Transport impacts of government employment decentralization in an Australian city - testing scenarios using transport simulation

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ABSTRACT

Australia's largest cities are more mono-centric than most US cities and may be over-centralising, particularly in terms of office employment. Government worker relocation programs are being employed with policy debate over what should be an ideal urban structure including in terms of travel behaviour. The paper explores research approaches to explore transport impacts of employment decentralisation. A review shows the results of: surveys of workers moved to suburban locations; longitudinal analyses of transport and land use changes in city-regions using cross-sectional census or HTS data; comparative analysis of urban structure variables across cities using similar datasets; combinations of longitudinal and comparative research; and, scenario-based modelling approaches. A modelling framework is then developed to appraise the possible transport impacts of decentralisation in Brisbane. To test the possibilities further, two decentralization scenarios modelled and compared. Decentralization mostly to middle-suburban locations better addresses jobs-housing balance and maximises proposed new public transport services, producing good transport outcomes. However, decentralization to outer-suburban locations in Brisbane exacerbates the propensity for decentralisation to increase travel distances, especially by car.

This research is supported by the Clean Air and Urban Landscapes Hub, funded by the Australian Government's National Environmental Science Program.

1. INTRODUCTION

This paper reports on a modelling exercise that explored the transport impacts of employment decentralisation scenarios in Brisbane, Australia. The rise of the knowledge economy is seeing cities around the world (re)centralising office employment due to a combination of agglomeration forces and urban policy including ambitious infill targets of over 50% [1]. Unlike many US cities, Australian cities never lost the primacy of their central business districts (CBDs) and continued for decades with automobile-dependent, low-density suburban expansion. As such, the growth in employment downtown and wide swathes of suburbia deliver spatial mismatches in housing and employment. This in turn generates numerous social and economic problems, the most visible of which tends to be traffic congestion. With similar centralisation commencing in a number of North American cities policy-makers there may be confronted with similar problems.

Understanding how land use at the city-region scale affects travel behaviour and traffic flows has been a concern for planners dating back well before the development of regional transportation models. We looked to both old and new methods to explore what might occur if a large decentralisation program for government workers was employed. More recent advances in geo-spatial modelling and the availability of richer datasets have significantly increased our understandings of the relationships between the built environment and human

travel behaviour. Much of the research base has focused on issues of local or neighbourhood scale effects. From early work on the "3 D's" of density, (street) design and (land use) diversity [2] this expanded into analyses with a much larger set of variables across many urban contexts. This body of work has shown that neighbourhood level built environment factors do tend to influence mode choices, travel distances and other behaviours, albeit there is dispute as to exactly how much (see [3, 4]). Comparative research of multiple cities, using different methods over time, has similarly shown macro-scale built environment factors influencing city-region travel behaviours, with denser European and Asian cities tending to have more public transport, walking and cycling than North American or Australian cities [5, 6, 7]. Analyses of urban structure are fewer in the literature, though not in professional practice. We define urban structure as the configuration of the structuring elements of the city at metropolitan scale; as opposed to neighbourhood scale urban form. A range of land use and transport models have been developed, some of which allow for rich interaction at a city-region scale [8]. But it is not always necessary to explore issues using the most complex techniques.

This paper reveals how we undertook our analysis, key decision-points in the approach and methods, and the implications these had for the results. The paper is organised as follows. Firstly, the key theory on the influence of jobs-housing locations on travel behaviour is outlined, followed by the results of previous studies using a wide diversity of methods to explore interactions between decentralisation and travel behaviour. This sets out a case for context-specific applied research on the topic. The approach and method of a small modelling exercise are then provided exploring what would occur under specific decentralisation scenarios in Brisbane, with the results summarised. A discussion section then focuses mostly on the limitations of existing studies and the outstanding research gaps in this field.

2. BACKGROUND

White collar employment in Australia's five largest cities is increasingly mono-centric. Economic value and high-paying jobs are increasingly concentrating in the nation's city centres [9] whilst socio-economic disadvantage is being suburbanised [10]. In Brisbane this helps produce strong tidal flows of workers from the suburbs into the city-centre each morning. Indeed, 29 per cent of journeys-to-work are made in an inward direction and only 6 per cent outwards for the whole South East Queensland (SEQ) region centered on Brisbane [11]. The region has recently spent over A$12 billion (US$10 billion) on expansive road tunnels in the inner city, $4 billion on new segregated busways and is calling on the Commonwealth Government to fund a >$5 billion rail tunnel. Such investments tend to be more expensive than suburban roads projects due to the presence of the Brisbane river, requiring bridging and tunneling, and the high density of existing built form in the inner-city. Cost recovery is low on the commuter train system, partly due to the dead-running of near empty trains in the non-peak direction of travel.

Theoretically, changing urban structure by relocating office employment to clustered nodes in suburban regions should help meet both socio-economic objectives around equity and accessibility to work opportunities, as well as help reduce commuting times, improve cost recovery on public transport, and reduce traffic on congested inner-city links [12]. Governments can readily shift their own workers out to suburban locations and may save rent on office space by doing so. But there are trade-offs. If we take a Hägerstrand-like [13] perspective that sees an individual's time-space activity as the product of their temporal and spatial constraints, including a travel time budget, we begin to focus on commuting time as a

major concern. Workers will tend to weigh up the wage and other benefits provided by a particular job offer, the place utility of a particular residence, and commuting time (or time/cost, as used in transport economics, which also bundles in fares and/or costs of motoring) [14]. Travel time budgets tend to be relatively constant, on average, within a given region [15, 16]. Though most workers will try to minimise their travel times, many commutes have positive utility by offering respite between the stresses of home and work, social benefits, and utilitarian benefits, including capacity for productivity as work has now encroached on the commuting experience via technology [17, 18]. Workers who find their job moved to a suburban location don't self-select their home and workplace in the time-space prism, and may face great challenges commuting to the new office, especially by public transport. The habits and travel attitudes that workers have that help explain mode choice [19] may not be strong enough to maintain their previous travel choices in the new context, and particularly increase car driving. Workplace locations in the suburbs are unlikely to have the same destination accessibility, particularly by public transport, as the CBD, increasing non-car travel times significantly. As such, the group of workers moved out will, over time, make choices whether to move house, change job, or make other changes in their life to adapt. Firms should, in theory, recruit from a more local labour pool. New public transport and cycling facilities are likely to be provided for larger suburban employment nodes, increasing their destination accessibility, but only over a longer time period. Eventually the urban system will settle into a new equilibrium. But as Ma and Banister [12] note, there are two contrary implications: 1) dispersed/polycentric urban structure may provide potential to improve jobs-housing balance and reduce trip lengths; however, 2) moving from a monocentric to a dispersed urban structure may also significantly increase trip lengths. The existing urban structure of the city and the type of decentralisation employed are critical to determining transport impacts.

The potential for divergent transport outcomes under decentralisation is shown by the previous studies on the topic. Given these temporal dynamics, studies of employment decentralisation at the metropolitan scale tend to consider either the short-term effects, when the system is put into disequilibrium, or the longer-term effects. Of the studies looking at short-term effects, most use travel behaviour surveys of workers affected by aworkplace relocation, capturing revealed choice data. These tend to use variables such as travel times, travel distances and commuting mode choice. Workers in Melbourne, Australia, moved out to a middle-suburban site on average used public transport less and increased car ownership and use, in part to minimize increases in travel times [20]. Workers in Oslo, Norway, and in Luxemborg also made similar changes in behaviour [21, 22, 23]. In Lisbon workers moved who had longer travel distances made similar changes, but those with decreased travel distances did not reduce their travel times, suggesting travel budget constraints are more important than travel time minimisation [24]. Summarising this literature, as the above theory would suggest, in the short term travel behaviour tends to be less sustainable after workplace relocations.

Very few cities use longitudinal panel data for their regular household travel surveys (HTSs) which would capture repeated information on travel, home and workplace location as cities grow and change. Alternative approaches must therefore be used to study the longer-term effects of decentralisation. Most studies in the literature tend to use either: *i)* longitudinal analysis of transport and land use changes in city-regions using cross-sectional census or HTS data; *ii)* comparative analysis of urban structure variables across cities using similar datasets; *iii)* combinations of longitudinal and comparative research; or, *iv)* scenario-based modelling of the transport and land use system in a particular city.

Longitudinal studies tend to look at changes in employment across a city-region and the city-wide effects on travel behaviour over time. Planned employment decentralization in Singapore to rail corridors along with residential and mixed use 'transit villages' had effects in creating increased mode share for public transport, whilst decreasing congestion [25, 26]. In Istanbul, less planned and more scattered decentralization of employment decreased commuting times, despite growth in traffic volumes over time [27]. Paris used the car more, with more 'reverse commuting' following a redistribution of jobs including to outer-suburban new towns [28]. London actually reduced central area employment from 1963 to the mid-1980s and saw trips into the central city decline, reducing over-crowding on transit [29]. Scattered market-led decentralisation in the San Francisco Bay Area increased commute travel times and distances [30]. Minneapolis-St Paul saw both households and jobs decentralise from 1995-2005, but densification of suburban centres, in part along the region's beltway freeway, led to increases in job accessibility overall, despite significant increases in travel congestion [31].

Of the comparative analysis studies across cities many use regression techniques to explore the influence of a range of measures including employment centring/sub-centring. But many of these studies focus on US cities where the non-clustered dispersal of office employment across large metro regions differs greatly from the more clustered nodes seen in European or Asian cities. A focus of the research in the US is on what role stronger downtowns and clustered sub-centres play. Across 19 US metros car ownership and distances travelled by car both decreased when the share of employment within regional employment sub-centers increased [32]. In a study of 50 US metros using different congestion measures found cities with more mono-centric employment tended over a ten year period towards having shorter commute times and less congestion per capita [33]. A recent paper by Kashem, Irawan and Wilson [34] has for the first time combined both longitudinal and comparative data in an improved methodology for a set of US cities. They found that metros with stronger sub-centers had a lower increase in commute distances per capita and a higher increase in public transport ridership, relative to metros that were more dispersed. Indeed, the role of centring/sub-centring was found to be more important than either land use mix, residential density or street connectivity measures [34]. Caution should be applied in using these US findings elsewhere though. As Mindali, Raveh and Salomon [35] showed distinct clusters can be observed across cities worldwide. Using a comparative analysis on data from the 1980s they found employment density in US and Australian cities had little or no effect, but in denser European cities they found a strong negative correlation between transport energy use (a proxy for car use) and outer area employment [35].

The modelling studies into decentralisation generally model and/or analyse travel behaviors at the metropolitan scale, either using real-world data or via scenario testing to predict future outcomes. Early scenario testing studies in Sydney showed that car mode shares would increase, public transport decrease, but that travel times would improve under decentralisation policy [36]. Similarly, employment decentralisation scenarios in Vilnius, Lithuania, and in Bristol, UK, were both shown to increase car use, in studies used to promote compact city policies [37, 38].

There remain gaps in this literature. For instance, though we are now well aware of the influence of residential self-selection on travel behaviours [39] no attempt has yet been made to explore its role in influencing the outcomes for workers moved in employment relocations. Further, as cities grow and change, new urban structures emerge with a need for new applied

research studies in cities where specific problems are emerging. Australian cities appear to be at such a juncture. Sydney, a city of five million people, effectively has only one secondary CBD, and a set of smaller sub-centres, with much of its white collar employment in its city-centre. Melbourne, at four million, has no secondary CBD. Brisbane, Perth and Adelaide, all of more than one million, have none either.

There are outstanding research gaps that need attention and resolution to understand what kind of decentralization approach would best suit an Australian city with specific urban formations and structures. There tends to be consensus in Australia that decentralisation should be clustered in centres, reflecting the stronger traditions of town planning in Australia than the US. The state governments of both Western Australia and Queensland promised to move 20% of their public sector employees out of their centres of Perth and Brisbane [40, 41] and embarked on a limited set of targeted relocations in the early 2000s. But where jobs are moved to is contentious. Some Queensland government workers were moved to middle-suburban Carseldine, 16km north of the CBD in Brisbane's Northern Suburbs, while others were moved 44km west to Ipswich. It is not known whether decentralization to middle suburban locations would be more beneficial than decentralisation to outer suburban locations in low-density and dispersed cities like Brisbane.

3. STUDY AREA

Brisbane, with a population over two million persons, has seen a significant rise in CBD office employment in the past 30 years [42]. Centralization of employment is particularly strong in the government sector, which comprises over 20% of CBD office lettings [43]. The inner, urban core of Brisbane not only houses its government offices, but also most of the financial, legal services, cultural and social institutions. There are many reasons behind this hyper-centralization. The CBD is supported by the radial road and public transport systems including over 200km of commuter rail and a large exclusive busway network city (see [44]). The CBD provides the highest levels of accessibility in the region, for the largest number of workers. Planning and investment at the state and local government levels has encouraged commercial developments in the CBD and its immediate frame, leading to their growth and expansion, but has restricted office parks in suburban areas. Brisbane's few suburban office parks are relatively small in comparison to those of US cities. The city has modest congestion levels with only around 25% of trips made in congested conditions [45] but sees strong tidal flows in the peak direction in and out of the central area each day.

A key policy question is the location of future government worker relocations. Local governments in the region stand to win or lose based on where jobs go, through rate revenue and other benefits from the development of new employment centres. Research needs include determining which approaches to relocation will deliver better transport outcomes, including in making better use of roads and public transport systems by encouraging contra-flow travel on congested parts of the network.

4. METHOD

We recently adopted a simulation approach similar to those noted above [36, 37]. This approach uses a form of conventional strategic transport modelling [46] to compare the transport impacts of different decentralization scenarios. Such modelling was undertaken with

the help of the Brisbane Strategic Transport Model (BSTM). This is the main transport model used by the Queensland Department of Transport and Main Roads (TMR) to generate multi-modal transport forecasts for the Brisbane region. The BSTM works on the principle of using small-area based population and employment projections as an input and running 4-step transport models to estimate trip generation from these spatial arrangements, transport mode usage by travellers, and then traffic volumes across the transport networks. The modelling horizon of BSTM was set for the year 2031. This model included numerous transport system improvements, new land developments and other changes in urban structure forecast for the city. This included re-conceptualisation of both the city's rail system with new cross-river capacity as well as new bus networks in accordance with the regional transport plan [47]. The 2031 model includes a greater density of cross suburban bus routes, including high frequency routes concentrated on suburban activity centres, which would support employment decentralization, especially in the middle-suburbs.

Two hypothetical, ideal employment decentralization scenarios were created within the trip generation sub-model of the BSTM. These were developed for comparison against each other, and the base case. Each of the scenarios was partly drawn using decentralisation program information released to the public (Sector-wide 2008) and the employment and activity centres in the regional plan [48]. The first scenario moved 15,630 jobs out of the CBD, representing a sizeable proportion of the future growth of the city centre. This scenario moved 75 per cent of them to middle suburban locations and 25 per cent to outer-suburban locations, most of which are 30 kilometres from Brisbane CBD, nearer to or on the edge of the Greater Brisbane's urban footprint. The second scenario flipped this ratio, moving the same number of jobs, but sending them 25 per cent to middle suburban sites and the 75 per cent to outer suburban locations. In both scenarios, the jobs were placed strictly in activity centres on the key transit links (either busways or rail nodes). The number of jobs by employment category was changed in the decentralization zones representing the key activity centres, reflecting the gross rise in total employment. This study also assumed modest 'multiplier effects' in both the decentralization scenarios, the assumption being that the relocation of government offices attracts a few additional private sector firms to join them at their locations.

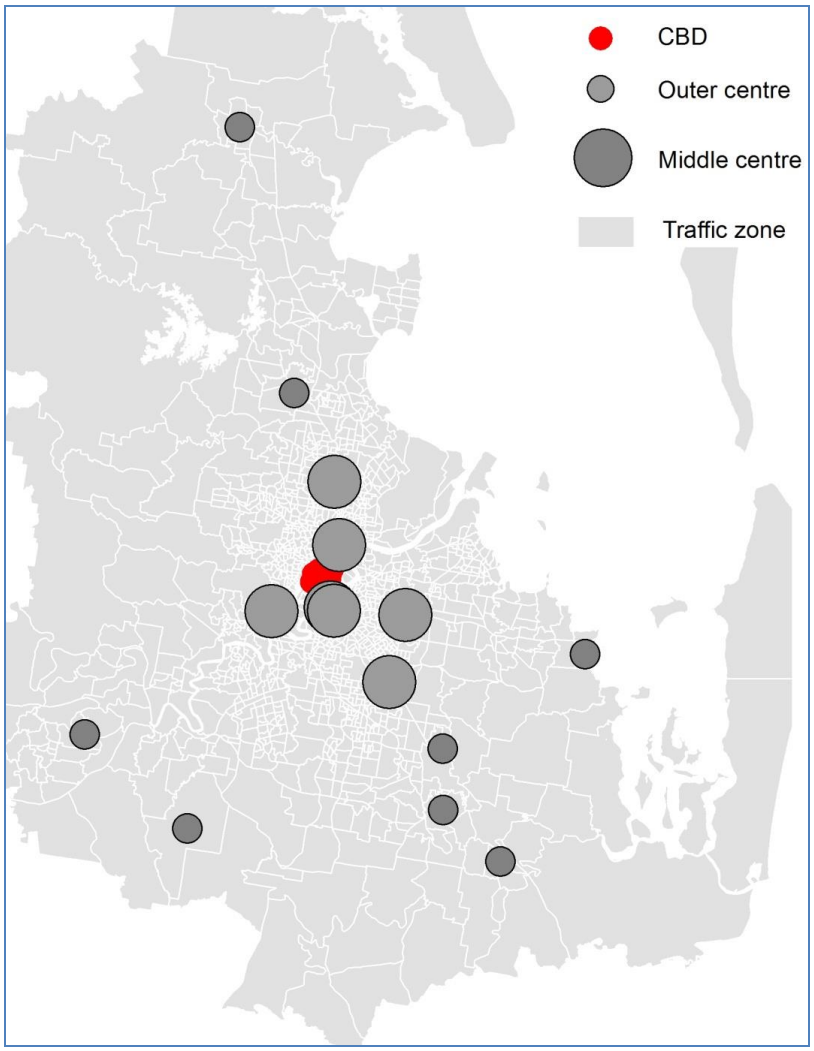
Table 1 shows the difference in job numbers at key centres for the base case, as well as both the decentralization scenarios, as modified within the trip generation sub model of the BSTM. Figures 1 and 2 depict the locations of these sites. It is however, important to note the decentralization scenarios and the models have limitations, notably that they are not regional/inter-city models and will poorly approximate interactions with nearby cities such as Gold Coast. The scenarios are in no way government policy. They represent a future state of equilibrium after the short-term disruptions of workplace relocation have been resolved.

Table 1 Changes in total employment between the base case and the two idealized decentralization scenarios, Brisbane, 2031

Scenario 1			
Total no. of jobs moved to middle suburban locations (75% of relocated jobs)		Total no. of jobs moved to outer suburban locations (25% of relocated jobs)	
Chermside	2,408	Ipswich	488
Garden City	2,408	Cleveland	488
Carindale	2,408	Beenleigh	488
Indooroopilly	2,408	Caboolture	488
Buranda/ Bowen Hills	2,100	Logan Central	488
		Springwood	488
		Springfield	488
		Strathpine	488
TOTAL	*11,732*	*TOTAL*	*3,904*
Scenario 2			
Total no. of jobs moved to middle suburban locations (25% of relocated jobs)		Total no. of jobs moved to outer suburban locations (75% of relocated jobs)	
Chermside	845	Ipswich	1466
Garden City	845	Cleveland	1466
Carindale	845	Beenleigh	1466
Indooroopilly	845	Caboolture	1466
Buranda/ Bowen Hills	522	Logan Central	1466
		Springwood	1466
		Springfield	1466
		Strathpine	1466
TOTAL	*3902*	*TOTAL*	*11728*

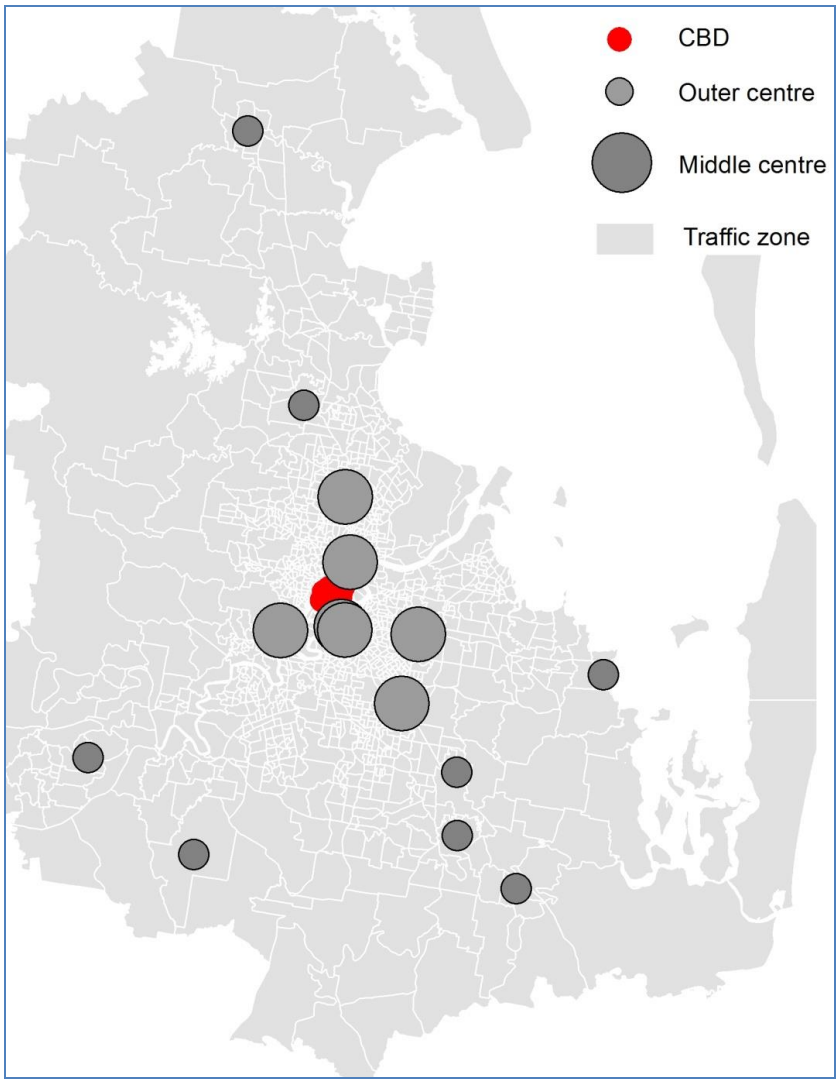
Insert Table 1 here

Figure 1 Locations of middle-suburban centres receiving employment (Scenario 1)



Insert Figure 1 here

Figure 2 Locations of outer-suburban centres receiving employment (Scenario 2)



Insert Figure 2 here

For each scenario we ran the full BTSM procedure including trip generation, trip distribution, mode choice and trip assignment. Within the parameters of the trip distribution sub-model, the number of trips between trip productions and adjusted attractions (origins and destinations, or O-Ds, respectively) were recalculated in both the decentralization scenarios. Destination choice was made on the basis of the newly estimated total travel cost between O-D pairs. The final outputs of the BSTM are total traffic volumes, vehicle travel distance and vehicle travel time on links, nodes and intersections, as well as for the network as a whole.

5. RESULTS

We focused on AM peak hour transport impacts given the interest in congestion-management. A comparison of total trips by mode for the three model runs is provided in Table 2. For Scenario 1, where jobs were shifted mainly to the middle suburban locations, the model predicts a slight decrease in car driver trips in car passenger trips and in walk-only trips compared to the base case, the latter partly balanced by a rise in bicycle trips. Transit trips grow by 6.96%, with the major contribution coming from park'n'ride transit trips (+19.4%,

off a low base). This is a little at odds with the previous literature but highlights the role of the new high-frequency suburban bus networks and rail expansions in facilitating travel to suburban activity centres within the model, which the decentralised employment scenarios may support a bit more than the centralised base case urban structure. For Scenario 2, where jobs were shifted mainly to outer suburban locations, the model predicts that car driver trips, car passenger trips and transit trips stay relatively steady, compared to the base case, whereas both walk-only trips and bicycle trips decline slightly.

Table 2 Comparison of trips by mode between the base case and the decentralization scenarios – AM Peak Hour trips only – 2031

Travel Mode (AM)	**Base case scenario**	**Scenario 1 (mostly middle-suburban)**	**Total Change**	**% Change**	**Scenario 2 (mostly outer-suburban)**	**Total Change**	**% Change**
Total travel distance (km)	14,054,805	13,718,766	-336,039	-2.39	14,412,837	+358,032	+2.5
Total travel time (hour)	402,310	365,138	-37,172	-9.24	422,860	+20,550	+5.1
Car driver trips	895,159	888,346	-6,813	-0.76	896,997	+1,838	+0.21
Car passenger trips	347,962	335,211	-12,751	-3.66	345,530	-2,432	-0.70
Transit trips (total)	348,059	372,270	+24,211	+6.96	352,451	+4,392	+1.26
Kiss'n'ride transit trips	64276	68,800	+4,523	+7.03	65,269	+993	+1.54
Park'n'ride transit trips	38,144	45,540	+7,396	+19.4	41,070	+2,926	+7.67
Walk to transit trips	222,110	232,606	+10,196	+4.59	221,977	-133	-0.06
Bicycle trips	22,639	23,446	+807	+3.56	22,362	-277	-1.22
Walk only trips	114,714	111,354	-3,360	-2.93	111,796	-2,918	-2.54
TOTAL	1,705,004	1,705,004	0	0	1,705,004	0	0

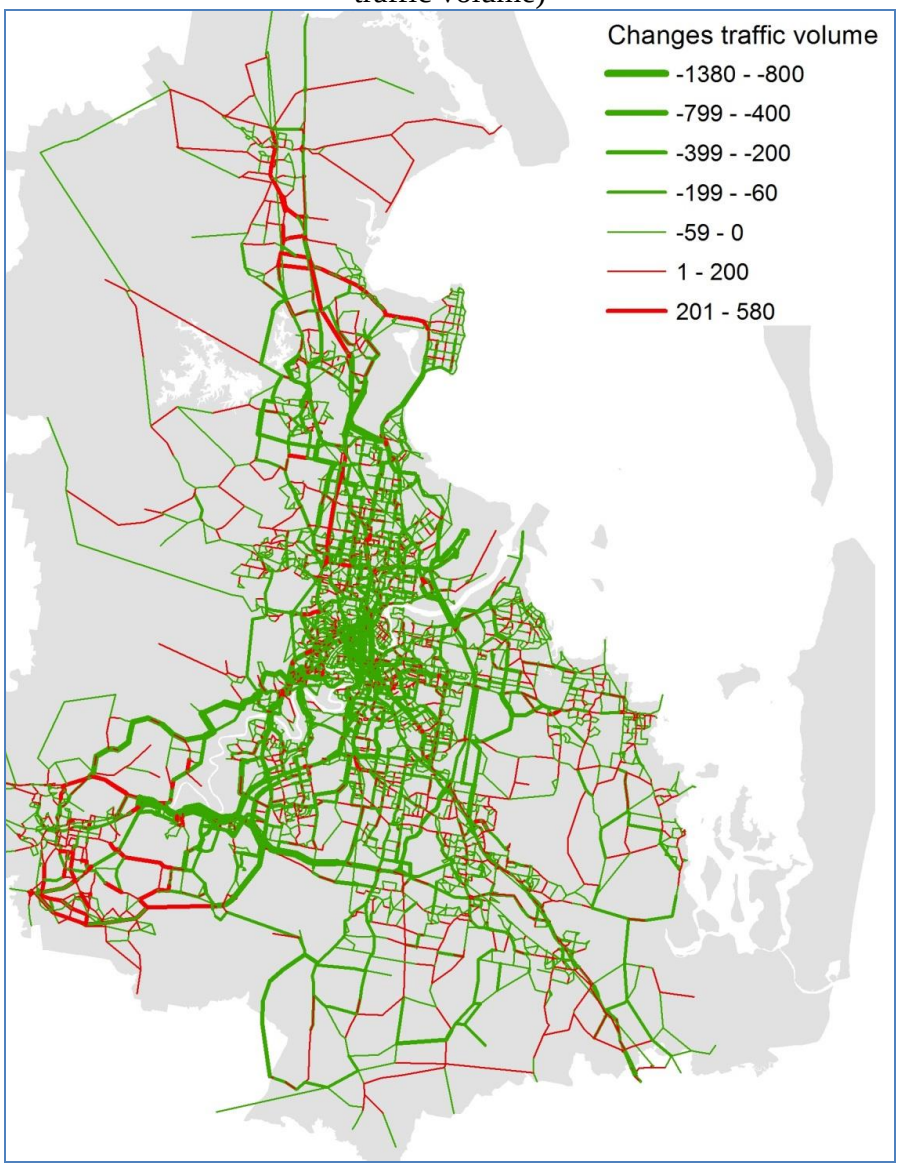
Insert Table 2 here

Compared to the base case, Scenario 1 produced a -3.0% decrease in vehicle kilometres travelled (VKT) and an even greater -9.7% decrease in private vehicle hours travelled (VHT) in the AM Peak Hour, suggesting that by addressing job-housing balance in a hyper-centralising city the middle-suburban decentralisation scenario would offer significant benefits. By contrast, Scenario 2 provided a 2.55% rise in VKT and a 5.11% increase in VHT, as drivers had to travel much further to jobs on the outskirts of the city.

Most of the arterial road network in Brisbane's inner city areas is congested in the AM peak, and these volumes are predicted to rise in the base case for Brisbane in 2031. However, significant volume reductions from these levels on key road links were predicted for the decentralization scenarios. Figures 3 and 4, show comparisons of traffic volume changes on the road network for Scenarios 1 and 2, respectively, compared with the base case for the AM peak. When most jobs are moved to middle-suburban locations the majority of links experience a decrease in traffic flows (displayed as links with green bars). Key links such as the Ipswich and Logan Motorways, experience very helpful road volume decreases. A number of outer-suburban arterials experience a modest increase in vehicular traffic but often on contra-flow routes where congestion is negligible. When jobs are moved to outer suburban locations, the additional VKT being driven shows up with increases in traffic on a much greater proportion of the road network suggesting negligible congestion relief under this scenario.

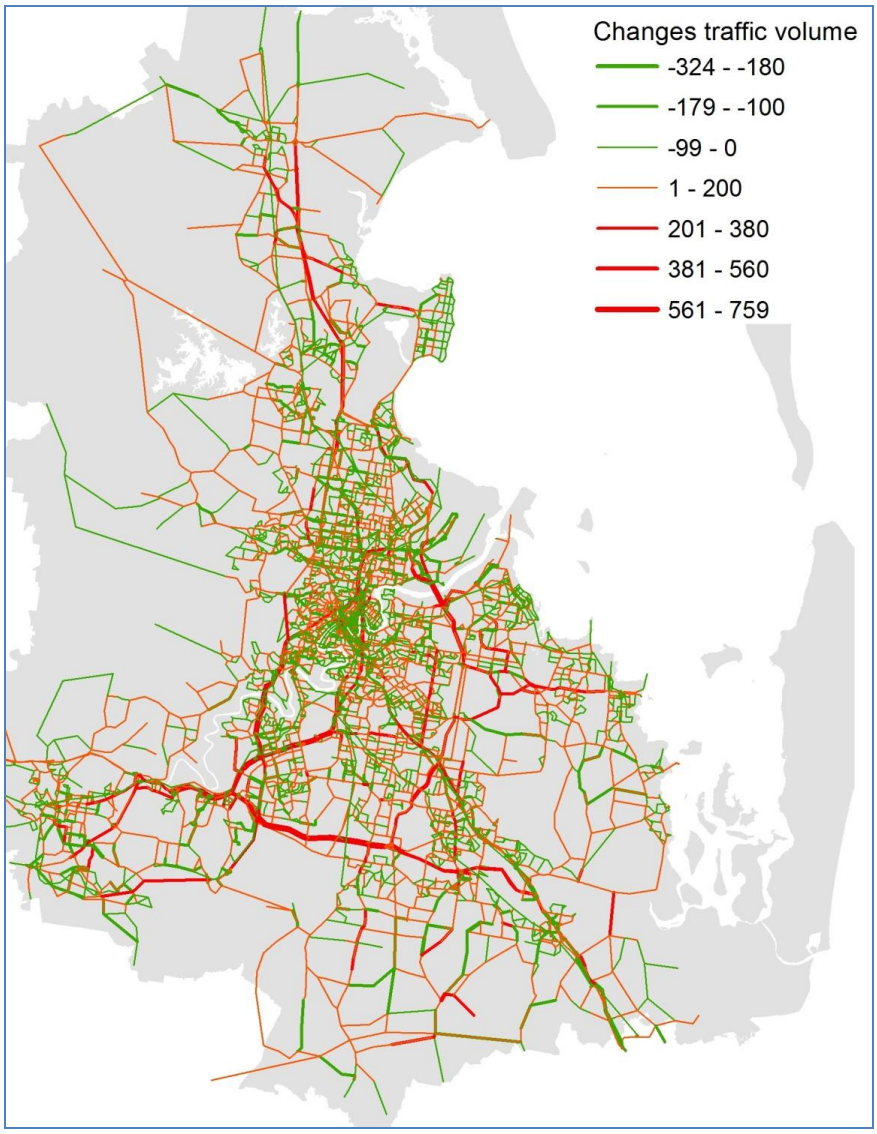
Figure 3 Changes in traffic volume on road links, Scenario 1 – AM Peak Hour only – 2031

(Note: a green bar represents a decrease in traffic volume; a red bar represents an increase in traffic volume)



Insert Figure 3 here

Figure 4 Changes in traffic volume on road links, Scenario 2 – AM Peak Hour only – 2031
(Note: a green bar represents a decrease in traffic volume; a red bar represents an increase in traffic volume)



Insert Figure 4 here

6. DISCUSSION

The results give weight to the predictions that Brisbane is potentially over-centralising, particularly in terms of white collar employment. As suggested by Ma and Banister [12] the two contrary transport outcomes of decentralisation that can occur appear to play out in these two different scenarios. Dispersed/polycentric urban structure does seem to provide potential to improve jobs-housing balance and reduce trip lengths, as best demonstrated by Scenario 1; however, moving from a monocentric to a dispersed urban structure may also significantly increase trip lengths, as shown in Scenario 2. The type of decentralisation one encourages matters greatly. In terms of implications from the research, a scenario where a sizeable program of government worker relocations in undertaken in Brisbane, mostly to middle-suburban locations, combined with increases in high quality public transport supply to these suburban activity centres, may produce significant transport benefits for the city. By contrast, doing nothing and allow agglomeration to continue, or moving workers in large numbers to the outer edges of the urban area, may be less productive policies to pursue.

These results are highly specific to Brisbane and may have limited application outside

Australia. But the research shows the value of continued study of urban structure and travel behaviour in an applied, context-specific manner. As economic restructuring is providing a rise in knowledge work, as gentrification has reclaimed city centres in many nations and is starting to do so in the US, there will be a need to help decision-makers understand the impacts of their policy-settings. Worker relocation programs differ as do the cities in which they take place. This suggests further work is needed to survey workers before and after relocations, in the manner of Bell [20] and Hanssen [21], to determine the short-term impacts and how best to alleviate them. Further cross-sectional analysis of specific cities and comparison across cities is needed. Exploring local context will help policy-makers recognise the differences between cities and to ensure cities in Europe, Asia or Australia aren't adopting inappropriate policies due to a reliance on meta-analyses [4] or multi-city analyses [34, 32, 33] derived mainly from North American datasets.

Beyond the context-specific applied research, some larger research questions need answering. Some attempt is needed at exploring the impacts of a propensity for residential self-selection and travel attitudes/perceptions [49, 50] to explain which workers tend to move house, shift travel mode, change job or otherwise make significant changes when their workplace is relocated to the suburbs. Travel behaviour change interventions that can reduce the short-term impacts for workers affected are also under explored, yet have considerably assisted private sector decentralisation efforts [51]. We don't know how long firms take after relocation to revert to a more local labour pool, so that we really don't know how long deleterious short-term transport impacts will occur. There has also been little attempt at tying surveys of relocated workers to modelling and forecasting studies of the type presented above for improved accuracy.

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