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PRACTICE REVIEW

A Decade of Transit Oriented Development Policies in Brisbane, Australia: Development and Land-Use Impacts

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ABSTRACT

Transit-Oriented Development (TOD) involves intense, mixed development around transit nodes. This article investigates the extent to which TOD policies have become reality in Brisbane, a city of two million in eastern Australia, which has embraced TOD at a policy level. It also aims to present a straightforward method which cities in Australia and internationally can employ to measure the outcomes of their TOD policies. Through GIS analysis, the authors measure the level of concentration of population, dwellings, and jobs in rail-based TOD nodes—as opposed to areas that are unserved by the train network. The results do not support the notion that Brisbane is a transit-oriented city. Nonetheless, there is a moderate trend toward the concentration of people and dwellings in TOD areas. The planning sector could accelerate this trend through policy measures.

以公共交通为导向的发展（TOD）指围绕公交枢纽进行密集型、混合型开发。本文考察布里斯班 实施TOD 的情况。这座澳大利亚东部城市人口200 万，已经制定了TOD 政策。本文还试图推荐 一种可在澳大利亚和其他国家城市中用来衡量TOD 效果的简便方法。通过GIS 分析，作者测量了 轨道交通枢纽的人口、居住和工作密集度，并与不通火车的地区进行了对比。结果显示布里斯班 算不上以公共交通为导向的城市。不过，TOD 地区人口和居住密度略有增加。规划部门可通过政 策措施加速这一趋势。

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Transit Oriented Development; Brisbane, Australia; GIS analysis

1. Introduction

Starting in the second half of the twentieth century, many western cities, especially those within the Anglosphere, have spread horizontally in a low-density fashion. Urban sprawl has resulted in loss of green space, lack of choice in terms of housing products, segregation of land uses, long distances between destinations, over-reliance on automobiles, traffic congestion and related externalities, and costly requirements to expand infrastructure (Downs 2007). These problems are acute in Australian cities, especially lower density ones. In response, in the last few decades a number of planning concepts—including "growth boundaries," "planned unit development," "form-based zoning," "green urbanism," etc. - have been introduced or revived in order to manage urban expansion in a more efficient and sustainable manner (see Goetz 2013).

Recently, there has been keen interest in creating a more coordinated approach to growth management in order to achieve a more sustainable urban form (Curtis 2012a). One emerging concept is Transit Oriented Development (TOD), which involves intense, comprehensive development around transit nodes.

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The term encapsulates the process of focusing the development of housing, employment, activity sites and public services around existing or new railway stations served by frequent, high quality and efficient intra-urban rail services (Cervero 1998). In practice, TOD can take place under two different circumstances, which can occur within the same city. The first circumstance includes framing new urban growth around TOD nodes; the second involves restructuring established areas to enhance TOD (Curtis 2012a).

In both cases, common TOD traits include compactness, pedestrian and cycle-friendly environs, public and civic spaces near stations, and stations as community hubs (TCRP 2002). The creation of dense, compact, mixed-use, and attractive neighbourhoods within walking distance of rail stations is thought to promote active and public transport, increase accessibility, and shorten commutes. In parts of Europe and Asia, the TOD approach reaches further than single locations towards a network approach, which aims at realigning entire urban regions around rail transport and away from the car. While these are the basic TOD tenets, the model has been revised to fit a variety of contexts (including low-density cities and regions), as accounts of TOD practices from North America, Europe, Asia, and Australia illustrate (for specific examples, see Curtis et al. 2009). However, TOD is not a panacea. Cities around the world have attempted its implementation with varying degrees of success (Hale 2012). In Australia, TOD has been somewhat sporadic and limited (Curtis 2012b).

Brisbane - a city of two million inhabitants in eastern Australia - has attempted to embrace TOD at a conceptual and practical level. Here TOD has become an important goal as the city is under pressure to balance transportation infrastructure provision and a rapid population growth (driven by a relatively strong economy and a mild, subtropical climate). Brisbane is the centre of Southeast Queensland - the fastest growing region in Australia (BCC, 2008). An increase in population in the past two decades has been accompanied by a proportional increase of private car ownership and use.

The city features an attractive train network, which however, is underutilized. Undeveloped or underdeveloped areas around train stations offer a major opportunity to create TOD. In recognition of this potential, the state and local governments have begun promoting TOD strategies in the last decade. It has been determined that in order to guarantee the success of TODs, a strategic planning framework and statutory planning base that requires development at the necessary intensity of use is essential (Newman 2009). However, currently in Brisbane there are no existing statutory planning mechanisms for TOD alongside a lack of private-public funding mechanisms (Newman, 2009).

This study investigates the extent to which TOD policies have become reality in Brisbane. Through GIS analysis, the authors measure the level of concentration of population, dwellings, and jobs in TOD nodes—as opposed to areas that are unserved by the train network. The study also aims to present a straightforward and accessible method which cities in Australia and internationally can employ to measure the outcomes of their TOD policies. The study timeframe is the period between 2006 and 2011, which encompasses the two latest censuses since the first mention of TOD in a regional-level policy document.

The article is divided into four main sections. The first section provides background on TOD, including rail-based and bus-based versions. The second section is an overview of the case study: current land use and transport issues in Brisbane, as well as TOD policies adopted in the last decade. The third section delineates the study method, and the fourth section presents the findings.

2. Brief Review of TOD Concepts and Issues

Successful TODs promise a range of benefits to a variety of parties. The public sector can benefit from TOD through increased transit ridership and fare revenue; joint development opportunities; enhanced economic development; increased tax revenues; and reduced infrastructure costs. The community can benefit from TOD through neighbourhood revitalization; reduced traffic congestion; reduced travel distances; reduced pollution and fuel consumption; increased safety (from traffic and crime); increased physical activity; contained sprawl; and preserved open space. Finally, the private sector can benefit from TOD through increased real estate values; increased rents; increased retail sales; increased labour pool access; and reduced parking provision costs (TCRP 2002).

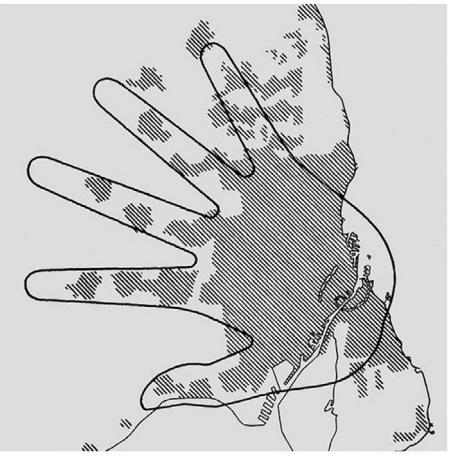

Figure 1. Copenhagen's "Finger Plan" based on the first master plan of 1947. Map courtesy of the City of Copenhagen.

Within Europe, "finger cities" including Copenhagen (Figure 1), Stockholm, Amsterdam, and Helsinki, have been among the most successful in applying TOD (Knowles 2012). This planning concept, albeit called by other names or not named at all in policy, has been an intrinsic principle of planning in these capital city regions since WWII. In the early post-war period, entire new satellite towns, "lobes," or "fingers" were developed around the peripheral stations of the train and metro systems. Every station became a focal point for high density housing and local retail services, with linkages provided between each suburb and onto the CBDs. This period reflected the economic prosperity and a popular desire to suburbanize. In later years, in parallel with the urban revival movement, TOD efforts were transposed to the inner cities, in new brownfield redevelopments. In both cases (earlier greenfield suburban and later brownfield urban TODs), the national, regional, and local governments played a major role in steering development towards public transit stations and lines—or in servicing existing housing developments with public transport. The TOD phenomenon (a marriage of transit and land use) did not occur naturally (Knowles 2012; Bertolini and Spit 1998; Cervero 1995).

However, studies to date maintain that TOD is a complex concept, which cannot be easily transferred in its entirety from place to place (Pojani and Stead 2014a). A meta-analysis of 11 international TOD case studies identified 16 critical success factors in TOD implementation, the most significant being: political stability and continuity, relationships between actors in a region, interdisciplinary teams used to implement TOD, and public participation. In different contexts, different combinations of critical success factors apply (Thomas and Bertolini 2014, 2017). Failure outcomes are also useful in understanding the paths to successful TOD implementation. Barriers may include inopportune timing (dependent of economic cycles), low appeal or poor marketing of the TOD concept, fragmented land ownership, zoning regulations, complex institutional setup, and low stakeholder interest (Pojani and Stead 2014b; Searle et al. 2014).

The foregoing studies of critical success factors and barriers to TOD implementation refer to cases in which the public and private sectors have made a concerted effort to capitalise upon the proximity to transit. If development is physically near transit but fails to constitute an activity centre and achieve high transit performance, it is sometimes labelled as Transit Adjacent Development (TAD) (TCRP 2002; Kamruzzaman et al. 2014). The quantitative benchmarks for distinguishing between TOD and TAD are unclear (Hale 2012). Therefore, the present study combines TOD and TAD outcomes but distinguishes between TOD centred on rail (R-TOD), Bus Rapid Transit (B-TOD), and ferry (FOD) stations and corridors.

2.1. Rail-Based TOD

Rail-based TOD focuses on the areas surrounding rail transit stations. It is the most traditional form of TOD (see Knight and Trygg 1977; Cervero 1998). Most existing TODs are created in suburban areas and greenfield sites, in which the transit system and urban development have taken place simultaneously. Successful, dense and high-quality R-TODs set into motion a virtuous cycle in which they generate income, which then goes into creating future high-quality TODs, which further boost economic returns, and so on. However, many large metropolitan regions have existing well-developed rail systems which present a different set of difficulties in terms of TOD. The soil around pre-existing train stations might be polluted and in need of costly clean-ups before new housing development can take place. Also, station areas might be the foci of social problems and therefore less attractive to developers whose target is the middle class (Loo et al. 2010; Loo and Lam 2007). In some contexts, the development tradition and public values might be against high-density TODs around train stations - especially where high density housing is associated with overcrowding, low income, and crime issues. To overcome R-TOD barriers, cities around the world have employed a variety of incentives for developers, including development bonuses, tax reductions, and reductions in car parking requirements. In some cases major retail and office development in non-TOD areas is also strictly restricted in order to steer development toward stations (Babalik-Sutcliffe 2002).

2.2. BRT-Based TOD

While rail is more closely related to high-density and large-scale developments, Bus Rapid Transit (BRT) too provides opportunities for TOD development. BRT has gained prominence worldwide as a cost-effective alternative to urban rail investments which can be utilized to address urban congestion (Currie 2006a; Pojani 2014). However, bus services are associated with lower density and smaller scale development. The lack of dedicated TOD development staff in the bus industry, the noise and pollution impacts of buses, and a poor track record of buses in relation to TOD are some other weaknesses of B-TOD. In some cases, long-range strategic planning and urban development objectives are usurped by near-term engineering and cost-minimisation objectives, resulting in BRT lines being routed and stations sited in areas with minimal development potential (Currie 2006b; Cervero & Dai 2014; Judy 2007).

2.3. Ferry-Based TOD

The literature examining FOD is quite limited, as ferries are a somewhat neglected mode. As of late 2002, when the last report on this type of TOD was produced, less than 2% of the projects centred on ferry stations or corridors (Sipe and Burke 2011). In certain post-industrial cities, with abandoned freight ports, a desire to remedy brownfield sites, revitalize waterfronts, and achieve smart growth has created FOD opportunities. A few very successful FODs exist in London, New Jersey, and Gothenburg. FOD will likely expand as in cities near water bodies ferry ridership is growing. This is due to a revamped image of earlier stodgy ferries, as well as to the safety, comfort, enjoyment (including aesthetic pleasure), and speed (lack of congestion) of ferry travel compared to road-based modes. However, ferries are at a risk of losing passengers if highways, bridges, and tunnels are built in their proximity, which would then lower the potential for FOD. (Ferry systems that run parallel to the land, in rivers as opposed to bays, are less common and have traditionally had a difficult time competing with land-based transport modes.) (Sipe and Burke 2011).

3. Case Study: Brisbane

Brisbane is the capital and the largest city in the state of Queensland. At two million inhabitants, it is the third most populous city in Australia after Sydney and Melbourne. It is also one of the most

important economic centres of Australia. It is located in the south-eastern region of the state, which comprises nine local governments, including the City of Brisbane and two major tourist destinations on the Pacific Ocean—the Gold Coast and the Sunshine Coast. As mentioned, South East Queensland is the fastest growing region in Australia (BCC 2008). Between 2006 and 2011, Brisbane experienced a population increase of 11.5% (ABS 2015). In conjunction, household sizes have shrunk and the share of older persons has shifted upwards. Due to exorbitant housing costs in inner-city neighbourhoods, newcomers have tended to concentrate in the city's outer suburbs (BCC 2008). As for employment, higher status white-collar jobs, especially in government, are heavily clustered in the CBD (Burke et al. 2010). The residential population dispersal has produced long commutes and traffic congestion especially when combined with employment concentration within a relatively small central area and a large volume of daily commuters from surrounding municipalities.

3.1. Transit Availability and TOD Potential

The Brisbane public transport network comprises more than 380 km of rail and numerous bus lines, including segregated busways (BRT), which are overseen and coordinated by an integrated agency (TransLink) established in 2003 (Figure 2).

Brisbane's rail network developed in the late nineteenth century. It was initially intended to service freight routes. Consisting of six suburban lines, it extended from the CBD in a radial pattern. The early urban settlement was shaped by the railway. As the city developed, railway stations clustered tightly near the CBD, which is attractive and includes multiple activity hubs and services. However, the contemporary urban form reflects a linear city that has grown around its highway system, with the car being the dominant form of transport for all trips except the CBD journey to work (Spearritt 2009).

Brisbane's BRT was first introduced in 2000. Including primarily segregated busways, frequent service, and rapid speed but lacking pre-board fare payment, it is classified as Silver BRT (Pojani 2014). A total of 25 km (in three lines: Southeast Busway, Northern Busway and Eastern Busway) were built up to 2011. Although limited in size, the BRT system has been successful and currently serves more than 70 million passengers per year. At station locations, significant investment has taken place. The majority of this development either existed or was planned prior to the government's decisions on station locations. In fact, these decisions were largely dependent on existing and planned development. The five stations closest to centre city are fully transit oriented, while the five stations furthest from the CBD clearly reflect suburban development patterns. B-TOD development in Brisbane is not the result of market forces, but the result of careful coordination between government agencies undergoing facility expansion, and negotiations with private developers in the target growth areas. In fact, the government has contributed in kind to station area private development (e.g., by acquiring land and working with developers to build integrated station/TOD.) Additionally, multiple tiers of government have contributed to station area development and urbanization by building for their own needs in these locations. Overall, Brisbane has used a "carrot" approach to encourage TOD at BRT stations rather than "sticks," such as requirements for high density development or pedestrian accommodations (Judy 2007).

Alongside BRT and railway lines, Brisbane also has a network of catamaran river ferries (CityCats), introduced in 1996. Ferries have helped reorient the city back to its river and encourage inner city densification while promoting a greater use of public transport. The growth of the CityCat network has been significant over the past decade. Currently, ferries are considered as a key transportation mode. In 2008, they carried more than 6 million passengers, servicing 23 locations throughout the city. However, key transport and land use planning policies in Brisbane have not yet considered the use of CityCats as a means to achieve TOD (Sipe and Burke 2011).

While vehicle ownership has grown in Brisbane (with only 8% of the households being carless citywide), public transport patronage has increased too (Barlow and Streeting 2007). However, the modal share of public transport remains relatively low - only 8%. Inner city neighbourhoods

Figure 2. Public transport lines (trains and buses) in Brisbane. Map courtesy of TransLink.

Brisbane have lower car ownership (less than 1 car per household) and higher public transport use (up to 15%) (BCC 2008). Reflecting job centralisation, both bus and train services are much more frequent within the city core, while the remaining areas are heavily reliant of private cars for transport.

In view of this situation, in its first statutory regional plan in 2005 the Queensland Government (QG) set forth TOD as a key strategy to achieve sustainable urban development outcomes in the

Brisbane metropolitan region (QG 2009a, 2015). A fine-grained TOD guide was prepared some years later, along with a few TOD site plans around key stations (QG 2009b, 2010, 2014). The transit sector and the City of Brisbane also indicated their commitment to TOD through several policy documents (BCC 2014a, 2014b; Batts 2011). Development is in process in a few prioritized nodes along the train network.

The case of Varsity Lakes, a small suburb in the Gold Coast (not within Brisbane), is noteworthy. In the late 1990s, a study was completed to identify a future rail corridor to connect Robina/Varsity Lakes to the Gold Coast Airport. As a result, a regional plan in 2004 identified potential to convert the Varsity Lake station into a TOD node and "urban village." The 14 ha (then vacant) site was acquired by the public sector in 2006 and TOD planning promptly started (Richards 2009). The master plan provided for a wide variety of housing types, employment opportunities, shopping, and social activities. A form-based design approach was applied. It encouraged subtropical building forms up to 12 stories, which could take advantage of views to the ocean and the hinterland. The master plan won the prestigious Karl Langer Award for Urban Design in 2009. Combined with nearby Robina and Bond University, the Varsity Lakes TOD constitutes one of the largest health and knowledge precincts of the Gold Coast.

This TOD was expected to become a model for future similar developments in the region, but it has had limited success in this respect (QG 2009b). Beyond this case, there is some evidence to indicate that implementation in other prioritized TOD nodes has been piecemeal and inefficient (Batts 2011). However, where TOD has succeeded, it has led to reductions in car use and increases in active transport (Shatu and Kamruzzaman 2014). But the level of concentration of people, homes, and jobs in rail-based TOD areas has not been systematically measured so far. The present study aims to fill this research void.

4. Methodology

The method was inspired by an earlier study (Cervero and Landis 1997), which investigated the land-use and development impacts of the Bay Area Rapid Transit (BART) system in the San Francisco Bay Area, California - twenty years after its inception. As the earlier study, it focuses on rail-based TOD—while recognising the importance and potential for B-TOD and FOD in Brisbane. The present analysis relies on Geographical Information Systems (GIS)—a mature technology for the analysis of geo-referenced data (i.e. statistical data referenced to the Earth's surface). GIS allows for both the statistical processing of data and the creation of maps to present processed information visually.

The demographic data was collected from the Australian Census, accessed via the Australian Bureau of Statistics (ABS) website. Census data availability and consistency poses some restrictions to this analysis. In the case of population and housing units, data was downloaded on a "Mesh Block" (MB) level. MBs are the smallest geographical unit in the Australian Statistical Geography Standard for which census data is available. Most residential MBs contain approximately 30 to 60 dwellings. MB counts are only available for the 2006 and 2011 census. At the time of the 2001 census, a different geographical unit was employed (ABS 2015). Therefore, to keep comparisons uniform the data was only analysed for 2006 and 2011. Also, as mentioned, TOD was first put forward as a desirable regional policy goal in 2005.

In the case of job units, data was downloaded on a "Destination Zone" (DZN) level. DZNs are the smallest census unit that contains information on where employed people over 15 years of age worked in the week prior to the Census Night. DZNs are larger than MBs. Georeferenced data on employment are only available for 2011. In earlier censuses this information was not collected (ABS 2015). Therefore, the available data allows for a snapshot of job locations—whether within or outside TOD areas—but does not allow for a comparison of the 2011 situation and earlier periods.

The analysis proceeded according to the following steps:

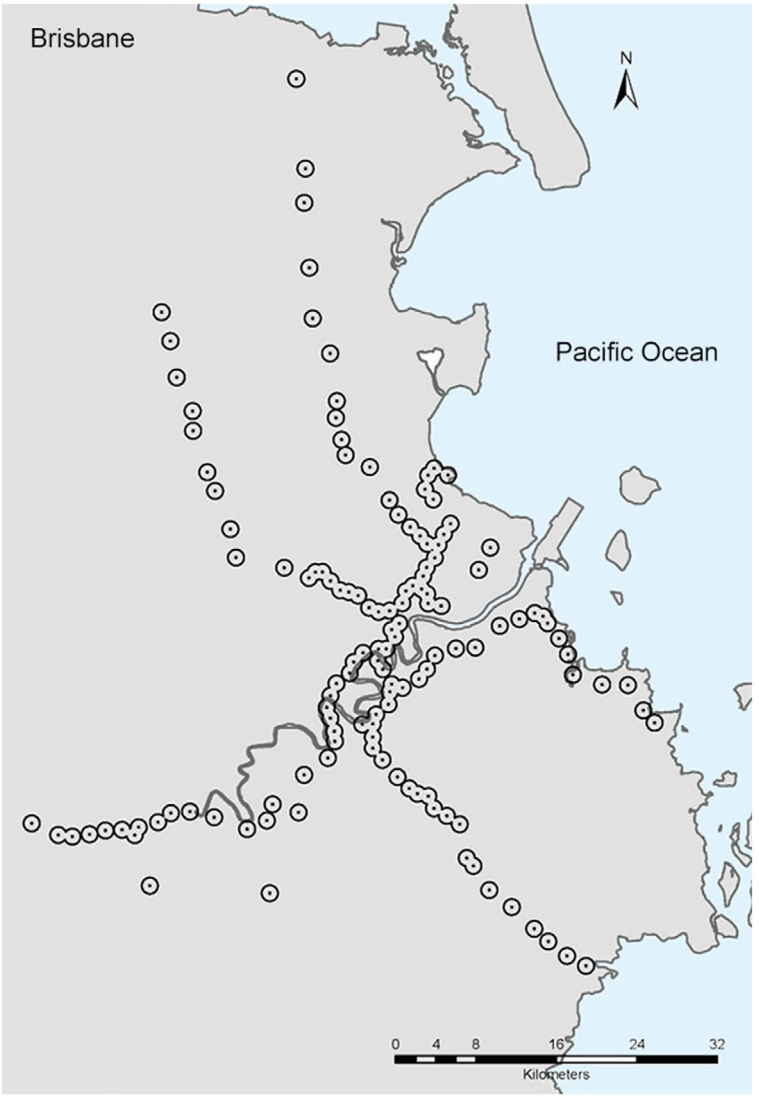

Figure 3. TOD buffers (circles and corridors) around train stations. Map by authors.

First, TOD areas in Brisbane were identified by creating a buffer around the 133 train stations which fall within the city limits (Figure 3). The buffer radius was set at 800 m because this is the distance recommended in the TOD guide prepared by the Queensland Government. It is considered a comfortable 10 min walkable distance (QG 2010). In some cases, especially in the city centre, TOD buffers overlapped. Where this was the case, the areas within the overlapping circles were merged together and calculations were performed for the entire TOD corridor thus formed. MB and DNZ units which fell within, or intersected with, TOD circles or corridors were included in the analysis. All the other areas were considered Non-TOD (Figure 4).

Second, the authors sought to discern whether concentration in TOD circles and corridors is due to the presence of the train station or merely to the distance from the city centre. For this purpose, a series of circles centred on the CBD were drawn on the map to help with the analysis. The circle

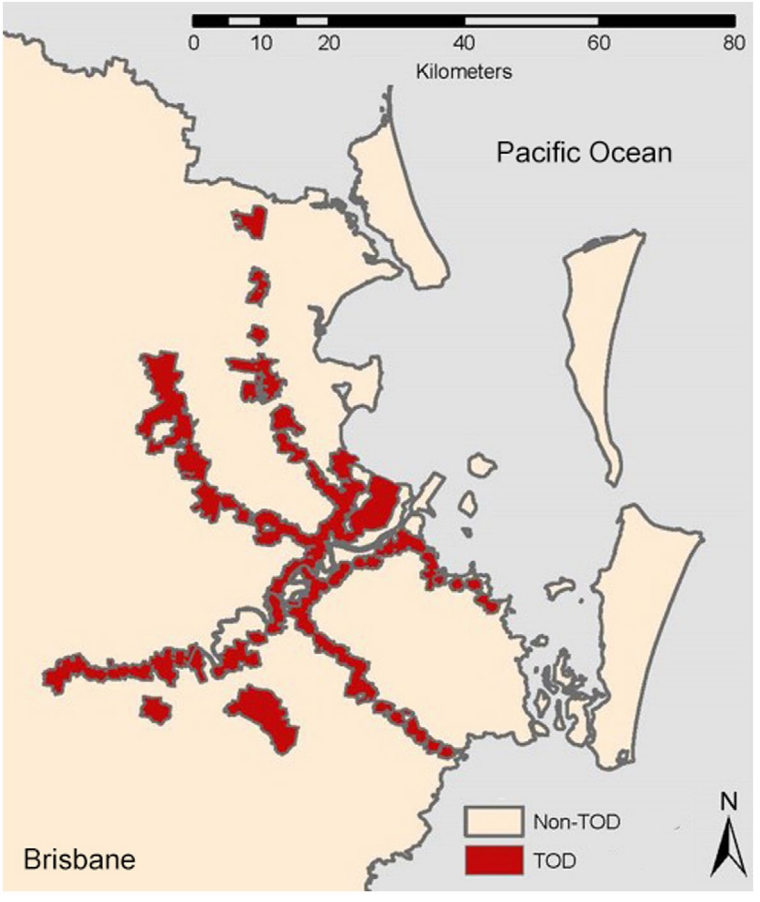

Figure 4. MBs which fall within or intersect with TOD circles and corridors. Map by authors.

radii were 3, 5, 10, 20, and 30 km. The circles were more frequent in the centre as here land-uses are finer-grained and urban services are more densely-packed.

Third, an analysis was undertaken of population, housing, and employment concentration in TOD areas vs. Non-TOD areas (as a total and broken down by distance to the city centre). The various densities in Non-TOD areas within each band were averaged for ease of analysis. In the case of population and housing units, snapshots were taken of the 2006 and 2011 situation, and the percentage change between 2006 and 2011 was calculated. In the case of employment, only a snapshot of the 2011 situation was taken as data for 2006 is missing, as mentioned.

A note on the methodology. One might argue that an imperfect match between TOD buffers and census geographies (i.e. the fact that some census data lies outside TOD circles) is detrimental to the analysis. However, the authors reasoned that a TOD circle (like a census unit) is an arbitrary geography. The perimeter of a TOD circle is equidistant from the station point on an abstract map. In reality, people within a TOD zone do not move in straight lines from the circle border to the station but follow road layouts and pedestrian paths, which vary based on local design patterns. Also, the density of people, houses, and jobs, is not evenly distributed within the TOD circle. Therefore, the modification of TOD areas based on ABS geographies is likely to have little impact on the study outcomes. Moreover, even if a higher level of precision were desirable, the way census data is coded

Table 1. Concentration of people, dwellings, and jobs in TOD vs. Non-TOD areas (overall).

	2006	*2011*	Absolute change *2006–2011*	Percentage change *2006–2011*
Persons				
Number				
TOD	349,629	376,243	+26,614	7.61
Non-TOD	1,515,769	1,690,417	+174,648	11.52
Density (persons/sq. km)				
TOD	555	734	+179	32.25
Non-TOD	100	110	+10	10
Dwellings				
Number				
TOD	157,929	164,805	+6876	4.35
Non-TOD	586,069	657,546	+71,477	12.20
Density (dwellings/sq. km)				
TOD	251	322	+71	28.29
Non-TOD	39	43	+4	10.26
Jobs				
Number				
TOD	n/a	595,133	n/a	n/a
Non-TOD	n/a	289,315	n/a	n/a
Density (jobs/sq. km)				
TOD	n/a	385	n/a	n/a
Non-TOD	n/a	20	n/a	n/a

in GIS (in vector rather than raster format) would not allow the authors to intersect TOD geographies and MB or DNZ geographies. Had the data been available in raster format, an intersection of these geographies would produce an approximate result in any case because GIS would assume an average distribution of people, houses, and jobs in the MB or DNZ unit—which is not the case in reality, as mentioned.

5. Findings

If one considers TOD vs. Non-TOD areas as a whole, it is clear that all three components under analysis (population, dwellings, and jobs) are more heavily concentrated around train stations than in areas unserved by the train network. Also, between 2006 and 2011, the density of both population and housing units has significantly increased in TOD areas compared to Non-TOD areas (Table 1). These findings are encouraging in terms of transport sustainability in Brisbane. A notable and growing concentration of population, dwellings, and jobs in TOD zones implies that these areas are attractive to residents, employers, and developers.

When the distance from the CBD is taken into consideration in the analysis, as expected, the density of people, houses, and jobs in both TOD and Non-TOD zones decreases the farther from the centre. However, a more nuanced picture emerges in this case (Table 2). In terms of population densities, in all but the outer urban edges (where there are few services away from train stations), the population density is currently higher in Non-TOD areas than in TOD areas—nearly twice as high closer to the urban core (Figure 5). The reasons for this outcome are unclear. They might be due to an aversion (at least until recently) to living close to train stations and associated noise pollution and soil vibration. In that case, the density difference pre-dates TOD and would take years of successful TOD to change. On a local level, the Brisbane City Council encourages development in TOD areas and allows for density bonuses. At the same time, due to their environmental drawbacks, proposals in TOD areas require higher level impact assessment, creating a conflicting stance on part of the public sector.

Table 2. Concentration of people, dwellings, and jobs in TOD vs. Non-TOD areas (by distance from the CBD).

	2006	*2011*	Percentage change *2006–2011*
Population density (persons/sq. km)			
0 km–3 km			
TOD	2267	2784	22.82
Non-TOD	4316	4505	4.38
3 km–5 km			
TOD	2071	2352	13.56
Non-TOD	2916	3051	4.62
5 km–10 km			
TOD	991	1212	22.28
Non-TOD	1415	1537	8.61
10 km–20 km			
TOD	536	728	35.85
Non-TOD	724	735	1.57
20 km–30 km			
TOD	256	357	41.05
Non-TOD	402	446	10.95
30 km–city limit			
TOD	179	255	42.40
Non-TOD	30	36	19.29
Dwelling density (dwellings/sq. km)			
0 km–3 km			
TOD	1395	1476	5.84
Non-TOD	2354	2341	–0.55
3 km–5 km			
TOD	1009	1105	9.49
Non-TOD	1291	1331	3.11
5 km–10 km			
TOD	472	561	18.83
Non-TOD	601	640	6.40
10 km–20 km			
TOD	220	294	33.70
Non-TOD	268	271	1.29
20 km–30 km			
TOD	102	142	38.79
Non-TOD	146	163	11.78
30 km–city limit			
TOD	73	105	43.57
Non-TOD	12	14	20.32
Job density (jobs/sq. km)			
0 km–3 km			
TOD	n/a	5787	n/a
Non-TOD	n/a	1463	n/a
3 km–5 km			
TOD	n/a	1201	n/a
Non-TOD	n/a	985	n/a
5 km–10 km			
TOD	n/a	558	n/a
Non-TOD	n/a	447	n/a
10 km–20 km			
TOD	n/a	243	n/a
Non-TOD	n/a	188	n/a
20 km–30 km			
TOD	n/a	79	n/a
Non-TOD	n/a	72	n/a

(*Continued*)

Table 2. (*Continued*).

	2006	*2011*	Percentage change *2006–2011*
30 km–city limit			
TOD	n/a	56	n/a
Non-TOD	n/a	6	n/a

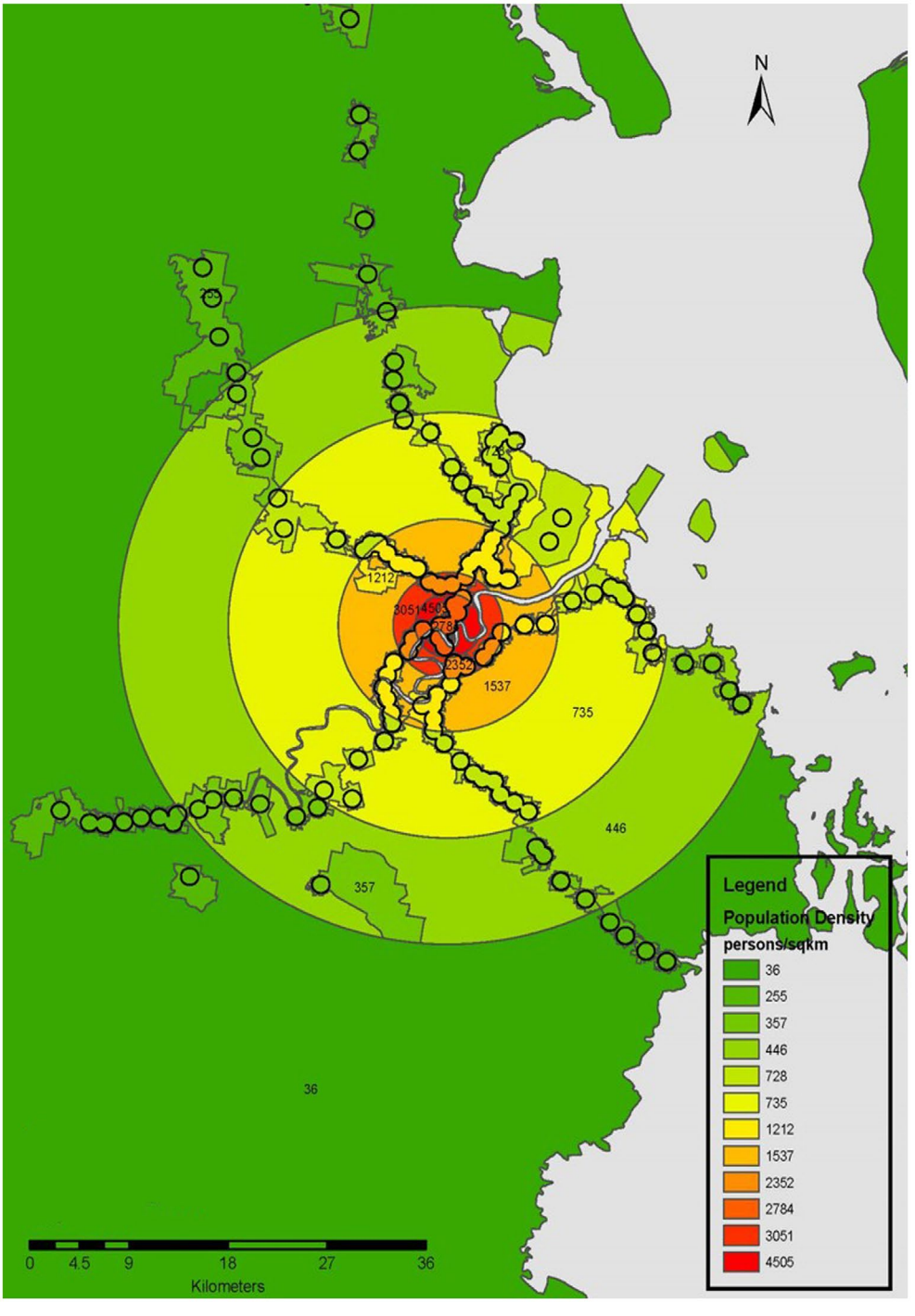

Figure 5. Population densities for 2011 in TOD vs. Non-TOD areas by distance from the CBD. Map by authors.

But the direction of change is positive. In all cases, population densities have been growing faster in TOD areas than in Non-TOD areas—especially farther from the urban core. Nonetheless, population densities have somewhat grown in non-TOD areas too - likely due to lack of incentives for people to locate near train stations, or lack of regulations to discourage them from locating away from train stations. Ideally, growth in Non-TOD areas should have been null and TODs should have absorbed all incoming population. While confining all new development towards designated TOD areas might be ideal (if unusual), the authors recognise that in practice this might not be viable because it would involve downzoning of sites already available for residential development due to longstanding planning decisions.

The analysis of dwelling densities shows similar findings to the analysis of population densities. There is a decrease in dwelling densities the farther the distance is from the core. In the immediate vicinity of the CBD, there is a higher concentration of housing units in Non-TOD areas. This is likely due to the fact that historically in the Brisbane CBD, the space near train stations has been taken over by office buildings. As the distance from the core grows, housing densities in TOD and Non-TOD areas are similar. An exception is the outer edge of the city in which dwellings are concentrated in TODs. As mentioned, this is likely due to the fact that in these areas there are few services away from train stations. As with population densities, the direction of change is positive. Housing densities are growing much faster in TOD rather than Non-TOD areas—especially in TODs located farther from the core. An exception is the CBD itself, which is generally seen as a place for work rather than living. Also, in proximity to the CBD, there is less available land to cater for more residential construction whereas around outer train stations there is more undeveloped land that can be converted into TOD.

In terms of employment densities, as mentioned, the available data only allows for a snapshot of the situation in 2011. Results show that, throughout Brisbane jobs are much more heavily concentrated in TOD areas than in Non-TOD areas. In the CBD, the difference is substantial. Outside the urban core, the differences are not as dramatic.

6. Conclusion

This study examined TOD outcomes in Brisbane since this concept was first promoted in policy documents in 2005. The analysis considered the concentration of population, housing units, and jobs in TOD zones (the areas within an 800 m radius of the 133 train stations in the city) as opposed to Non-TOD zones (overall and broken down by distance to the CBD). This analysis is important because the local planning sector has sought to encourage and enable TOD to take place in Brisbane. Planning policy frameworks include the provision of TOD strategies within the regional plan, fine-grained TOD guidelines, and various policy documents representing the transit sector and the Brisbane City Council's commitment to TOD.

The results do not support the notion that Brisbane is a transit-oriented city. However, a comparative or benchmarking study would be needed to confirm this. The findings show that in 2011, within 3–5 km of the CBD, there was a concentration of 1201 jobs/sq.km in TOD areas versus 985 jobs/sq.km in Non-TOD areas. This compares to a population density of 2352 persons/sq.km in TOD areas versus 3051 persons/sq.km in Non-TOD areas and a dwelling density of 1105 dwellings/sq.km in TOD areas versus 1331 in Non-TOD areas within 3–5 km of the CBD. While jobs tend to be more heavily clustered in TOD locations, for the most part population and housing densities remain higher in Non-TOD areas. This trend is reflected across each distance band from the CBD.

Barriers identified in the literature review include poor marketing of the TOD concept to residents and developers, fragmented land ownership around train stations, disabling zoning regulations, and complex institutional setup in Queensland. These might have played a role in this outcome, which is unfortunate given that the local train system is of good quality and could support the creation of a "finger city" after the example of several northern European capitals.

However, the study results also show that there is a moderate trend toward the concentration of people and dwellings in TOD areas within Brisbane. This is especially evident in the outer edges in which few urban amenities can be found away from train stations. It must be noted that, in TODs, a unit area of land competes for multiple uses (jobs, housings, and recreation). Planners aim for a balanced development within a TOD, and as a result, the site does not solely accommodate residences. By contrast, Non-TOD sites are solely (or mostly) used for residential purposes (or other mono-uses), and are therefore capable of accommodating more residents. Changes in population density are more important than density itself in understanding whether recent developments in Brisbane are transit-oriented.

TOD consolidation is likely to provide a good foundation for urban sustainability. Given the nature of this research, it is impossible to determine whether the trend towards TOD consolidation identified in this study is due to public policies or simply market forces. Further research, entailing interviews of planners and developers, as well as population surveys, is needed to establish causation. Either way, this finding is encouraging especially in view of the relatively short study timeframe (2006–2011). It implies that public sector policies to further promote TOD would go "with the grain." This is a key finding as prior studies have identified a NIMBY attitude of local residents as a deterrent to TOD success in Australian cities (Searle et al. 2014). The planning sector can capitalise on the growing attraction of TODs and accelerate it through policy measures, including land assembly mechanisms, interdepartmental TOD task forces, public outreach efforts, tax and zoning incentives for TOD developers, and limits to development in areas unserved by train services. If cities wish to implement TOD, the practice must be recognised as integral to smart growth and sustainable urbanism policies. Periodic measuring of TOD outcomes is also important, for instance, using the type of GIS method outlined in this article.

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