Policy intent meets reality: the conformance of 20 years of metropolitan compact activity centre policy in greater Brisbane, Australia

Abstract

For two decades, increasing concerns about urban sustainability have driven Australian metropolitan planning efforts to call for fundamental changes to existing urban forms. These changes are intended to develop more compact cities characterised by a poly-nodal network of dense activity centres. In this paper we provide the first long-term, comprehensive evaluation of the implementation of this policy in greater Brisbane. We combine census, employment, Google Street View, and aerial imagery data to evaluate the conformance of greater Brisbane's nominated activity centres against policy intent and find that the policy has conformed poorly. These results lend support to a growing number of studies that suggest Australia's market led approach to implementing strategic land use policy is ineffectual.

Keywords

compact city; activity centres; urban consolidation; plan evaluation; poly-nodal settlement; land use planning

Introduction

Drawing on a database of Google Street View (GSV) and aerial imagery, this paper evaluates one of the most widely adopted forms of compact city policy in Australia; the promotion of activity centres. Metropolitan planning policy in Australia has focused on creating more compact cities for the past twenty years. Policy makers argue that reshaping the existing urban form to incorporate a poly-nodal network of activity centres characterised by higher residential densities, a greater diversity of housing types, and more mixed clusters of employment generating uses, will support a range of sustainability benefits (Forster, 2006; Freestone, 2012).

However, a number of critics, both in Australia and internationally, have raised concerns about whether compact city policies would result in the purported sustainability outcomes, and predicted that the policies to reshape existing urban forms would prove difficult to implement (Birrell et al., 2005; Breheny, 1997; Gordon and Richardson, 1997; Troy, 1996; Williams, 1999). More recent empirical studies in Australia tend to support these predictions and evidence suggests that compact activity centre policies are having little effect on the evolution of urban form, either in terms of housing development (Chhetri et al., 2013; Newton and Glackin, 2014; Phan et al., 2009), or employment clustering (Day et al., 2015).

There are however a range of limitations associated with existing studies which prompt the need for further research. Existing empirical studies from Australia predominately focus on cases drawn from a single city and are based on data that is now ten years old, thereby omitting the significant growth in recent infill residential development. Although activity centre plans typically involve planning

horizons of 20 years or more, most policy evaluations to date have involved observations over shorter timeframes of less than five years (BITRE, 2013; Chhetri et al., 2013; Phan et al., 2009; The State of Queensland, 2006, 2008). This raises concern as to whether current evaluations have permitted sufficient time for plans to take effect.

Longer term comparisons of discrete urban areas are inhibited by a range of data limitations, particularly in terms of key population and housing data from censuses, prompting researchers to consider alternative methods and data sources on which to base their research (Buxton and Tieman, 2005; Coffee et al., 2016). This research overcomes these extant data issues and provides an up to date, holistic evaluation of compact activity centre policy. We describe greater Brisbane's activity centre policies, which we then use to inform the development of indicators to evaluate changes to centre intensity. We find that activity centre policy has conformed poorly to its stated objectives, and few of the nominated activity centres have changed in a manner that is likely to materially achieve their intended sustainability outcomes. These results align with findings from research in other Australian cities and indicate that current approaches to managing growth towards more sustainable urban forms lack suitable implementation mechanisms. This has implications for the achievement of the purported sustainability benefits intended by compact activity centre policy. We argue that evaluations of this nature are essential to subsequently determine whether compact sub-centres, even if implemented as intended, provide feasible mechanisms for more sustainable outcomes and set out a direction for future research to better guide how policy makers can best improve urban sustainability issues.

The case of greater Brisbane

We consider the case of activity centre policy for the greater Brisbane area; the capital city of Queensland, Australia. We selected Greater Brisbane as it has had metropolitan scale activity centre policies in place continuously since 1995 (The State of Queensland, 1995, 1998, 2000, 2005, 2009, 2017) and, to date, there has been no long-term and robust empirical evaluation of the implementation of these activity centre policies. These policies were adopted in response to rapid forecast population growth (at the time South East Queensland was one of the fastest growing regions in Australia), and examining their implementation provides critical lessons for future growth management interventions.

Starting with the voluntary policies of the Regional Framework for Growth Management of the 1990s, Brisbane's metropolitan policy became more formalised with the statutory planning of the South East Queensland Regional Plans that continue to dictate activity centre policy today. These regional plans cover a diverse array of topics including general issues of growth management, environmental preservation, and rural and economic development. The plans are also geographically expansive, covering an area of approximately 200x130km. Although some consider this area to constitute a 200km linear city, the primate core of urban economy in the region is constrained to the Brisbane CBD and its "concentric penumbra of residential suburbs" (Nightingale, 2006). We therefore focus our attention on the plans' policies for the development of activity centres within this Brisbane based conurbation by selecting the nominated activity centres that are within a 35km radius of the CBD.

The activity centre policies classify numerous areas across the region as sites for concentrations of higher density residential uses, a greater diversity of housing types, and the promotion of mixed clusters of uses that generate employment and provide services. The centres are differentiated in a two type hierarchy that differs primarily in the intensity of intended development, along with some additional centres intended for specialised uses rather than general sites for concentrations of

compact urban development. The existing nature of the centres however do not necessarily reflect their planned hierarchy and take a variety of forms including traditional style centres composed of shopping streets (e.g. Cleveland, Wynnum), centres dominated by large suburban shopping malls (Chermside, Upper Mount Gravatt), and historic town centres formed around railway stations and key administrative services (Ipswich, Beenleigh). Although the intended intensity of development in the centres increased with subsequent plans over time, the overall intent, locations, and implementation mechanisms for centres policy has been remarkably consistent for the past two decades.

To determine whether centre development has conformed to regional policy, we consider land use and demographic change for all nominated principal and major activity centres in the greater Brisbane area, between 1996 and 2016. This includes a total of 22 centres of which three were excluded (North Lakes, Springfield, and Ripley) due to being "greenfield" centres that are not directly comparable with the other centres in relative terms[1]. As the regional policy does not provide detailed spatial extents for each centre, we define this as all properties within a 1,200m walkable catchment from each centre's primary public transportation node. This definition provides a consistent basis for comparison between centres and consists of an 800m walkable catchment as defined in the centre policy itself with an additional 400m buffer to account for a "ripple effect" extending onto surrounding properties (Newton and Glackin, 2014).

Method

We evaluate plan implementation from a conformance perspective; a positivist approach that seeks to connect planned objectives to changes in the physical world (Alexander and Faludi, 1989; Loh, 2011; Oliveira and Pinho, 2009; Talen, 1997). This approach focusses on the degree to which a plan achieved its goals rather than untangling matters of multicausality (Loh, 2011; Talen, 1997). To do so, we compare the planned intent of activity centre policy with observable land use and demographic change.

We use Google Street View (GSV) and aerial imagery to create a detailed land use database, which we then use in dasymetric areal interpolation of census data to generate population and dwelling estimates at 1996 and 2016 across all properties within the study area (n=44,063) (Limb et al., 2018)[2]. We then combine this database with development approval data and data from shopping centre directories[3] to develop floor area estimates and create an estimate of the employment capacity of the built form[4] using typical employment to floor area ratio data[5]. We then reviewed a range of indicators commonly used to measure city compactness to select thirteen indicators based on their suitability to measure land use, demographic, and employment changes as intended by greater Brisbane's regional policy over a twenty year period (1996 to 2016) (Table 1, page 4).

If metropolitan planning policy intends to focus residential and employment growth within centres, it would be expected that after twenty years, higher rates of centre compaction would be observable compared to locations outside the centres. To measure this, we compare centre intensification with baseline changes across the broader conurbation. Data availability limits possible

[1] Centre locations are mapped in Figure 1, page 11

[2] We use recently released historic aerial imagery from the Queensland Government (The State of Queensland, 2018) to add current and past building footprints to the land use database.

[3] (Building Owners and Managers Association Queensland Division, 1993; Property Council of Australia, 2016)

[4] Although this estimate is principally an indicator of the employment capacity provided by a given built form and land use, it concords well with actual employment records in the Australian Bureau of Statistics' (ABS) Journey to Work data (ABS, 2016) for the 11 ABS destination zones that aligned with centre boundaries (Lin's concordance coefficient (Lin, 1989): Rc = 0.901 (95% CI, 0.690-0.971)).

[5] (City of Sydney, 2012a, b, c, d, e, f, g, h)

baseline measures and requires the development of a separate set of indicators to compare the centres with non-centre areas (Table 2).

Comparisons to baseline changes on previously undeveloped areas necessarily result in high relative change and these locations therefore need to be avoided in order to make fair comparisons to the already urbanised activity centre areas (for example. see discussion on BITRE reports in Limb et al., 2018). A 1991 map of existing urban areas was used to limit the baseline area to already developed areas (The State of Queensland, 1993). The baseline data was drawn from 1996 and 2016 census (ABS, 2016) using a method similar to that described by Coffee et al. (2016). The inner, middle and outer distance rings (inner = 0-5km, middle = 5km to 15km, and outer = 15 to 35km) were used to select the census areas that had a centroid within the rings, summing data in each ring, and excluding census areas that intersected the centre areas, or locations that were outside the 1991 developed areas. A lack of appropriate land use data also prevented the calculation of baseline employment density. Employment could therefore only be compared in terms of overall relative change. The baseline employment figures were calculated in the same way as the baseline population and dwelling numbers except using Journey to Work data with 1996 statistical local areas (SLAs) and 2016 Destination Zones (DZNs)[6].

Table 1 - Centre intensification indicators

Indicator	Description	Data	Source
Density			
Relative population change	Relative difference in population	Land use database	Google Street View (ABS)
Relative dwelling number change	Relative difference in numbers of dwellings		Nearmap aerial imagery (ABS)
Net population density change	Change in persons per net residential hectare		Google Earth historic aerial imagery (2001-2016)
Net dwelling density change	Change in dwellings per net residential hectare		QLD government historic aerial imagery (1995-1997)
Change in average land area of low density dwellings	Change in net land area of low density residential uses divided by the number of low density dwellings		
Change in proportion of population living at low densities	Change of population of low density uses divided by total centre population	Census data	ABS Census (2016)
			ABS Census (1996)
Dwelling Mix			
Relative change of low density dwellings	Difference in number of low density dwellings divided by the number of initial low density dwellings (the lower the difference the more compact)	Land use database	As above
		Census data	As above
Relative change of low medium density dwellings, medium density dwellings, and high density dwellings	Difference in number of low medium density dwellings, medium density dwellings, and high density dwellings divided by the respective number of initial dwellings. The higher the difference, the more compact the dwelling types		
Employment			
Relative employment change	Relative difference in estimated employment	Land use database	As above
		Building footprints	Google Street View (2016)
Net job density change	Change in the number of estimated jobs divided by the area of employment land in hectares		Nearmap aerial imagery (2016)

[6] We increased the 1996 employment totals by a factor of 1.086 to make them comparable to the 2016 figures as described by Terrill et al. (2018)

Indicator	Description	Data	Source
Change in Employment plot ratio	Change in the floor area of employment buildings divided by the area of employment land		QLD government historic aerial imagery (1995-1997)
		Workspace ratios	City of Sydney floor area survey's (2012)
		Shopping centre floor area data	Property Council of Australia (2016) Building Owners and Managers Association (1993)
		Census data	ABS Census – Place of work (2016)

Table 2 - Baseline (non-centre) intensification indicators

Indicator	Description	Data	Source
Density			
Relative population change (non-centre)	Relative difference in population in non-centre, initially built-up areas	Census data	ABS Census (2016) ABS Census (1996)
Relative dwelling number change (non-centre)	Relative difference in numbers of dwellings in non-centre, initially built-up areas	Map of built up areas 1991	Queensland Government (1993)
Relative population density change (non-centre)	Relative change in population density (population by built up hectares of non-centre areas)	Census data	ABS Census (2016) ABS Census (1996)
		Map of built up areas 1991	Queensland Government (1993)
Relative dwelling density change (non-centre)	Relative change in dwelling density (number of dwellings by built up hectares of non-centre areas)	Queensland land use classifications	Queensland Government 1999 and 2016
Change in proportion of population living at low densities (non-centre)	Change of population of low density uses divided by total centre population (non-centre)	Census data	ABS Census (2016) ABS Census (1996)
		Map of built up areas 1991	Queensland Government (1993)
Dwelling Mix			
Relative change of low density dwellings (non-centre)	Difference in number of low density dwellings divided by the number of initial low density dwellings (the lower the difference the more compact) (non-centre)	As above	As above
Relative change of low medium density dwellings, medium density dwellings, and high density dwellings (non-centre)	Difference in number of low medium density dwellings, medium density dwellings, and high density dwellings divided by the respective number of initial dwellings. The higher the difference, the more compact the dwelling types (non-centre)		
Employment			
Relative employment change (non-centre)	Relative difference in estimated employment	As above	As above

Analysis

Due to the relatively small number of centres, combining indicators into an overall index using techniques such as factor and principal component analysis (as undertaken by Ewing and Hamidi, 2014) is not possible. The small number of centres however does permit the direct comparison between centres, and their change overtime. Along with direct comparisons of the values of each

indicator, z-scores can be calculated to measure a combination of indicators (Burton, 2002; Galster et al., 2001; Stathakis and Tsilimigkas, 2014). To reduce the possibilities of any one indicator having an overly dominant effect, this study follows the approach used by Burton (2002) and averages the z-scores to develop rankings of each indicator category, as well as a total compactness ranking. The scores have been given equal weighting due to a lack of supporting information to justify alternative weightings. The z-scores only allow for comparison between the centres themselves. Baseline measures are therefore compared directly to the centre measures to provide an indication of how the centres are faring in comparison to development across the broader conurbation.

Results

The results demonstrate that conformance with activity centre planning policies has been poor, with few centres showing evidence of intensification that is consistent with all aspects of the activity centre policies or displaying evidence of growth that exceeds general development increases that have been achieved across the wider urban area. The results also highlight the considerable differences between centres, and a pattern of change that sees clusters of conforming centres in inner and middle locations, with non-conforming centres mostly located in outer areas. The lack of conformance was primarily the result of limited change, rather than of changes that were directly contrary to compact activity centre policy. These results indicate that the activity centre policy was not implemented as intended. In this section we describe the combined results before discussing the results for each indicator type and their comparison to baseline changes.

Combined results

The combined intensification scores for each centre are shown in Table 3. The colour coding in the table is based the score's distance from the average for each indicator group,[7] and graded as either below average (score <= -0.5 - orange), average (score > -0.5 and < 0.5 - grey), or above average (score >= 0.5 - green). The asterisk indicates where the centre recorded greater than baseline change in the majority of the available baseline indicators for a given category.

Table 3 - Overall centre intensification scores, 1996 to 2016

Location	Centre	Overall intensification score	Density intensification score	Dwelling mix intensification score	Employment intensification score
Middle	Chermside	1.53	**1.74***	**1.77***	**1.07***
Middle	Carindale	0.73	-0.36	**-0.27***	**2.81***
Middle	Indooroopilly	0.65	**0.83***	**0.58***	**0.53***
Outer	Cleveland	0.64	**1.05***	**0.66***	**0.19***
Inner	Toowong	0.56	0.79	0.67	0.21
Middle	Toombul	0.40	**1.13***	**1.02***	-0.94
Middle	Upper Mount Gravatt	0.32	-0.01	**0.10***	**0.87***
Outer	Capalaba	0.10	**0.76***	**0.11***	-0.57
Outer	Ipswich	-0.07	-0.78	-0.02	0.60
Outer	Strathpine	-0.14	-0.08	**0.02***	-0.36
Middle	Mitchelton	-0.29	**0.13***	-0.24	-0.77

[7] As these scores are derived by averaging the z-scores of the various indicators, a score of 0 is approximately equal to the average of the composite scores.

Outer	Browns Plains	-0.35	-0.82	-0.58	**0.35***
Outer	Beenleigh	-0.36	-0.40	**-0.19***	-0.49
Outer	Redcliffe	-0.38	-0.64	**-0.32***	-0.16
Outer	Logan Hyperdome	-0.44	-0.71	-0.68	0.06
Middle	Wynnum Central	-0.55	-0.14	-0.73	-0.79
Outer	Logan Central	-0.57	-0.58	-0.57	-0.56
Outer	Goodna	-0.70	-0.88	-0.73	-0.50
Outer	Springwood	-0.80	-1.04	-0.59	-0.79

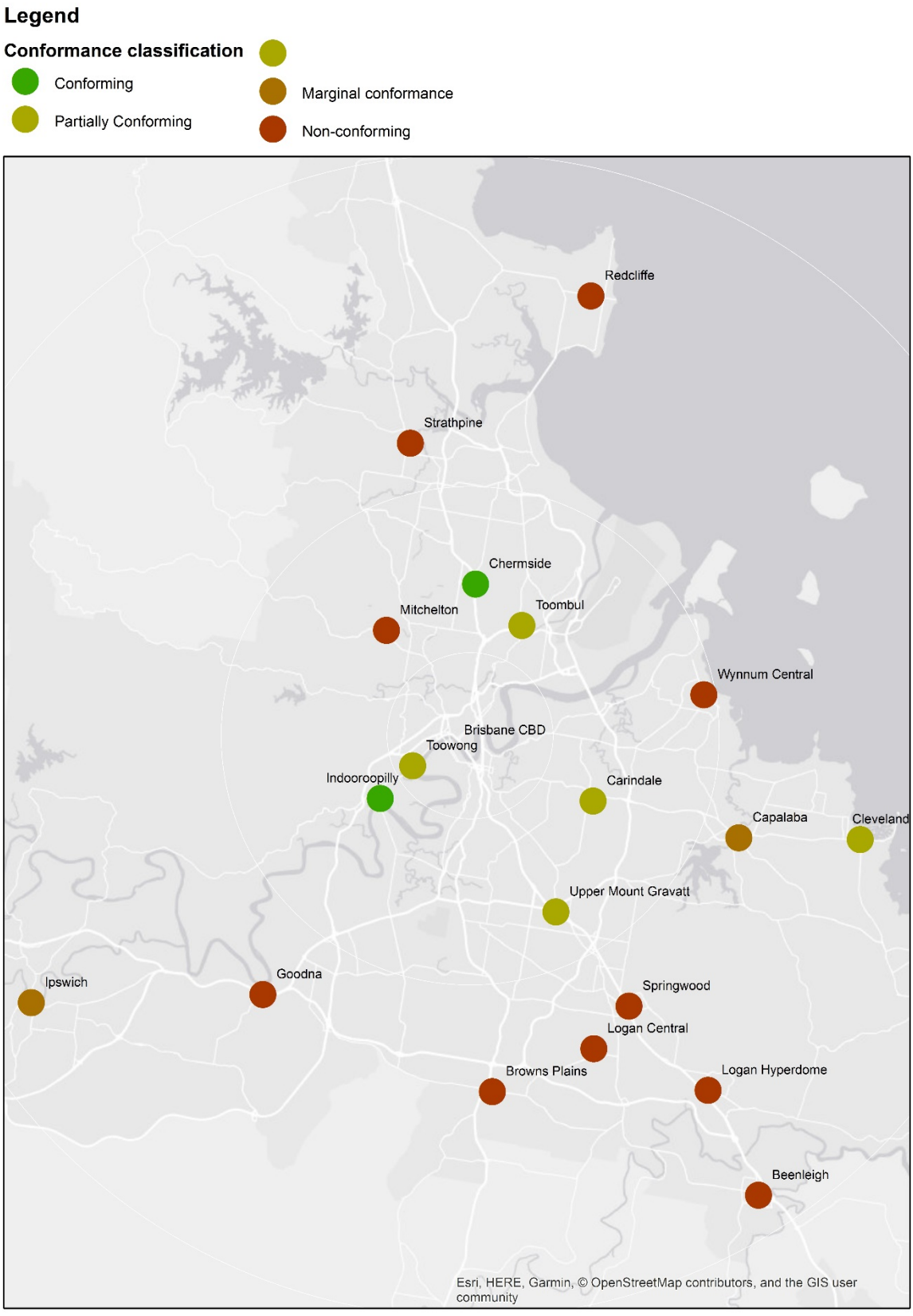
The centres were assigned one of five categories based on these intensification scores, a consideration of the centre's characteristics of development, and their relative change in comparison to the baseline changes. The results of this classification are described in Table 4.

Table 4 - Classification of centre conformance

Category	Centre	Score based criteria
Conforming	Chermside Indooroopilly	Above average scores in all indicator groups.
Partially conforming – residential	Cleveland Toowong Toombul	Above average scores in both residential groups
Partially conforming - employment	Carindale Upper Mount Gravatt	Above average score in the employment group and average scores in the residential groups
Marginal conformance	Capalaba Ipswich	Above average score in one group, but below average score in another group
Non-conforming	Strathpine Mitchelton Browns Plains Beenleigh Redcliffe Logan Hyperdome Wynnum Central Logan Central Goodna Springwood	All scores average or below average

Figure 1 plots the classification of centres spatially. As with the individual indicators, the conforming centres are mostly clustered within middle rings locations.

Figure 1 - Centre locations with conformance classification



Categorising the centres into different types of conformance captures the key centre differences, however the creation of such categories inevitably requires a line between categories to be drawn

somewhere. Although examples of s*ome* positive change can be observed in all the centres, regional centre policy intends for these centres to change at a scale that would make a material difference to the overall sustainability of the urban form. The ultimate line for conformance therefore requires positioning to reflect centres that have seen an appreciatively significant change to the urban form.

There are not only fundamental differences between how the centres have changed overtime, but also in terms of their core physical structures and functions. These factors shape potential development possibilities and the end result is a complex picture of change that includes wide variations in patterns of development. Only two of the nineteen centres display substantive progress in becoming more compact in all nominated categories, while just five centres showed partial conformance (Table 4). Centres in outer ring locations typically conformed more poorly compared middle ring centres. Here, the lack of conformance was primarily the result of limited change rather than of changes that were directly contrary to compact activity centre policy, suggesting metropolitan policy has an implementation problem.

Higher residential densities

Proposals to increase residential densities in proximity to centres have been a consistent feature of regional policy and key to the justifications of the purported sustainability benefits of more compact urban forms. The results show that although there is typically positive conformance in terms of reductions in the amount of land used for low density dwellings, the key indicators for population, dwelling and density change reveal that most centres failed to intensify greater than baseline population and dwelling growth.

Population, dwelling and density change

The results in Table 5 and Table 6 show that there are clearly significant differences between how centres have densified and a pattern emerges of inner and middle centres showing greater intensification than outer centres. When comparing to patterns of change in non-centre areas, these results are contrary to the intent for metropolitan centre policies to concentrate higher density residential development in centres.

In total, only five of the nineteen centres exceed baseline measures for changes in population, dwelling and residential density by more than five percentage points. Although most inner and middle centres are growing at a similar rate as surrounding areas, only half of the centres (Chermside, Indooroopilly, Toombul, and Mitchelton) have growth that exceeds baseline measures by more than 5 percentage points. The outer centres conform particularly poorly on this metric. Only Cleveland outpaces baseline growth in all categories. Capalaba and Strathpine grow at rates similar to non-centre outer areas, although Capalaba does display greater residential density change. All other outer centres have population and dwelling change that is less than the outer area baselines.

Table 5 - Results of population, dwelling and density change

Location	Centre	Relative population change	Relative dwelling change	Net population density change (person per hectare_	Net dwelling density change (dwellings per hectare)
Inner	Toowong	0.48	0.39	25.78	11.62
Middle	Carindale	0.11	0.26	1.78	2.71
	Chermside	0.77	0.79	26.20	14.58
	Indooroopilly	0.49	0.43	21.45	8.98
	Mitchelton	0.30	0.36	8.52	4.64
	Toombul	0.53	0.49	26.49	13.88
	Upper Mount Gravatt	0.23	0.22	9.45	3.64
	Wynnum Central	0.23	0.19	8.37	3.40
Outer	Beenleigh	0.12	0.04	5.88	1.64
	Browns Plains	-0.02	0.06	-0.61	0.67
	Capalaba	0.15	0.29	10.79	8.04
	Cleveland	0.58	0.81	10.72	8.10
	Goodna	0.03	0.01	0.72	0.12
	Ipswich	-0.06	-0.01	1.87	1.89
	Logan Central	0.14	0.02	5.77	0.47
	Logan Hyperdome	-0.05	0.02	0.30	0.68
	Redcliffe	0.03	0.11	1.67	2.17
	Springwood	-0.06	-0.04	-1.30	-0.24
	Strathpine	0.31	0.37	1.70	1.85

Table 6 - Difference between centre and baseline population, dwelling and density change

		Difference in percentage points between relative change for centre and baseline in respect to:			
Location	**Centre**	**Population change**	**Dwelling change**	**Population density change**	**Dwelling density change**
Inner	Toowong	1.6	-2.0	0.6	-2.9
Middle	Carindale	-12.1	2.5	-11.1	2.9
	Chermside	54.3	55.7	58.7	60.1
	Indooroopilly	26.6	20.1	33.4	26.9
	Mitchelton	7.0	12.7	12.1	17.8
	Toombul	30.1	25.8	31.5	27.4
	Upper Mount Gravatt	-0.3	-1.4	2.2	1.2
	Wynnum Central	0.0	-4.2	5.8	1.7
Outer	Beenleigh	-16.7	-30.4	-1.2	-14.2
	Browns Plains	-31.0	-28.3	-25.9	-23.5
	Capalaba	-14.1	-4.7	1.4	11.4
	Cleveland	29.1	47.3	44.6	63.4
	Goodna	-25.7	-32.7	-13.9	-20.2
	Ipswich	-35.1	-34.9	-19.6	-18.8
	Logan Central	-14.5	-31.7	0.9	-15.6
	Logan Hyperdome	-33.3	-32.2	-17.8	-16.0
	Redcliffe	-25.6	-22.6	-10.1	-6.5
	Springwood	-34.2	-38.0	-18.7	-21.9
	Strathpine	2.6	3.4	3.1	3.9
The figures below are the baseline results for change in the built-up conurbation for non-centre areas.					
Baseline	Inner	45.9%	40.8%	46.9%	41.8%
	Middle	22.8%	23.3%	17.0%	17.4%
	Outer	28.6%	34.0%	13.2%	17.9%
	All	28.0%	29.9%	18.3%	20.0%

Legend

	exceeds baseline by > 5 percentage points
	less than baseline by < 5 percentage points
	similar to baseline by +- 5 percentage points

Note: These density change figures are calculated in terms of built-up hectares in order to be directly comparable to baseline density figures as discussed previously. They differ to the net density for centres results shown in Table 5.

Low density living

Low density dwellings are defined as detached dwellings and duplexes. Conformant centre policy should see the reduction in land area used by these types of uses, as well as reductions in the proportion or population housed in these dwelling types overtime. These measures show better conformance than density measures. Table 7 shows the difference in these indicators overtime. All centres show some reductions in average lot areas, with Capalaba demonstrating a large change

primarily related to the conversion of a number large low density lots to low-medium density townhouses. Other reductions were the result of a combination of low-medium density conversions and subdivision of existing low density dwellings to create additional low density dwellings, such as observable in Wynnum. Most centres have also seen reductions in the proportion of the total population living in low density dwellings. As with changes to densities, these changes are greater in the middle ring centres. Comparing these figures to measures of baseline areas shows that most centres saw reductions greater than changes to the broader conurbation (shaded in green). However, this was typically a pattern already established prior to the commencement of activity centre policy as most centres already exhibited a smaller percentage of population living in low density dwellings compared to non-centre areas.

Table 7 - Results of changes to low density dwellings and populations

Location	Centre	Change in average land area of low density dwellings (m2)	Change in proportion of population living at low densities
Inner	Toowong	-71.28	-10.2
Middle	Carindale	-6.05	-14.1
	Chermside	-24.82	-36.7
	Indooroopilly	-84.32	-17.8
	Mitchelton	-66.61	-12.1
	Toombul	-59.71	-19.8
	Upper Mount Gravatt	-25.88	-18.5
	Wynnum Central	-87.53	-5.5
Outer	Beenleigh	-55.74	-10.8
	Browns Plains	-29.30	-4.1
	Capalaba	-326.38	-12.7
	Cleveland	-85.38	-25.2
	Goodna	-38.03	0.9
	Ipswich	-35.05	-4.9
	Logan Central	-22.20	-6.7
	Logan Hyperdome	-106.37	-1.7
	Redcliffe	-20.75	-5.7
	Springwood	-6.72	-2.3
	Strathpine	-14.05	-18.4
Baseline	Inner	n/a	-17.2
	Middle	n/a	-7.4
	Outer	n/a	-4.6
	All	n/a	-8.1

Dwelling mix

The relative change for each dwelling type by centre is shown in Table 8. Almost all centres a saw a reduction in proportions of low density dwellings, or if low density dwellings increased, they did so at a rate lower than the baseline rate. In outer baseline areas for example, low density residential uses represent the single largest increase in dwelling types. The outer activity centres however are not following this trend, with most centres showing reductions in the proportion of low density dwellings. The middle centres are similar however Wynnum and Mitchelton do show higher proportions of low density dwellings due to a pattern of small scale, one into two subdivisions. The baseline measures for low-medium density dwellings show that these forms of housing are common in middle and outer non-centre areas. The middle centres typically match or exceed baseline changes. In outer areas only Capalaba, Cleveland and Strathpine outpace their surrounding areas.

The most pronounced differences between baseline and centre changes relate to medium and high density dwellings types. This is primarily evident in middle ring centres, where the changes typically far exceed the baseline changes. In outer locations however, these forms of dwellings are not common either within, or outside the centres. Only Beenleigh, Cleveland, and Redcliffe deliver a significant quantum of medium/high density dwellings. Like the density measures, indicators for dwelling mix show uneven results, but higher degrees of conformance in middle locations. Where dwellings are added in any significant number, they typically are of higher density types. The issue for the outer centres however is the overall lack of development activity in general and several of the outer centres have seen little in the way of residential development. This is especially pronounced in Browns Plains, Goodna, Ipswich, Logan Hyperdome, and Springwood, where few new dwellings have been added.

Table 8 - Relative change in dwelling types, 1996-2016

Location	Centre	Relative LD dwelling change	Relative LMD change	Relative MD Dwelling change	Relative HD dwelling change
Inner	Toowong	-3.6%	-0.5%	17.8%	25.1%
Middle	Carindale	0.9%	18.3%	0.0%	6.6%
	Chermside	-14.5%	39.6%	4.1%	49.8%
	Indooroopilly	-2.3%	5.3%	14.5%	25.8%
	Mitchelton	6.9%	12.8%	12.4%	3.9%
	Toombul	-5.7%	10.2%	20.6%	24.0%
	Upper Mount Gravatt	-4.1%	7.0%	3.7%	15.3%
	Wynnum Central	7.1%	8.3%	3.2%	0.5%
Outer	Beenleigh	-3.3%	-1.1%	8.0%	0.0%
	Browns Plains	0.5%	5.2%	0.0%	0.0%
	Capalaba	-3.9%	31.6%	1.6%	0.0%
	Cleveland	4.3%	53.3%	13.1%	10.5%
	Goodna	1.6%	0.2%	-0.5%	0.0%
	Ipswich	-8.5%	1.9%	3.3%	2.3%
	Logan Central	-0.4%	1.6%	0.0%	1.0%
	Logan Hyperdome	1.2%	0.6%	0.0%	0.0%
	Redcliffe	-0.6%	-0.4%	3.1%	9.2%
	Springwood	-1.7%	-2.4%	0.0%	0.0%
	Strathpine	-0.6%	36.2%	1.8%	0.0%
Baseline	Inner	-3.8%	1.9%	9.4%	25.4%
	Middle	7.1%	9.2%	1.9%	1.6%
	Outer	20.9%	8.8%	0.4%	0.9%
	All	10.3%	7.6%	2.5%	5.4%

Legend

	exceeds baseline by > 5 percentage points
	less than baseline by < 5 percentage points
	similar to baseline by +- 5 percentage points

Note: The low density dwelling column is coded inversely to reflect the normative position that more compact centres should see reductions of low density dwelling types.

Employment factors

Table 9 shows the relative change between the measures of estimate employment in 1996 and 2016. The results are colour coded to show how they compare to the baseline changes in employment for their respective locations. In the inner and middle centres, it is the big box shopping dominated centres that show increases greater than the baseline. In the outer centres, only Browns Plains and Cleveland show larger employment changes than baseline growth. With only six centres

showing higher than baseline growth, the policy is conforming poorly in terms of objectives to focus employment based uses within centres.

Table 9 - Estimated relative change in employment net job density and employment plot ratio, 1996 to 2016

Location	Centre	Relative estimated employment change	Net job density change (jobs per hectare)	Change in Employment plot ratio
Inner	Toowong	28.3%	41.50	0.11
Middle	Carindale	**147.4%**	93.38	0.30
	Chermside	**73.5%**	61.37	0.16
	Indooroopilly	**59.0%**	35.48	0.14
	Mitchelton	14.3%	8.68	0.03
	Toombul	7.2%	4.88	0.02
	Upper Mount Gravatt	**72.8%**	47.05	0.16
	Wynnum Central	6.3%	8.97	0.04
Outer	Beenleigh	40.8%	10.15	0.04
	Browns Plains	**144.0%**	-1.67	0.07
	Capalaba	30.0%	7.20	0.05
	Cleveland	**71.0%**	23.34	0.09
	Goodna	41.7%	9.40	0.04
	Ipswich	55.9%	42.84	0.14
	Logan Central	24.9%	11.45	0.05
	Logan Hyperdome	56.8%	22.78	0.09
	Redcliffe	43.7%	23.20	0.06
	Springwood	13.7%	6.98	0.03
	Strathpine	40.9%	13.48	0.06

Legend		Baseline location	Relative baseline change		
		Inner	35.5%	No baseline data available	No baseline data available
	exceeds baseline employment rates	Middle	44.9%		
	less than baseline employment rates	Outer	65.0%		

The job density indicator also shows very large differences between centres. Carindale for example, is notable for its high density which is almost entirely the result of a large scale expansion to a major shopping centre - Westfield Carindale. Although Carindale has lower absolute employment than Westfield Chermside, the Carindale shopping centre is located on a smaller lot, with less external land area used for car parking, and it therefore achieves a higher overall density. Other big box dominated centres (Indooroopilly and Upper Mount Gravatt) also show high employment densities, and Chermside's big box centre is bolstered by significant expansions to the nearby Prince Charles Hospital. Ipswich is noticeable among the outer centres both in terms of initial employment density, as well as overall change from 1996. The city centre has seen the development of Riverlink Shopping

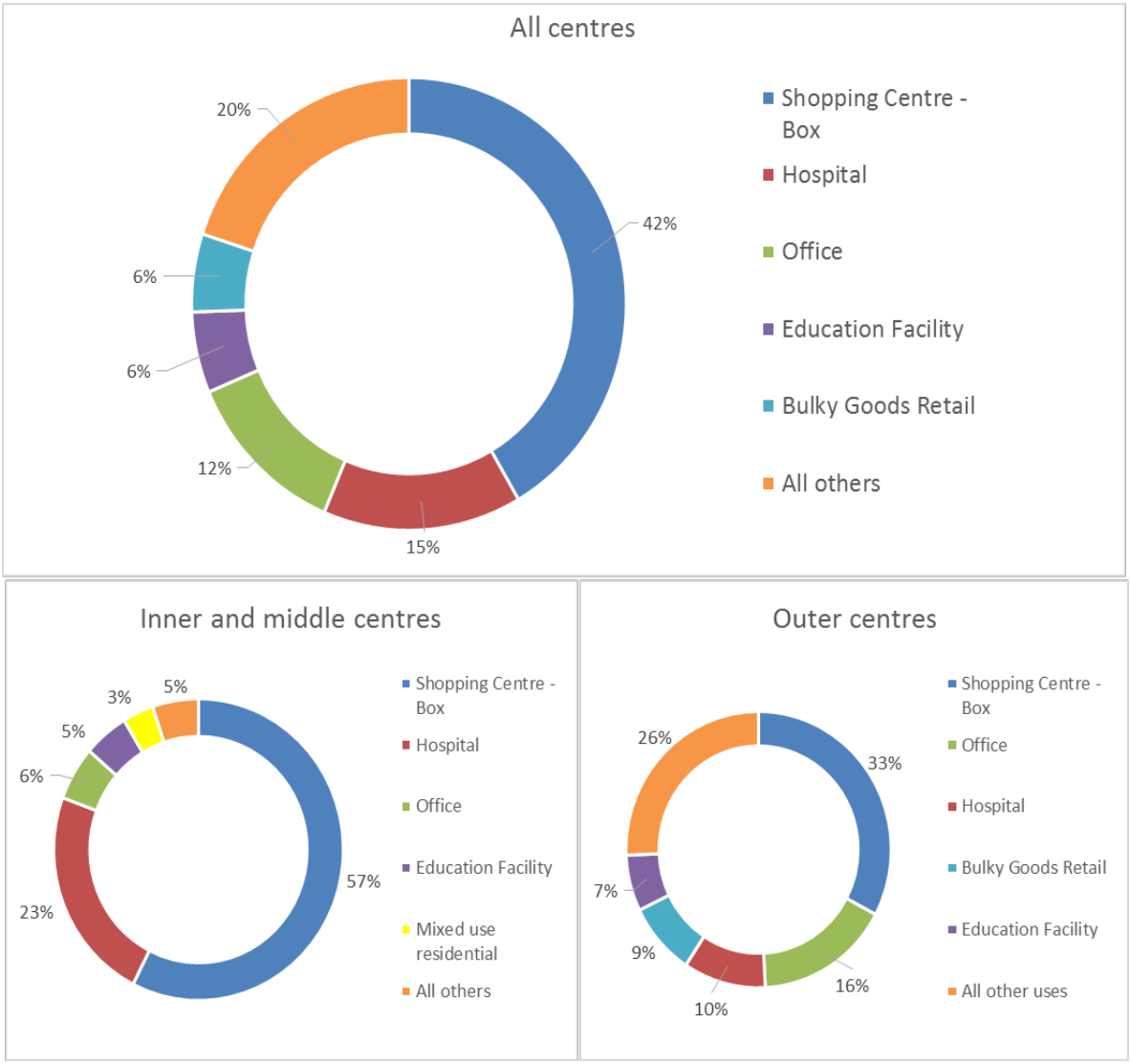
Centre (a big box shopping mall), expansions to the Ipswich hospital, and a new multistorey office development led by a council owned development corporation. All centres have seen some increase in employment density, except for Browns Plains. This centre has had a large number of new employment generating developments, including a new mixed use “main street”. However, it has also seen the development of land hungry uses within the centre such as large scale bulky goods retail, low intensity mixed industry development, and significant areas of warehousing. These uses are characterised by expanses of car parking combined with large floor areas and low job ratios, which have resulted in the reduction in overall employment density despite the addition of new employment. Toombul is another centre of interest and has seen the conversion of a number of employment uses into mixed-use residential towers. However, these towers often contain ground floor employment based uses that are small, and which sometimes resulted in reduced employment capacity compared to the retail and light industrial uses they replaced.

Plot ratio scores show similar variations with the dominance of Westfield Carindale and its large floor area on a relatively small site (for a big box centre of its scale) revealing the highest plot ratio. Other centres that had large scale big box shopping centre upgrades also scored highly. Toowong’s high rise built form yields higher plot ratios, as do the multi-storey offices of Ipswich. Toombul’s change to a more high rise built form did not translate to notably higher plot ratios as these new developments are primarily residential, and the associated employment uses are confined to portions of the lower floors.

Types of Employment change

The type of employment change that is occurring is typically in line with regional planning intentions. The employment change is occurring in desired use types such as shopping centres (i.e. combination of retail, office, and some services), institutions (hospitals, schools, etc.), and offices. Some of the outer centres show growth in bulky goods retail. Bulky goods retailing can be problematic in that it makes use of large floor spaces, with relatively low employment rates, and often requires the movement of goods that are of size that require private transportation. These traits do not align well with overall compactness objectives. Bulky goods retailing is none the less provided for in regional activity centre policy and is therefore technically not contrary to planned intentions. Browns Plains was the only centre that showed large increases in uses not intended by centre policy (warehousing). Employment change shows differences between inner, middle and outer areas (Figure 2). Big box shopping centres offer the most significant type of employment growth across all areas, however in the inner and middle areas this use type dominates employment growth. Outer area employment growth is split between greater varieties of use types. Without shopping centre employment growth, the employment figures for the centres would be considerably more marginal compared to the baseline. Although shopping centres consist of uses typically desired for centres, the employment associated with their growth is likely to be low skilled, retail focussed, and the big box nature of these developments tends to cater primarily to those arriving by car. This begs the question of how beneficial such dominant growth in this sector is to the broader sustainability objectives that justify compact activity centres, and whether planning policy needs to better consider the nature of employment that should be delivered in centres.

Figure 2 - Percentage estimated employment change by use, top 5, 1996-2016



Discussion and conclusion

Australia has a long history of large scale policies that have attempted to manipulate urban growth both within and away from cities, typically with poor results (Davidson, 1997; Jain and Courvisanos, 2009; Lonsdale, 1972; Simons and Lonergan, 1973).The results of this research unfortunately contribute to this disappointing pattern of Australian strategic land use implementation failures, where grand visions were developed absent the presence of feasible mechanisms for their implementation. As long as forty years ago, scholars argued that attempts to centrally plan large scale population and employment relocations in a society that "…places an overriding premium on economic productivity, efficiency, and growth", were working against economic forces that were "…too powerful and too fundamental to be overcome by the kind of efforts that governments have been willing to take" (Lonsdale, 1972). Twenty years later, McLoughlin (1992) demonstrated that planners' efforts to reshape Melbourne according to a predetermined pattern of commercial centres had failed to materialise, leading to the conclusion that planning had achieved few of its more strategic objectives and instead succeeded primarily in maintaining suburban forms of development through the enforcement of prescriptive development controls such as building setbacks for minor developments.

The rise of compact city policy is another example of planners once again seeking to resolve urban issues through fundamentally reshaping broad-scale urban forms. In the incipient days of these policy movements Breheny (1997) cautioned that implementing the compact city was likely to prove highly challenging due to the "daunting" task of "…reversing the economic geography that underpins demographic geography". These challenges are even greater when considering the activity centre concept, which requires large scale urban development trends to be channelled into relatively precise geographic areas that are often far removed from locations with the greatest economic demand.

This was also a key conclusion of a prophetic paper by Birrell et al. (2005) in relation to Melbourne's activity centre policy which they believed had failed to "…keep in perspective the difficulty of changing land-use patterns sufficiently to meet the broad objectives of [the] strategy, given the limited tools available to the current planning system." Forster (2006) notes that activity centre policies appear to be conceived in a "parallel universe", where planning intent exists in a realm separate from the realities of the Australian urban form and development processes. The results from this research support these claims and show that consistent attempts to develop regional scale activity centres in greater Brisbane over the past two decades have mostly failed to materialise. These results add to the findings of other empirical studies from Melbourne (Chhetri et al., 2013; Day et al., 2015; Newton and Glackin, 2014; Phan et al., 2009) and suggest that there is a key disconnect between Australian strategic policy objectives and implementable reality, and that this situation is consistent across multiple jurisdictions.

The ultimate purpose of the centres policy is justified by the reasoning of achieving ecological sustainability. Although the activity centre policy was not expected to achieve this result alone, it was intended to have positive impacts on this aim. Gleeson (2012) argues that the difficulty of implementing the compact city, and the slow incremental changes that the planning system is capable of delivering, means that the underlying justification will almost certainly fail to be met within the urgent timeframes required to avert key sustainability challenges such as climate change. Understanding implementation challenges is therefore vital if planning is to have meaningful effect on its core justifications and we suggest three key areas of future research to advance this aim.

First, it is necessary to better understand the factors related to implementation success or failure of activity centre policy. Have the observed implementation failings been due to issues of plan *performance,* i.e. the use of the plan by local governments when making/amending their land use plans and subsequent development approvals? Or is it more the result of fundamental issues around property economics, transport, and/or existing urban characteristics? We address these questions for greater Brisbane in a series of additional forthcoming papers where we find the plan has performed well, and that factors related to the economics of property development best explain centre development[8]. We believe expanding similar research to cover additional cases is important to determine if these trends are applicable to other cities that utilise similar planning approaches.

The results from the research in this paper also suggest that identifying the key characteristics that drive activity centre development may be more complex than existing narratives of diversity of use and transport accessibility suggest. Although there was clearly a pattern of greater intensification of centres nearer the CBD, the existing nature of those centres appears to bear little resemblance to their degree of intensification. For example, although the heavy rail focussed concentration of uses at Indooroopilly centre saw high levels of intensification over time, so too did the poorly connected, big-box shopping centre based environment at Chermside (which demonstrated greater overall

[8] Citations to this research will be provided once published

intensification compared to all other centres). Traditional shopping streets supported by heavy rail didn't necessarily guarantee intensification either; while Cleveland developed mostly as intended, similar centres such as Wynnum did not. Exploring such aspects further is fundamentally important not just for gaining an understanding of the implementation of centre policy, but of any similar policy that seeks to shape the physical reality of development, particularly in the current context where the dynamics of real estate speculation and property economics are so powerful.

Second, it is necessary to better understand whether activity centre policies, if implemented, contribute to their purported sustainability objectives. Although there is an ongoing consensus that more compact cities are generally more sustainable (Ewing and Hamidi, 2015), there is a lack of research that evaluates sustainability outcomes for activity centres within cities. To empirically confirm this however, we must be able to identify the locations where planned intensification occurred if we are to undertake subsequent evaluations to determine if there is a corresponding improvement in measures of sustainability.

This leads to the third key area of future research which should focus on improving conformance-based evaluations. The results from this research highlighted some of the complexities involved in making reliable comparisons of urban intensification. The assembled indicators would therefore benefit from further analysis and refinement. By including additional cases, the selected measures could be subjected to more statistical testing, as well as permit the development of more complex models that can better explain their results. The development of suitable indicators also proved challenging, with new methods being required in order to overcome data limitations. This future research would therefore benefit from the expansion of existing open data policies, especially in terms of detailed land use data and historical data sets.

After two decades of policy attempts, sufficient time has now passed to further evaluate whether land use planning interventions in the urban form are yielding the promised results. This research has demonstrated that activity centre policy in greater Brisbane is mostly not, and that the policy has proven difficult to implement just as predicted by early compact city critics (Birrell et al., 2005; Breheny, 1997; Troy, 1996). It would be optimistic at best to believe that this failure of conformance is limited to activity centre policy and does not extend to other aspects of planning policy. As warnings of catastrophic climate change become increasingly dire (IPCC, 2018), the consequences failing to respond to sustainability issues are more pressing than ever. Now is the time for further planning evaluation to determine what aspects of policy are effective and as a consequence, exactly what role planning can best play in improving urban sustainability.

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