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Measuring Building Adaptability and Street Vitality

ALAN MARCH, YOGITA RIJAL, SARA WILKINSON & EBRU FIRIDIN ÖZGÜR

Abstract
A long-standing urban design principle is that successful places exhibit vitality, being vibrant and diverse. This vitality depends on levels of economic and social success that sustain over time urban diversity including cafes, restaurants, delicatessens, bakeries, cinemas and galleries, grocery stores, pubs and clubs of varying sizes and types to suit individuals of varying taste, preference and socio-economic status. Accordingly, a successful public realm includes a complex ‘transaction base’ of activities. Since vitality occurs in physical, primarily human-made built forms and spaces, the qualities of physically permanent urban places influence vitality. However, the built form may eventually become inappropriate for its original purpose, the use redundant, or changes to demand may occur. Many buildings and spaces, specifically, are therefore refurbished or reused, but time, cost, inability, or environmental constraints associated with changes may impede physical change and therefore the ongoing maintenance and enhancement of places’ vitality. Importantly, some physical structures facilitate adaptability better than others overcoming a decline of activity or the need for expensive adaptation or outright demolition and redevelopment. This research examines the suggestion that greater levels of place adaptability facilitates higher levels of ongoing vitality, due to the ability for structures to be used for a range of purposes over time, without the need for changes to physical form, particularly in the move to higher densities. The paper outlines a method for measuring vitality and building adaptability in parallel and reports the results of empirical research of key locations in Melbourne’s Central Business District (CBD). It is argued using empirical data that adaptability, when translated to actual adaption, facilitates sustained vitality.

Introduction
It is generally understood amongst planners that urban areas must provide for human needs, notwithstanding all the complexity and contradiction that this entails. It is also generally accepted that sustainability is desirable and that the ways permanent and semi-permanent structures are built will have a range of impacts upon sustainability. This paper suggests that it is necessary to develop better measures of the ways settlements meet certain aspects of human needs and are sustainable. It is necessary to ensure that these tests are integrated with the
areas of action that urban design and planning can meaningfully act upon to achieve outcomes.

This paper argues that adaptability and vitality can be measured in ways that have implications for the improvement of urban policy. The paper develops measures of urban vitality and of building adaptability, drawing together relationships between the two. The study also develops a working system of measures of one element of built form sustainability, the ability for existing structures to be adapted and reused with the minimum of modification. The concurrent examination of vitality and adaptability then suggests an important question: ‘can improved adaptability in an urban place improve its vitality?’ While one might intuitively consider that these 2 place elements are linked, it remains to be seen whether, empirically, the 2 elements are related. Further, it is suggested that it can be shown that adaptability and vitality can be mutually influential, even while it is recognized that inflexibility may be associated with some vital places that are suited to their functions. Overall, it is necessary to examine places over time to begin consideration of this relationship.

The paper begins by setting out principles for understanding the nature of adaptability and vitality, and the potential for urban planning to affect them. It goes on to consider the ways these elements of place have implications for urban policy and practice. On this basis, the paper then demonstrates a method for the measurement and analysis of vitality and adaptability that is appropriate to the development of improved policy. The final component of the paper reports results of the analysis, suggesting further research and improved policy.

**Planning for Adaptability and Vitality**

Urban planning’s premise is that intervention in the spatial characteristics of urban and regional systems might allow for improved outcomes (Hall, 1992; Hopkins, 2001). This approach depends upon influencing the ways that land use is distributed, and the ways buildings are designed, to allow for the range of functions associated with human settlements to be improved. This paper focuses upon certain elements of urban design that urban planning systems may be able to affect, such as land use distribution and building design via professional practice and development control. The substantive focus of the research is upon urban features typically dealt with by urban designers, architects and urbanists, even while actual manifestations of these aspects in a planning system vary across traditions and places. As will be shown, even while adaptability and vitality are desirable characteristics, they cannot easily be sought by planning mechanisms without proper understandings of their sub-elements.

Vitality is defined by the Oxford English Dictionary as: ‘force, power, or principle as possessed or manifested by living things ... the ability or capacity on the part of something of continuing to exist or to perform its functions; power of enduring or continuing’ (2nd Edition, 1989). Lynch’s (1981) normative dimensions of city performance include inter alia vitality—the support of vital functions; and fit—the match between urban patterns and behaviour. Lynch (1981) argues that a place’s vitality depends on whether it ‘supports the health and biological well-functioning of the individual and the survival of the species’.
Urban planning has a long history of seeking to improve health and well being. In the Western tradition pioneers, such as Howard (1898), Geddes (1915) and Mumford (1946) addressed a range of matters of land use distribution and type seeking improvement to living conditions. In parallel with planning controls were numerous health and safety laws and regulations influencing building design and infrastructure such as sewage and water supply (Cullingworth & Nadin, 1994). Accordingly, planning has developed a strong tradition of acting as a mechanism to support human well-being.

In the urban design tradition, Montgomery (1995, p. 105) defines vitality as ‘a theory or miscellany of beliefs which contend that living process are not to be explained in terms solely of material composition but . . . living things are animated by a vital principle such as an elan vital or life force’. Urban vitality includes busyness and animation, people on the streets at different times, and human variety, even including times of political or social unrest. This encompasses a wider concern for the needs of humans being met in a place, also including provision for quiet and solitude. Accordingly, vitality reflects activity, alongside a diversity of transactions (not necessarily economic) between people (Montgomery, 1995, p. 106). Successful urban places require a diversity and depth of activity beyond a simple mixture of commercial, residential and industrial use. This mixture depends on sufficient levels of ongoing demand being sustained to support a diverse range of economic activities, which may include cafes, restaurants, delicatessens, bakeries, cinemas and galleries, grocery stores, pubs and clubs of varying sizes and types to suit individuals of varying taste, preference and socio economic status. Importantly, economically ‘successful’ buildings may not result in successful outside spaces, depending on their connectivity to, and relationship with the street. (Montgomery, 1998; Carmona et al., 2003).

The theory of building obsolescence has been thoroughly documented by Baum (1991) and others (Barras & Clark, 1996). Obsolescence is a measure of a lack of utility or function relative to the conditions prevailing in the population of similar building stock as a whole and thus the supply of buildings is a factor in obsolescence as well as demand. Obsolescence affects every building to some degree at some stage during its lifecycle (Douglas, 2006). As buildings age, the rate of decay increases and the decline in building condition escalates unless arrested in part by regular maintenance and upkeep (Millman, 2004). Building obsolescence has been likened to the Second Law of Thermodynamics, whereby all processes manifest a tendency towards decay and disintegration (Douglas, 2006). There are 6 principal types of obsolescence; economic, functional, social, legal, physical and aesthetic (Barras & Clark, 1996). Put simply, when a certain level of obsolescence is reached, a building may require adaptation (Nutt et al., 1976; Barras & Clark, 1996; Douglas, 2006).

Adaptive reuse is of particular interest in this research: when a particular function is no longer relevant, adaptive reuse is the ability of the building to convert to a new purpose (Langston et al., 2008). Lynch (1981, p. 164) suggested that places should be designed to become sufficiently flexible for them to reshape to their requirements suggesting a relationship between adaptability and vitality. A well-adapted place is one in which function and form are compatible. ‘This may be achieved by adaptation of the place to the activity, or vice versa, and also by
mutual adaptation . . . . adaptability in the more general sense is also achieved by the presence of adaptable persons . . . .’ (Lynch, 1981, p. 167). The concept of ‘loose fit long life’ (Rogers, 1996) suggests that sustainability depends upon the ability of a structure to accommodate a variety of uses over time with minimal modifications. Wilkinson et al. (2009a, 2009b) describe an adaptable building as one that can easily accommodate a within-use change or across-use change to satisfy new requirements.

Despite there being considerable conceptual understanding of vitality and adaptability, there is no real ‘bridge’ between these aspects in planning, urban design, architecture and building, particularly in a regulatory sense. Further, the various disciplinary approaches have not been integrated into urban planning alongside procedural, communicative, instrumental and other theories (Dagenhart & Sawicki, 1994; Dyck, 1994). Of course, it remains to be seen whether there is an interrelationship between adaptability and vitality. Accordingly, it is necessary to examine the features of adaptability and vitality that might be improved by planning and design, to more instrumentally bring about and maintain vibrant and sustainable urban places.

**Measures of Adaptability and Vitality—Case Study Selection**

The study combines field research and desktop study to understand links between adaptability and vitality. Quantitative and qualitative approaches are employed to investigate the relationships between building adaptability and street vitality in the Melbourne Central Business District (CBD). Melbourne’s CBD is dense and vibrant by Australian standards. It was founded by Europeans in 1835 and has seen steady growth and change since 1851 when gold was discovered in Victoria. It is the most mature property and land use market in the state. The Melbourne CBD represents a useful case study, since it does not have traditional zoning separating land uses (although planning permits are required) and has relatively even levels of public transport access throughout. This section sets out the method used to select case study sites within the Melbourne CBD.

The primary question that guided the study is: ‘Is greater adaptability linked with greater vitality in mixed use areas of Melbourne’s CBD?’ Subtests were developed to examine: levels of building adaptability; levels of street vibrancy; and, whether greater levels of adaptability are associated with a greater variety of activities in a place over time. Case studies were chosen to represent characteristics exemplifying key aspects of the study, namely, *prima facie* high or low levels of adaptability and vitality.

A sieving exercise was conducted in order to choose cases for detailed study, based on 2 sources. The first was a survey conducted by Gehl Architects and the City of Melbourne (2004) providing information on the location of activities in the CBD and which was mapped to conduct the sieving exercise (see Figure 1). Adaptability information for sieving came from the study of Wilkinson and Reed (2010). Wilkinson’s study recorded building work types ranging through minor work, alteration, change of use and extension to show the levels of adaptation between 1998 and 2008. These data were translated from a spreadsheet to a map for a sieving exercise (see Figure 2).
The sieving exercise was conducted by first establishing areas with high and low activity levels: the location of retail, entertainment, 24 h convenience, accommodation and eateries were recorded. Streets that had a high level of activities were 1, 2 and 3, whereas low levels of activities were categorised in 4, 5, 6 and 7 (Figure 1). Second, areas of high and low levels of adaptability, based on

Figure 1. Sieving exercise-activity distribution.

Figure 2. Sieving exercise—overall building work type.

The sieving exercise was conducted by first establishing areas with high and low activity levels: the location of retail, entertainment, 24 h convenience, accommodation and eateries were recorded. Streets that had a high level of activities were 1, 2 and 3, whereas low levels of activities were categorised in 4, 5, 6 and 7 (Figure 1). Second, areas of high and low levels of adaptability, based on
type of building work undertaken, were evaluated from the adaptability map. Areas with high levels of ‘change of use’ or ‘alteration’ were taken to be the most adaptable. Areas with high levels of adaptability were 1a, 1b, 1c, 1d and 1e, whereas low levels of adaptability were seen in 1f and 1g (Figure 3). A field trip was carried out to visit the chosen sites to verify the extent of vitality and adaptability evident by observation. Overlaying the 2 maps allowed 2 streets to be chosen, representing prima facie high and low levels of adaptability and vitality, respectively, as exemplars, an accepted technique for case study research (Yin, 1994).

Data presented in this research were collected for Russell Street (Case A) and William Street (Case B) in the Melbourne CBD area, shown in Figure 4. These 2 streets align North–South and are part of the grid laid out in 1837. They are located on the East and West sides of the Melbourne CBD, respectively.

Vitality and Land Use Mix

Urban planning has long sought to influence land use distribution, separating out incompatible uses to reduce conflicts, and most notably isolating negative effects upon health and amenity from living areas (Howard, 1898; Hall, 1996). This segregation, traditionally achieved via zone-based regulation or master-planning, has been one of the most powerful tools of modern planning, forming the basis for many statutory and policy tools. However, it is now an established part of western planning’s lore that broad-based zoning can also result in many negative effects: ranging from excessively sprawling, inefficient, homogenous and isolated suburbs; to car dependency (Mees, 2000); and neglect of older less planned areas (Jacobs,
Counter-arguments therefore exist, seeking to modify the negative effects of zoning used as a blunt tool. Mixed use is commonly a key component of new urbanism (Calthorpe, 1993; Bernick & Cervero, 1997), even prompting some to suggest the ‘death’ of zoning (Ohm & Sitkowski, 2003). Mixed use has become a core axiom for many urban designers seeking to produce successful urban places (Roberts & Lloyd-Jones, 1996). Despite arguments for mixed use, little is known about how to measure ‘mix’ and what its real effects are, even while many recognize that there are health, safety and amenity limits to relaxing controls on land use distribution (Lund, 2003).

The central city of Melbourne is a useful location to consider mixed use. It is wholly contained within the Capital City Zone. Within limits, there are few
prescriptive influences over what land uses are allowed in this zone. The sections below describe the methods developed to measure levels of adaptability and vitality in the case study areas of the CBD. While a range of different attributes may comprise measures of street vitality, this study has focused upon 2 key elements: the range of land use mix in a place; and, the temporal numbers of people in the street. These attributes were derived from the urban planning and design literature as a basis for developing measurement tools. These attributes also provide possibilities for lines of understanding linking vitality to the tools that urban managers might have some influence over. Where appropriate, the authors from whom these tests were derived are acknowledged under each attribute.

The level of use-mix accounts for the number and proportion of different land uses among 7 categories predetermined by the authors: education, entertainment, residential, retail, office, restaurant/cafe and other. Use-mix level is based on proportions of floor areas, compared with an assumed ideal mix of 7 land uses. Floor areas were aggregated according to use. A greater mixed use value means a more even distribution of the relative amount of floor area for the total land use present. Analysis assumed that a higher ratio of the level of mix indicates greater land use mix. The underlying formula is elaborated below (adapted from Lawrence Frank and Company Inc., 2005).

Land use mix = $A/(\ln(N))$,
where $A = (b_1/a) \times \ln(b_1/a) + (b_2/a) \times \ln(b_2/a) + (b_3/a) \times \ln(b_3/a) + (b_4/a) \times \ln(b_4/a) + (b_5/a) \times \ln(b_5/a) + (b_6/a) \times \ln(b_6/a) + (b_7/a) \times \ln(b_7/a)$.

The formula above is oriented to the ideal of an even mix between 7 land uses (see Table 1). An even mix is ranked more highly than an uneven mix. In combination, a mix of 7 land uses is ranked more highly, with 7 evenly mixed uses receiving the greatest potential score. For instance, a place with 7 evenly mixed land uses of approximately 14.3% each would receive a perfect score of 1. A place with 5 evenly distributed land uses would receive an overall mix score of 0.83; 3 unevenly mixed uses would receive 0.53; 2 evenly distributed land uses 0.36; 2 uses (one 90% of total) 0.16; a single land use would be given a score of only 0.01. While a broad description, the mix test has the advantage that it does not actually prescribe a ‘perfect’ set of proportions. Rather, it allows for places with different levels and distributions of mix to be compared, understanding that each place is at a different stage of change and plays a different role in its context.

The sum of each use for Case A is shown in Table 2, represented as $b_i$. Using the level of mix formula described above, $A$ equals 1.38 (negative values ignored) making the land use mix 0.71 or 71%. In contrast, the values for Case B (as shown in Table 3) give a land use mix score of only 37%.

In Case A, each of the 7 uses pre-categorized for a correct level of mix are relatively evenly distributed. The land use distribution is shown in Figure 5.

Many of the businesses within the study area of Case A were observed to have retail and restaurant activities occupying the ground floor. The upper floors of these buildings often had commercial uses connected with businesses below, with the remainder occupied by residences or offices. In contrast, Case B includes
mainly office uses, occupying 80% of the total Floor Area. Ground floor areas of most buildings are used as lobbies for the office uses above. The building floor area covering uses such as retail, restaurant and entertainment comprised only 5%. It seems likely that a greater range of experiences or transactions are immediately available to residents, office workers and passers by of Case A than B.

Vitality and Vibrancy: People on the Street

A wider view of a vital place is one that meets people’s overall needs (hence the test of land use mix above)—this requires consideration as to the range of experiences necessary for a healthy life, including privacy, rest and contemplation. Quieter, contemplative and solitary activities can occur in a range of locations. In a busy city centre, it is desirable to have vibrant, busy and interactive public life on the street, the most public of realms (Montgomery, 1995).

The number of people on both sides of the street was recorded from 6 points in each study area. This is shown in Figures 6 and 7, recorded for 5 min simultaneously at 8.30 AM, 10.30 AM, 12.30 PM, 2.30 PM, 5.00 PM, 7.00 PM, 9.00 PM and 12.30 AM on a weekday, a Saturday and a Sunday (used as standard recording times in the study).

From the sum of each count, the mean value of each time interval was calculated for the 6 different observation points. The total number of people observed on a weekday (between 8.30 AM and midnight) was found to be 111,181 in Case A and 76,888 in Case B. As shown in Figure 8, the highest pedestrian counts of 1151 and 1010 were recorded during main meal times, i.e. 12.30 PM and 7.00 PM. While lower, Case B also had its highest counts at meal times, as shown in Figure 9: lunch time (898 people), followed by standard opening (655 people) and closing hours (611 people). In Case A, the high counts at points c and d, at the intersection of Russell and Little Bourke Streets are related to its location at a

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Square metres</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Total m² floor area for all 7 land uses in study area</td>
</tr>
<tr>
<td>b1</td>
<td>Total m² floor area for education</td>
</tr>
<tr>
<td>b2</td>
<td>Total m² floor area for entertainment</td>
</tr>
<tr>
<td>b3</td>
<td>Total m² floor area for residential</td>
</tr>
<tr>
<td>b4</td>
<td>Total m² floor area for restaurant/café</td>
</tr>
<tr>
<td>b5</td>
<td>Total m² floor area for office</td>
</tr>
<tr>
<td>b6</td>
<td>Total m² floor area for other</td>
</tr>
<tr>
<td>n</td>
<td>number of land uses with FAR &gt; 0 (7)</td>
</tr>
<tr>
<td>ln</td>
<td>Natural log</td>
</tr>
<tr>
<td>N</td>
<td>Number of uses (may be less than assumed ideal of 7)</td>
</tr>
</tbody>
</table>

Source: Adapted from Lawrence and Frank Company Inc. (2005).
<table>
<thead>
<tr>
<th></th>
<th>Retail (i = 1)</th>
<th>Restaurant (i = 2)</th>
<th>Apartment (i = 3)</th>
<th>Others (i = 4)</th>
<th>Office (i = 5)</th>
<th>Medical (i = 6)</th>
<th>Entertainment (i = 7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>b</td>
<td>7152.252</td>
<td>13273.592</td>
<td>53558.5135</td>
<td>18651.4</td>
<td>8315.699</td>
<td>232.0081</td>
<td>1939.66</td>
</tr>
<tr>
<td>b/a</td>
<td>0.069356</td>
<td>0.128716</td>
<td>0.51936473</td>
<td>0.180865</td>
<td>0.080639</td>
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<tr>
<td>ln(b/a)</td>
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<td>-2.0501472</td>
<td>-0.6551489</td>
<td>-1.71</td>
<td>-2.51778</td>
<td>-6.09691</td>
<td>-3.973410956</td>
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<tr>
<td>b/a × ln(b/a)</td>
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<td>-0.2638867</td>
<td>-0.3402612</td>
<td>-0.30928</td>
<td>-0.20303</td>
<td>-0.01372</td>
<td>-0.074736548</td>
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TABLE 3. William Street—land use mix calculation

<table>
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<tr>
<th></th>
<th>Retail (i = 1)</th>
<th>Restaurant (i = 2)</th>
<th>Apartment (i = 3)</th>
<th>Others (i = 4)</th>
<th>Office (i = 5)</th>
<th>Medical (i = 6)</th>
<th>Entertainment (i = 7)</th>
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<tr>
<td>b_i</td>
<td>2683.67</td>
<td>1355.47</td>
<td>10104</td>
<td>28920.2</td>
<td>208420.9</td>
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<td>8658</td>
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<td>b_i/a</td>
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<td>0.0052105</td>
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<td>0.111171</td>
<td>0.801181</td>
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<td>0.033281797</td>
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<td>ln(b_i/a)</td>
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<td>-5.257081</td>
<td>-3.248297</td>
<td>-2.19669</td>
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<td>-3.402744656</td>
</tr>
<tr>
<td>b_i/a \ln(b_i/a)</td>
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<td>-0.027392</td>
<td>-0.1261648</td>
<td>-0.24421</td>
<td>-0.1776</td>
<td>0</td>
<td>-0.113249458</td>
</tr>
</tbody>
</table>
Figure 5. Case A—land use distribution.

Figure 6. Case A—6 survey points.
crossing to China Town with many popular restaurants and bars. A drastic decline in pedestrian numbers was observed in Case B after 5.00 PM. The count reached its minimum at midnight, a total of only 7 people. In contrast, Case A had

Figure 7. Case B—6 survey points.

Figure 8. Case A—weekday people count.
consistently higher pedestrians levels at all times of the day with the lowest count reaching 236 per 5 min at midnight.

In Case A, the total number of people on Saturday was calculated to be 122,040 between 8.30 AM to midnight. This is higher than the weekday counts. Figure 10 indicates high activity levels, reflecting the areas more recreational emphasis. There is a significant rise in the counts after mid-day, with 12.30 PM and midnight the busiest. This supports the view that restaurants and bars play an important role in generating vibrancy in the area. In contrast, Case B counts were much lower on Saturday, with only 12,787 counted between 8.30 AM to midnight. This suggests that the predominant office use was the main generator of activity during the week (see Figure 11).

The Sunday counts showed the lowest figures in both cases with Case A having 89,187 overall and Case B is 7207. In both cases, the street was the busiest between 12.30 PM and 7.00 PM, probably due to visits to specialized restaurants and retail in both areas, but particularly in Case A (Figure 12). Figure 13 shows the

![Figure 9. Case B—weekday people count.](image)

![Figure 10. Case A—Saturday people count.](image)
FIGURE 11. Case B—Saturday people count.


FIGURE 13. Case B—Sunday people count.
low levels of pedestrians in Case B, mainly after 2.30 PM, when numbers decrease sharply, reflecting the lack of non-office uses such as cafes, restaurants or retail that might generate movement during public holidays.

**Measuring Adaptability—A Field Test**

The study also examined levels of adaptability. A field test to assess the adaptability of buildings, based on physical design features, was formulated. Weightings were developed to designate scores to the attributes of individual buildings. This list of physical building attributes derived from Wilkinson et al. (2009a), was exported into SPSS for analysis, based on empirical data of building adaptation over the period 1991–2009 in the Melbourne CBD. A total of 527 data points of commercial buildings were used from within the Melbourne CBD, and analysis in SPSS was used to determine whether there was a relationship between adaptations and attributes such as building height, age, size, width and so on. Associations between the variables were examined via principal component analysis (PCA). Independent variables were attributes such as age, location, size, height, number of floors and so on (shown below). Outcomes of the analysis were used to provide weightings to determine the adaptation potential of buildings. In total, these variables account for 79.62% of variance.

Table 4 shows the list of variables that the PCA correlated and then derived variance for each attribute. Of the total variance of 79.62%, in CBD adaptations between 1998 and 2008, each of the 4 components had a variance of 36.5%, 20.01%, 12.45% and 10.64%, respectively. In Component 1, plan shape was the

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Component 1</th>
<th>Component 2</th>
<th>Component 3</th>
<th>Component 4</th>
<th>Total variance</th>
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<td>Plan shape</td>
<td>0.875</td>
<td></td>
<td></td>
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<td>36.5%</td>
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<tr>
<td>Hostile factors</td>
<td></td>
<td>0.936</td>
<td></td>
<td></td>
<td>20.01%</td>
</tr>
<tr>
<td>Services core</td>
<td>0.882</td>
<td></td>
<td></td>
<td></td>
<td>12.45%</td>
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<tr>
<td>Floor size</td>
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<td>0.786</td>
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<td></td>
<td>10.64%</td>
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<td>Building width</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Building height</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td>0.896</td>
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<tr>
<td>Location</td>
<td>0.596</td>
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<tr>
<td>Occupation</td>
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<tr>
<td>Type of construction</td>
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<td>Access to building</td>
<td>0.537</td>
<td></td>
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</tr>
</tbody>
</table>

*Source: Wilkinson and Reed (2010).*

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strongest factor followed by floor size and site boundaries. In Component 2, the highest variance was for services core followed by occupation, building width and location. However, 2 of these attributes, location and occupation type (owned privately or institutionally, or occupied by single or multiple tenants) were not considered for the next phase of analysis since both attributes do not represent physical attributes. Component 3 was led by construction type, followed by age. Lastly, in Component 4 hostile factor has the highest variance followed by site access and number of stories.

Weighted values were developed for each adaptability attribute. In order to determine this value, the ratio of each explanatory component of variance by share of correlation with explanatory component was used. For example, the variable weighting (VW) for Plan Shape = \( \frac{0.875}{3.081} \times \frac{36.5}{79.62} = 0.127 \). All corresponding VW are shown in Table 4. Once these weighting values were finalized, Phase 3 included the development of a Type Weighting within each attribute as a proportion of conformance value ranging from 0 to 1, where 1 signifies the ideal case and 0 the lowest. With guidance from Wilkinson and Reed (2010), each attribute was associated with various modes of measurement and its respective likelihood of occurrence. For example, in the case of Building Age, since older buildings are more likely to require adaptation, a value of 22% was given to buildings between 42 and 156 years old. Further, the following values were assigned to this attribute: 0–18 years—7.2% and 19–41 years—70.6%. In order to achieve adaptability scores, these percentage values were manipulated into relevant categories. For the above Building Age attribute, these values were calculated to be—0.1 for 0–18 years, 1 for 19–41 years, 0.3 for 42–156 years and 0 for 157 years and above. To derive the individual Building Adaptability Score (BAS), the product of VW and Type Weighting was calculated for each building and its respective attributes. Once the Variable Score was derived, the Mean variable was calculated. The sum of each Mean variable of the 10 attributes is the BAS.

Data were collected from a number of sources including field work observation, measurement and documentation, combined with the commercially available database-Cityscope. Planning Scheme maps (DPCD 2010), Google Earth and Google Maps were also utilized to enable each building to be viewed as plans. Specific variable scores were compiled for each building to determine individual a BAS. These were, in turn, aggregated to an overall score for each case study area, as shown in Tables 5 and 6. For case A, the Mean variable score in of BAS was 0.39446, where an ideal result would be 1. The major attributes reducing its score were excessively small floor size in many buildings, considerably older building stock, awkward plan shapes and difficult service core locations. In contrast, redeeming features in many of the buildings were that many had site access on 2 sides (often by virtue of the traditional Melbourne rear laneways), brick construction and low-rise of less than 6 storeys.

For Case B, the BAS was 0.42844, marginally higher than Case A. Floor size, plan shape and service core location had strong effects on increasing its score. The majority of buildings in Case B have floor areas greater than 700 m² and large adaptable floor plans. These attributes are given high weightings for adaptability (0.10 and 0.06, respectively) resulting in a relatively high BAS.
value being awarded, despite negative features of many of the buildings, such as steel frame, heights well in excess of 6 storeys and excessively wide street frontages.
**Vitality—A Need for Adaptability and Adaptation**

Relationships between adaptability and vitality are difficult to demonstrate conclusively. In the cases reported above, Case A demonstrated much higher
levels of land use mix and street vibrancy as 2 key indicators of vitality, while Case B rated poorly on these measures of vitality. However, both cases, while having quite different building attributes, on balance, were rated as having quite similar levels of potential building adaptation. Case A, however, has significantly older buildings, averaging 98 years old, compared with 63 years old in Case B. This means, whatever the reasons for many more of the Case A buildings being retained and modified over time, the buildings have been able to be adapted. Montgomery (1998) suggests that well-adapted places have the ability for adjustment of activities over time with minimum effort. He argues that there are many variables that affect the vitality of a place, among which adaptation of form plays a key role.

When actual adaption is considered empirically in the 2 cases, it becomes clear that there is a considerable difference between the 2 sites. City of Melbourne Council planning records were examined to provide insight into the levels of adaption in each study area. All planning permit summary records within the sites relating to change of use or work permits for each building were examined starting from 1991. This excluded permits that were for subdivision and total rebuilding. In Case A, there were a total of 233 change of use or minor development planning proposals. In contrast, in Case B only 101 applications of this type were lodged. Although these records include evidence of multiple criteria of change per building and include the possibility that some permits were not acted upon, it indicates a much higher level of buildings being adapted and reused in the past 20 years in Case A. This shows that Case A has undergone significantly more instances of actual change of use as compared to Case B. As adaptability reflects the capacity of a built form to undergo change of use, the above planning permits are closely related to buildings being physically capable of being adapted over time. In contrast, the BAS developed in the study represents only that buildings have the potential to be adapted. This means that if the area is relatively newer and lacks a diverse land use mix (being primarily oriented to offices in this Case B), particularly at higher levels of tall buildings, it is unlikely to deliver vitality. Further research is required into the links between mix, vibrancy, adaptability and adaptation. However, the findings suggest further exploration as to whether greater levels of actual building adaptation (understood as ranging from change of land use alone, to significant building changes) over time are a factor linked to greater vitality.

**Conclusions and Implications**

The broad suggestion of this research is that successful urban areas accommodate complex patterns of diversity and mix, evolving and adapting the built form to meet changing social, economic and ecological circumstances. Such places are likely to continue to succeed, despite challenges, because their built form is itself mixed or highly adaptable (Montgomery, 1998). Traditional zoning may discourage this by regulating and unmixing cities by the use of rigid zoning separating single land uses to different parts of the city (Hellman, 1970, p. 81). This generates cities with less diversity in local areas, purpose built buildings, more traffic, reduced safety and diminished attractiveness of local streets. Further, places cannot easily respond to changing circumstances within existing building
stock. Diverse, highly adaptable and functional land use is essential to the creation and maintenance of attractive, liveable and sustainable urban environments. While not the direct subject of this paper, the Melbourne CBD policy environment does seem to facilitate a lot of this mix of use since the zoning system does not preclude it—suggesting a need for further work in this area to explore this link. However, in the case of Melbourne many buildings are purpose-built, particularly for offices and more recently residential apartments and contain considerable levels of use and built form inertia and homogeneity.

Jacobs (1961) stated that ‘cities are an immense laboratory of trial and error, failure and success’. This suggests that a certain level of ability for places to evolve and change is necessary to allow desirable outcomes to be achieved. Excessive control over land use reduces the potential for the trial, error and adaptive process of placemaking and limits them from developing their identity. It would be of value to apply the method used in the paper to broader regions internationally to consider wider impacts and relationships between adaptability, adaptation and vitality.

What is evident is that some of the factors that might be seen to assist with adaptability, such as large floor plates, may paradoxically actually hinder adaptation over time when they are associated with low levels of land use mix. It is possible that the conditions created over 100 years ago may provide better conditions for incremental adaptation by attracting over time more frequent small-scale investment in adaptation and changes of land use. Research is needed to consider whether it is actually adaptability that supports vitality, or if it is in fact scale, grain, location and quality of places. Determining this would allow issues that affect vitality, at ground level in the street, to be better regulated alongside factors that assist in avoiding overall building obsolescence. It would be beneficial to expand this study geographically and to include longer time periods to develop more concise principles and regulations to make the most from our economic and social investment in cities.

References


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