectors may help organisations to arrange the best insurance and banking packages for their organisations.

Decisions affecting recovery

Organisations work in an increasingly interdependent environment where they are affected by the decisions

of others. It is therefore necessary to examine and understand organisational recovery from a system dynamics perspective, and how post-disaster decisions made by others, which organisations have little control over, can affect recovery. Some of the decisions cited as affecting organisations in the sample group include:

- damage to nearby buildings
- official cordons around nearby buildings
- delayed insurance payouts
- the duration of ongoing building inspections
- road closures and official curfew

Organisations reported all of the above as having other flow-on effects that led to varying levels of business interruption and loss of revenue. As a result of building inspection delays, owners could not access their premises and in some cases employees were reluctant to work from buildings they perceived unsafe. In addition, some organisations in the Christchurch CBD reported that cordons around nearby buildings gave customers the perception that the CBD was "closed". Also, as the rebuilding work did not start for a while after the earthquake, partly due to inspections and delayed insurance payouts, some building supply organisations reported difficulties deciding what material to stock or produce for when the work commenced.

Furthermore, the decisions made by an organisation in the immediate aftermath of disaster can influence not only their long-term recovery but that of other organisations also (Dietch & Corey, 2011). In the survey, organisations were presented with a series of statements about their organisation and asked to what extent they agreed or disagreed with the statement. Results for the total sample showing only "agree" and "strongly agree" are given in Table 5.

The critical infrastructure sector had the largest numbers of organisations "strongly agree" with all the statements. As discussed above, this is likely because critical infrastructure organisations realise how vital they are to other organisations and to the community as well as the preparedness exercises they are likely to engage in. More organisations "agreed" that "the way we plan for the unexpected is appropriate, given the people and organisations that count on us" than with any other statement.

Organisations from the building supply and rural farm sectors were more likely to "agree" that "there would be good leadership if our organisation were struck by a crisis". Overall, 54 per cent of organisations "agreed"

Table 5: Organisation level statements

|		ICT	Hospitality	Trucking	Critical Infrastructure	FMCG	Buildings Suppliers	Rural non-farm	Rural Farm	Christchurch CBD	Kaiapoi CBD	Total
There would be good leadership if our organisation were struck by a crisis	Agree	49%	53%	45%	42%	45%	77%	48%	67%	64%	65%	54%
	Strongly Agree	40%	28%	45%	58%	48%	17%	38%	20%	30%	23%	35%
Our organisation has clearly defined priorities for what is important during and after a crisis	Agree	45%	53%	42%	38%	48%	57%	50%	60%	61%	45%	49%
	Strongly Agree	11%	22%	24%	58%	36%	10%	26%	20%	21%	23%	24%
When we need to, our organisations can make tough decisions quickly	Agree	53%	53%	34%	50%	33%	60%	43%	53%	58%	60%	49%
	Strongly Agree	36%	28%	50%	50%	60%	23%	43%	33%	42%	30%	40%
Our organisation keeps in contact with organisations it might have to work with in a crisis	Agree	35%	44%	37%	46%	50%	27%	40%	50%	42%	48%	41%
	Strongly Agree	5%	6%	21%	54%	24%	3%	21%	23%	21%	13%	18%
Our organisation monitors what's happening in its industry	Agree	58%	47%	39%	33%	40%	47%	48%	60%	64%	50%	49%
	Strongly Agree	24%	19%	34%	63%	45%	13%	38%	13%	24%	25%	29%
I believe the way we plan for the unexpected is appropriate, given the people and organisations that count on us	Agree	65%	75%	39%	42%	55%	70%	64%	63%	67%	53%	59%
	Strongly Agree	16%	0%	32%	54%	26%	7%	14%	10%	15%	18%	19%
Our organisation is focused on being able to respond to the unexpected	Agree	55%	47%	39%	38%	57%	70%	50%	67%	58%	48%	53%
	Strongly Agree	11%	13%	32%	54%	26%	7%	17%	13%	18%	20%	20%

with this while 35 per cent "strongly agreed". This corresponds with the high number of all organisations (89 per cent) that either "agreed" or "strongly agreed" with the statement "when we need to, our organisations can make tough decisions quickly". Regardless of industry sector or organisation size, good leadership is necessary for decision-making and to effectively manage staff in a high stress crisis environment.

For the statement "our organisation has clearly defined priorities for what is important during and after a crisis", 49 per cent of the total sample "agreed" and 24 per cent "strongly agreed". These priorities may be specified as part of the organisation's crisis preparedness activities and adapted as necessary post-disaster. These preparedness activities could include defining the minimum resources the organisation needs to get through a crisis and the steps necessary to ensure staff well-being and business continuity.

For "our organisation keeps in contact with organisations it might have to work with in a crisis", 50 per cent of organisations from both the FMCG and rural farm

sectors "agreed" and 54 percent of critical infrastructure "strongly agreed". This is in contrast with organisations from building suppliers, ICT and hospitality where only 3, 5 and 6 per cent respectively "strongly agreed". Having information on for example where and how to access aid or what part of the supply chain is broken can help an organisation's recovery. The highest percentage of organisations to "agree" that their "organisation monitors what's happening in its industry" were from the Christchurch CBD (64%), rural farm (60 per cent) and ICT (58 per cent). For rural farm and ICT, this is likely because the trends in these sectors change very often. Also, knowledge of industry trends can be used to formulate corporate strategy post-disaster. For instance, an organisation might diversify to other markets while its local market was in recovery.

The hospitality sectors had the highest number of organisations (75 per cent) "agree" that "the way we plan for the unexpected is appropriate, given the people and organisations that count on us". This is possibly because of health and safety concerns were the regulations for food preparation not followed. Lastly, 70 per cent of
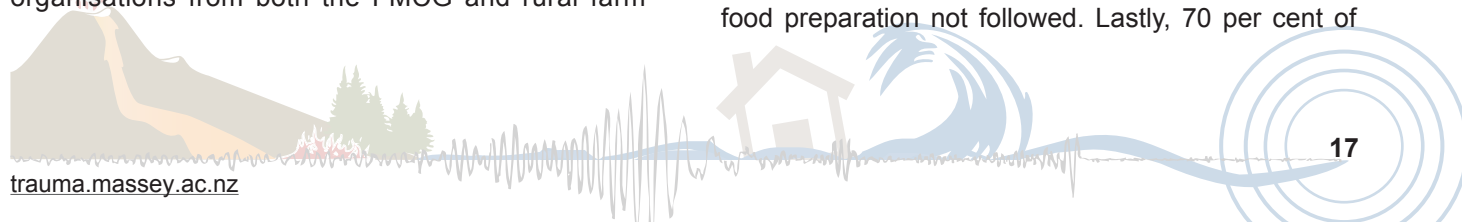
building suppliers "agreed" with the statement "Our organisation is focused on being able to respond to the unexpected".

Challenges and Opportunities

Disasters present both challenges and silver linings for organisations. In this survey, organisations were asked to report the "biggest challenges" they faced following the 4 September earthquake. Across all sectors and geographic areas, the most commonly reported "biggest challenge was the wellbeing of staff. However, other sector specific challenges also emerged.

Apart from difficulty forecasting demand, building suppliers also reported reduced sales while they waited for the rebuilding work to restart. Organisations in the construction industry were aware that there would eventually be a surge in demand for their services, but delays caused by ongoing aftershocks and lags in insurance pay-outs made it difficult to predict when reconstruction work would begin in full. Further, uncertainty about employment prospects might lead to skilled workers in this industry migrating out of Christchurch, causing a skills shortage when the rebuilding work starts in earnest (Tertiary Education Union, 2011). Conversely, as the economic landscape of Canterbury has changed, new skills will be required across many sectors, partly to re-train people who lost their jobs to re-enter the job market and also because of the need for specific skills (e.g insurance loss adjustors, builders) as a result of the earthquake (TVNZ, 2011).

The CBD and hospitality sectors cited cash flow, reduced customer numbers and reduced consumer spending as major challenges. This could be a result of changed consumer habits as they reduce spending due to uncertainty about the future economic climate. It could also be due to consumers continuing to shop in the suburbs even after the CBD shops reopened. The hospitality sector also noted problems with staff availability. This might be due to population outflow after the earthquake or that staff were not prepared to work from the CBD due to the perception that buildings were unsafe.

Several ICT organisations, on the other hand, reported their biggest challenge was dealing with increased demand for their services. This is possibly due to organisations adopting new technologies after the earthquake to do their business, as part of hazard mitigation and preparedness as well as the need to repair and replace damaged equipment. Trucking,

rural non-farm and FMCG biggest challenges included issues with supply chain and logistics. This brings to light the need for organisations to practice effective risk management for their entire supply chain, for instance by having more than one supplier or by product substitution where possible. Following the earthquake, organisations have the opportunity to re-evaluate and create a more resilient supply chain.

Conclusion

Post-disaster recovery is a complex economic, political, social and physical process. The physical damage to an organisation's property can be considered a one-off whereas the flow-on effects are not immediately apparent and linger for some time. Recovery is not just about rebuilding infrastructure, it should also be used to plan for future economic growth.

There are several factors that will act as determinants in the recovery of organisations. It is important to recognise which of these has the more substantial effects as well as how the effects on one sector impact other sectors.

The organisations in Canterbury had started on the path to recovery when they faced another devastating earthquake on 22 February 2011. Future work in this study will take into consideration the effects of this later event. Another outcome of the study will be the comparison of the determinants of recovery for different industry sectors, as well as the interdependencies and system dynamics as a result of the commerce between them. The factors important to recovery after disaster will inform organisations, policy makers and other interested parties on what to prioritise in the response and recovery stages after an event.

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