

Business Resilience and Recovery following the Canterbury Earthquakes

Combining Disruption Factors

Results Bulletin 2018-6

Findings from a survey of 206 organisations in the Greater Christchurch Urban area in mid-2016.

Question

Can the breadth of impacts experienced by Christchurch businesses be reduced to groups of measures, or factors, that may be useful in future research? If so, what are these factors?

Findings

Principle Component Analysis was applied to 27 original variables that capture impacts experienced by Christchurch businesses. Four factors were found, accounting for 73% of the variance; *Premises damage*, *Infrastructure damage*, *Operational issues*, and *Neighbourhood damage*. Each factor produced very high reliability. Five items were excluded from the PCA analysis based on unsuitability of the data.

Results

Impacts discussed in Results Bulletin 2018-5 (Hatton et al., 2018) include 27 items. These items span a range of factors that relate to infrastructure and non-infrastructure impacts with severity of impact to organisations gathered on a four-point scale. However, working with 27 individual items can be cumbersome, while reducing dimensionality enables easier classification and/or pattern recognition. Applying Principle Component Analysis (PCA), is one way of achieving this aim.

Mean scores, standard deviations and skewness of all 27 items were examined to ensure suitability for inclusion in PCA. Five items - Gas, Rail, Airport, Port and Fuel - were skewed and had insufficient variance to meaningfully contribute to final scales (De Vaus, 2002) and so were deleted from subsequent PCA. Reliability analysis of the remaining 22 items produced a very high Cronbach's Alpha of .952. This value was not able to be improved on with removal of any additional item, so all 22 items were retained for PCA.

Principle Component Analysis was undertaken using Varimax as orthogonal rotation of choice (Tabachnick & Fidell, 2007). The Eigen value was set at >1 and loadings less than 0.4 were suppressed. KMO measure of sampling adequacy (.897) and Bartlett's test of sphericity ($X^2=1460$; $p=.000$) were both sufficiently high to reflect the potential of latent factors in the data and suitability for inclusion in PCA (De Vaus, 2002). The initial PCA solution produced four factors explaining 73% of the variance. All four factors presented with very high reliability as shown in Table 1; Alpha ranged from .830 to .909.

Table 1: Principle Component Analysis of Impacts

	Premises damage	Infrastructure issues	Operational issues	Neighbourhood damage
Machinery Loss or Damage	0.813			
Structural damage to building	0.781			
Non-structural damage to building	0.740			
Damage to ground surface	0.716			
Office equipment loss or damage	0.668			
Perception of building safety	0.658		0.554	
Inventory loss or damage	0.629			
Phone network		0.808		
Sewerage		0.798		
Electricity		0.794		
Data network		0.790		
Water		0.788		
Difficulty accessing IT		0.621		
Road network		0.495	0.491	0.456
Supplier issues			0.807	
Emotional Wellbeing	0.438		0.712	
Customer issues			0.705	
Health and safety issues	0.517		0.635	
Staff availability		0.430	0.630	
Difficulty accessing premises		0.410		0.728
Damage to next door	0.557			0.714
Damage to local neighbourhood				0.674
<i>Cronbach's Alpha</i>	<i>.909</i>	<i>.905</i>	<i>.830</i>	<i>.879</i>

The first of the four factors, **Premises damage**, contains items that reflect impacts arising from seven items related to direct physical damage to buildings or equipment. While six of these are relatively transparent, perception of building safety is also included, on the basis that heightened perceptions of safety will likely arise because of damage. We would however note that a strong case could also be made for it to sit within the *Operational* category. While this item also loaded onto the third factor, loadings were higher in relation to *Premises damage*, further warranting its inclusion in the first factor. The second factor identified includes seven **Infrastructure** items (Alpha = .905). The first six of these, - Phone, Sewerage, Electricity, Data, Water and IT load solely onto this item. However, the last one, Road network, loads almost equally onto this factor as the subsequent two. On theoretical grounds it has been included with infrastructure, though an equally compelling argument could be made for its inclusion in either of the subsequent two factors. Factor 3, **Operational issues**, includes several items that are critical to ensure a business can still operate, irrespective of damage. These largely centre on people, staff, customers and suppliers (Alpha = .830). Finally, **Neighbourhood damage** captures proximal impacts as well as access problems relating to such damage (Alpha = .879).

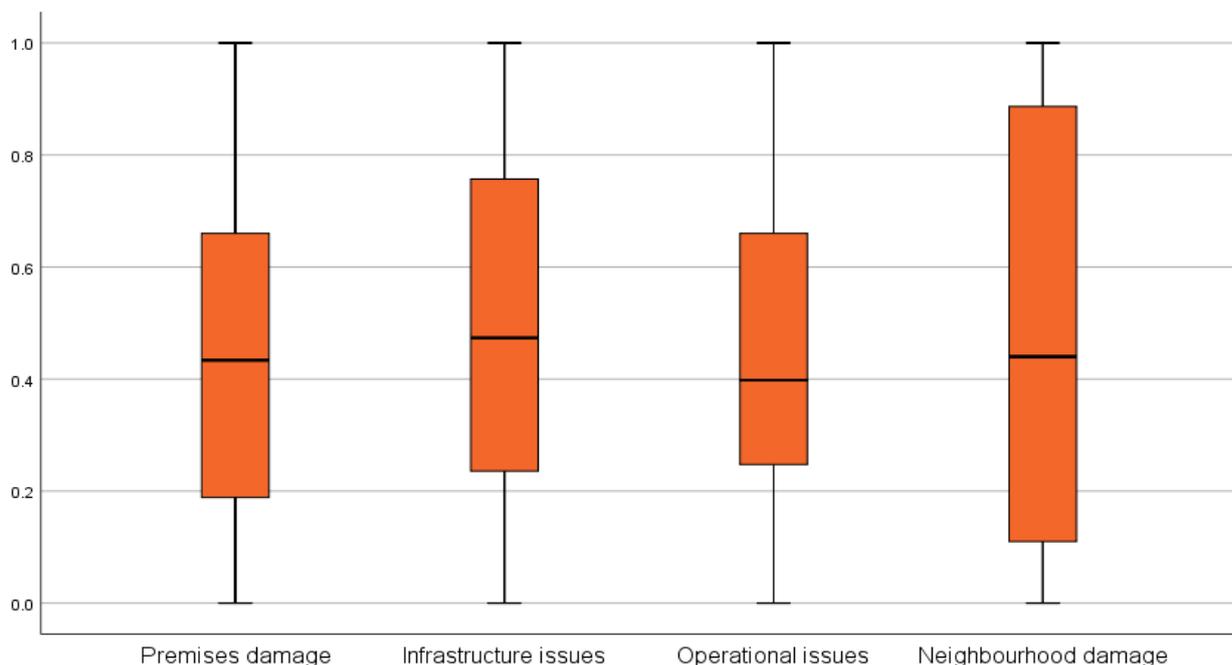
Next, scale scores were generated for the four factors, for each organization. To achieve this we weighted items from the original four point scale using the following values; *Not disrupted* = 0, *Slightly* = .33, *Moderately*= .66 and *Very* =1. (refer appendix for full survey wording). Where items *did not apply* to particular respondents' cases, data was treated as missing. Scale scores were then calculated by summing the weighted scores and dividing by the number of items included for each of the four factors. Hence, in the case where all seven items from the *Premises damage* factor were relevant to an organisation, all seven weighted scores were summed and divided by seven. If only three items were relevant, three were summed and averaged. In this way final scores are adjusted for comparability across all cases in line with DeVaus (2002). Descriptive data related to scale scores are reported in Table 2.

Table 2: Scale score descriptive for four impact factors

		Premises damage	Infrastructure issues	Operational issues	Neighbourhood damage
N	Valid	188	183	183	166
	Missing	18	23	23	40
Mean		.4432	.4852	.4402	.4953
Median		.4336	.4620	.4000	.4433
Std. Deviation		.30056	.30676	.27263	.37699

The most commonly reported factor related to *Premises damage*, with 188 of the 206 organisations rating items related to this factor. Conversely, *Neighbourhood damage* appears to have had the least widespread effect (n=166), though a wider range of impact score were reported (see Figure 1). The interquartile range for Q2 and Q3 the is the largest for *Neighbourhood damage* scores while the spread of Q2 and Q3 *Operational issues* scores is substantially narrower.

Figure 1 : Box plot distribution of impact scores for four factors



Approach

Measurement for disruption to non-infrastructure items was undertaken using the following question.

For each of the following factors, please indicate whether they affected your organisation and, if relevant, how disruptive the impacts were.

	Affected my organisation?		Not at all disruptive	Not very disruptive	Moderately disruptive	Very disruptive
	Yes	No				
Difficulty accessing IT data	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Structural damage to building(s) (integrity of building compromised)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Non-structural damage (fittings damaged e.g. windows or light fixtures)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Machinery loss or damage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Office equipment loss or damage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Damage to inventory or stock	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Damage to ground surface	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Damage to or closure of adjacent (next door) organisations or buildings	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Damage to local neighbourhood (e.g. other buildings in area, damage to pavements etc.),	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Difficulty accessing premises/site	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Health and safety issues for employees	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Supplier issues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Customer issues	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Availability of Staff	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Perceptions of building safety	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Changes in staff emotional wellbeing	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Other (please describe) - _____						

Measurement of disruption to infrastructure items was undertaken using the follow question.
Following the earthquakes, how disruptive was the loss of the following infrastructure services for your organisation?

	No loss of service or not applicable	Not disruptive	Slightly disruptive	Moderately disruptive	Very disruptive
Water Supply	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Sewage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Electricity	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Gas	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Phone networks (cell and landline)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Data networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Road networks	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Rail	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Airport	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Port	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fuel	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

For each of the infrastructure and non-infrastructure items, we recoded data where impact ranged from 0-1; *Not disrupted* = 0, *Slightly* = .33, *Moderately*= .66 and *Very* =1.

Limitations

This analysis assumes a similar level of perception of what *Very disrupted* means relative to *Moderately* or *Slightly*. Given the five-year time frame, it also assumes accurate recollection of impacts. See Results Bulletin 2 for details about sample representativeness. It should also be noted that these calculations are intended to reflect the disruption for individual organisations in this study. In line with assumptions of PCA, factors are directly derived from the 206 organisations that participated in this study, and as such are not necessarily able to function as estimates of the wider sector or region.

References

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Reference as:

Sampson, K., Hatton, T., Brown, C., Seville, E., (2018) Business Resilience and Recovery following the Canterbury Earthquakes. *Survey 5 Results Bulletin 2018-6*