Building adaptation in the Melbourne CBD: The relationship between adaptation and building characteristics.

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Overview

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Introduction

- The research question;
- *What is the identity and nature of the relationships between building adaptation events in the CBD and building attributes?*

- Building adaptation events in the Melbourne CBD 1998 - 2008 and building adaptation attributes identified in the literature as being important decision making factors.
- Previous studies limited - number of cases or buildings informing the research.
- *Every* building adaptation event between 1998 and 2008 in Melbourne CBD is included.

Factors influencing building adaptation

- Definition "*any work to a building over and above maintenance to change its capacity, function or performance' in other words, 'any intervention to adjust, reuse, or upgrade a building to suit new conditions or requirements*" (Douglas 2006).
- Previous research - determining factors as economic, social, environmental, technological, legal and physical
- Technical issues were; building size and height; depth; structure; envelope & cladding type; internal space layout & access; services; acoustic separation and fire safety

Table 1: Summary of building adaptation criteria.

Adaptive reuse criteria for existing buildings	Relevant research study
Age	(Barras and Clark 1996; Ball 2002) Ball, 2002; Fianchini, 2007
Condition	Boyd et al 1993; Isaacs (in Baird et al) 1996; Swallow, 1997; Snyder, 2005; (Kersting 2006)
Height	Gann & Barlow, 1996.
Depth	Gann & Barlow, 1996; Szarejko & Trocka-Lesczynska, 2007.
Envelope and cladding	Gann & Barlow, 1996.
Structure	Gann & Barlow, 1996; Kersting, 2006
Building services	Gann & Barlow, 1996; Snyder, 2005; Szarejko & Trocka-Lesczynska, 2007.
Internal layout	Gann & Barlow, 1996; Swallow, 1997; Fianchini, 2007; Szarejko & Trocka-Lesczynska, 2007
Flexibility for a range of differing uses and functional equipment	Gann & Barlow, 1996; Fianchini, 2007
Location	Isaacs (in Baird et al) 1996; Bryson, 1997; Ball 1999, 2002; (Remoy and van der Voordt 2006)
Perceived heritage value	Ball, 2002. Snyder, 2005.
Size	Gann & Barlow, 1996. Ball, 2002.
Accessibility	Gann & Barlow, 1996. Ball, 2002. Snyder, 2005. Kersting, 2006. Remoy & van der Voordt, 2006. Fianchini, 2007. Ellison and Sayce, 2007.
Proactive policy making / legislation (planning and building codes including fire)	Chudley, 1981; Gann & Barlow, 1996; Highfield, 2000; Heath, 2001; Ball, 2002; Listokin and Hattis, 2004; Snyder, 2005; Burby et al, 2006; Kersting, 2006; Galvan, 2006; Shipley, 2006.
Acoustic separation	Gann & Barlow, 1996.
User demand	Ball, 2002.
Site conditions	Isaacs in Baird et al, 1996.

(Source: Author)

Research Methodology

- Many studies adopt case study approach (Barras and Clark 1996; Ohemeng 1996.; Blakstad 2001; Heath 2001; Ball 2002; Kincaid 2002; Kucik 2004; Arge 2005; Remoy and van der Voordt 2007).
- Adaptation criteria derived from above.
- Stage 1 examined building adaptation criteria and these criteria formed the fields for the building attribute database.
- Cityscope, PRISM and Property Council of Australia.
- Empirical data was gathered by the researcher visually surveying the buildings.

Table 1: Criteria for Adaptation Database fields

|		
1. Building ID number	23. Occupancy type – sole occupier, multiple occupants, vacant	39. Green roof option
2. Cityscope Code		40. Aesthetic qualities
3. Map Number		41. Building envelope type
4. Property Number		
5. Unit Number	24. Zoning	42. Building envelope condition
6. Building Name	25. GFA	
7. Street Address	26. NLA	43. User demand
8. Street Number	27. PCA Grading	44. Site orientation
9. Street Name	28. Type of construction	45. Internal layout
10. Street Frontages	29. Plan shape. Elasticity potential – lateral extension Elasticity potential – vertical extension	46. Column arrangement
11. Description		47. Vertical services location
12. Historic Listings		
13. Proposals		48. Floor size
14. Number of floors		49. Cost in use profile – gross income
15. Year built		
16. Year refurbished / adapted	30. Site boundaries. Site access to building	50. Cost in use – statutory charges
17. Number of refurbishments / adaptations Extent of adaptation.	31. Tenure - institutional / private /government / educational. Proximity to transport	51. Cost in use – operating expenses
		52. Electricity consumption by PCA Grade
18. Parking	32. Greenstar rating	53. Gas consumption by PCA grade
19. Number of car bays	33. NABERS rating	54. Water consumption by PCA grade
20. Site Area	34. ABGR rating	
21. Total Building Area	35. Proactive legislation	
22. Occupant classification - owner, lessee, vacant.	36. Hostile factors	
	37. Roof overshadowing	
	38. PV option	

(Source: Author)

Research population and sampling

- Much research samples the population, the goal is a representative sample - external validity (Naoum, 2000).
- An unrepresentative sample avoided through the adoption of a census approach
- 13222 building adaptations recorded in the database.

Defining the Melbourne CBD area
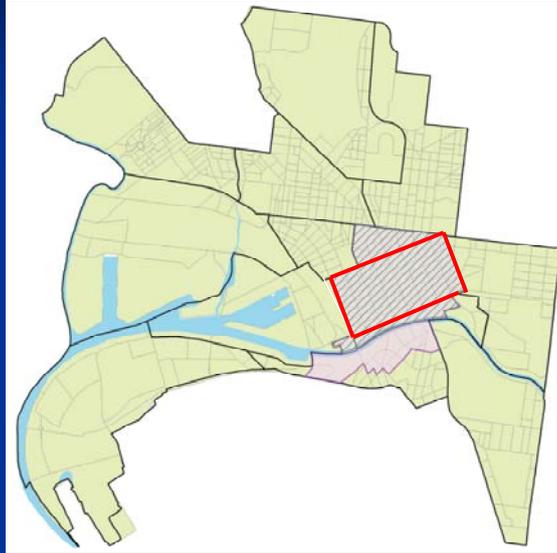
PCA

- Reliable proven method of highlighting dimensions in cross sectional data
- Capacity to uncover, disentangle & summarise patterns of correlation within a data set
- Purpose - condense information in original variables into a smaller set of new composite factors with minimum loss of information
- Focus is placed on *the explanation of the total variance* in the observed variables
- Initial step is to enter all variables into the PCA and produce a smaller number of factors

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PCA Procedure

- The final database comprised 54 variables
- The data was exported from Excel into SPSS.
- The key steps in a PCA were as follows;

1. Extract the components
2. Decide how many factors to retain
3. Rotate the factors
4. Interpret the factors
5. Create factor scores

Variables used in the final PCA of all building events in Melbourne 1998 – 2008

1. Site boundaries	2. NLA
3. Internal layout (columns)	4. Typical Floor Area
5. Vertical services	6. GFA
7. Existing land use	8. PCA grade
9. Street frontage (metres)	10. Site area
11. Historic listing	12. Plan shape
13. Number of Storeys (height)	14. Site access
15. Age in 2010	16. Property location

(Source; Author)

Table 6. KMO and Bartlett's Test PCA All adaptation events
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.699
Bartlett's Test of Sphericity	Approx. Chi-Square	9715.643
	df	120
	Sig.	.000

(Source; Author)

Table 7. Total Variance Explained PCA All adaptation events

Compone nt	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulativ e %	Total	% of Variance	Cumulative %	Total
1	9.920	61.997	61.997	9.920	61.997	61.997	8.428
2	2.388	14.924	76.921	2.388	14.924	76.921	4.186
3	1.753	10.956	87.877	1.753	10.956	87.877	5.613
4	.605	3.781	91.658				
5	.494	3.085	94.743				
6	.338	2.115	96.857				
7	.170	1.064	97.921				
8	.120	.753	98.675				
9	.077	.479	99.154				
10	.060	.374	99.528				
11	.051	.321	99.850				
12	.014	.090	99.940				
13	.008	.047	99.987				
14	.002	.010	99.996				
15	.000	.003	99.999				
16	.000	.001	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

(Source; Author)

Factor 1 & 2

Table 10. Factor 1 Analysis – Social / Physical

Variable	PCA Loading
1. Historic listing	.993
2. Age in 2010	-.944
3. Internal layout - columns	-.895
4. Typical Floor Area	.879
5. Site boundaries.	.816
6. Street frontage	.789
7. Site area	.635

(source: Author)

Table 11 Factor 2 Analysis – Physical (configuration)

Variable	PCA Loading
1. Vertical services location	.970
2. Plan shape	.860
3. Existing land use	.780
4. PCA Grade	.568

(source: Author)

Factor 3

Table 12. Factor 3 Analysis – design / economic

Variable	PCA Loading
1. Location	-1.028
2. NLA	.648
3. Number of storeys	.648
4. GFA	.628
5. Site access	.583

(source: Author)

Table 13. Summary of Main PCA Component Categories

Component number	Component name	Component variables
1	Social / physical	Historic listing Age in 2010 Internal layout - columns Typical Floor Area Site boundaries. Street frontage Site area
2	Physical (configuration)*	Vertical services location Plan shape Existing land use PCA Grade
3	Physical (size)	Location NLA Number of storeys GFA Site access

(Source: Author)

Findings from main PCA

1. Three defined interpreted factors.
2. PCA has correlated variables previous studies identified as separate and distinct (Blakstad 2001, Kucik 2004, Arge 2005). On this analysis the relationships between building adaptation & attributes are more complex than previously considered.

   One reason could be that some variables can be interpreted in more than 1 category; e.g. PCA Grade can denote the level of building amenity and quality, but equally rental yield and capital value

Conclusions

- The results of a PCA of 7,393 building adaptation events in Melbourne CBD from 1998 to 2008.
- Initial findings indicate previous studies may have adopted a more simplistic approach relying on limited cases
- The research question has been answered through the PCA and the presentation of the 3 factors in the pattern matrix (table 8).
- Physical building attributes feature strongly within all factors indicating physical attributes are more important than other attributes.

Thank you for listening – any questions?

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