CHAPTER 27

EASING CONGESTION THROUGH EMPLOYMENT DECENTRALISATION: A PARRAMATTA (OR TWO) FOR PERTH?

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INTRODUCTION

As cities grow and activities intensify, transport systems are increasingly under pressure to cope. While congestion could be considered a positive sign of progress, the cost of congestion in Australian capital cities, in terms of avoidable social costs such as delays, trip variability, vehicle operating expenses and emissions, has been forecast to increase from $13.7 billion in 2011 to around $53.3 billion in 2031, unless additional capacity and demand management strategies are implemented (Infrastructure Australia, 2015). City policy makers are accordingly embracing a range of land-use and transport strategies in their plans in an attempt to reduce congestion levels (see chapter 25). While the plans are theoretically persuasive and widely pursued as planning policy in many strategic spatial city plans, the case for reducing congestion and commuting through concentrated employment decentralisation in suburban activity centres and corridors is contested in the literature with mixed results obtained from empirical studies (Handy, 2005). Protagonists have reported reduced congestion levels, reduced commuting travel distance and time and increased levels of reverse commuting (Alpkokin, Cheung, Black, & Hayashi, 2008; Alqhatani, Setunge & Mirodpour, 2014; Burke, Li & Dodson, 2010; Giuliano & Small, 1993; Gordon & Richardson, 1997; Guth, Holz-Rau & Maciolek, 2009; Loo & Chow, 2011;

Weber & Sultana 2005; Zhao, Lu & de Roo, 2011). Antagonists have argued that decentralised urban structures offer little potential to reduce commuting to any significant extent (Cervero, 1998; Giuliano & Small, 1993; Lin, Allan, Cui & McLaughlin, 2012; Wang, 2000), in some cases actually increasing commuting distances, travel times and intrazonal travel (Aguilera, 2005; Buchanan, Barnett, Kingham & Johnston, 2006; Cervero & Wu, 1998; Lin et al., 2012).

While many cities across the world are developing more polycentric urban structures (Arribas-Bel & Sanz-Gracia, 2014), Perth, as is the case with other major Australian cities, is strongly monocentric in that by far the highest concentration of (particularly) office employment occurs in the CBD and its surrounds (Burke, et al., 2010; Forster, 2006; O'Conner & Healy, 2004). In terms of total metropolitan employment, the highest proportion occurs in suburban locations, but mostly across dispersed locations and in specialised clusters rather than in planned, significant, discrete, decentralised centres (Forster, 2006). As has been alluded to in chapters 7, 15, 17 and 21, strategic spatial plans for the Perth metropolitan area, including the current plan, have a long history of ambition for urban consolidation with decentralised employment and higher residential densities concentrated in a hierarchy of activity centres, with sub-regional, employment, self-sufficiency targets to monitor implementation (Biermann & Martinus, 2013; Curtis & Olaru, 2007). Despite these plans and policies, activity centres are not developing anywhere near anticipated levels, employment self-sufficiency targets are not being achieved (Biermann & Martinus, 2013) and commuting and congestion levels are increasing (Mees & Groenhart, 2014). Questions have been asked amongst others about the number of planned activity centres – are there too many? Is enough being done to attract businesses to these activity centres? Are planning controls inhibiting concentration of activities in these centres? The research presented in this chapter seeks to contribute to the policy debate by asking the hypothetical question: all else being equal, if employment decentralisation to two suburban activity centres occurred, what would be the impact on commuting and congestion?

To further contribute to the empirical literature on the effectiveness of employment decentralisation in reducing commuting and to inform current integrated land-use and transport planning and policy in Perth, the purpose of this chapter is to test the transport impacts of a hypothetical land-use scenario involving the redistribution of projected CBD employment growth to two decentralised activity centres in Perth, Western Australia (WA). Traditional four-step strategic transport models have been used previously to experimentally explore the transport impacts of alternative urban form scenarios (Aftabuzzaman, Currie & Sarvi, 2010; Alqhatani, et al., 2014). Using the outputs of the Strategic Transport Evaluation Model (STEM) for the Perth metropolitan area, this chapter considers the potential travel cost and time savings, change in total vehicle kilometres and reduction in the demand on key sections of the road and public transport networks. The travel time savings include, potentially, both shorter trip lengths and reduced congestion levels. The paper does not consider the feasibility or economic viability of developing the alternative employment centres. Its objective is to simply determine whether the scenario could have sufficient transport benefit to warrant further consideration, a significant component of which would be its overall feasibility and economic viability.

EMPLOYMENT DECENTRALISATION AND COMMUTING

Employment decentralisation, concentrated in suburban centres or corridors, has been pursued as a land-use strategy by urban policy makers and practitioners and promoted by the research community on the basis of empirical findings as a means to relieve congestion, reduce commuting travel distance and time, avoid costly new transport infrastructure, increase reverse commuting, reduce greenhouse gas emissions and, in general, achieve more sustainable development outcomes (Alpkokin et al., 2008; Alqhatani et al., 2014; Burke et al., 2010; Guth et al., 2009; Gaigné, Riou & Thisse, 2012; Legras & Cavailhès, 2016; Loo & Chow, 2011; Zhao et al., 2011). Employment decentralisation is a necessary part of achieving related land-use and transport integration and other smart growth policy ideals of suburban jobs–housing balance and Transit Oriented Development (TOD), with the common objective of reducing the need for travel to work and for other purposes, by locating jobs close to where workers live and, in the case of TOD more specifically, linking jobs and housing through efficient public transport (Curtis & Olaru, 2010).

While many, particularly North American and Western European cities are evolving into more polycentric forms, mono-centric city structures have continued to persist even in contexts of growing suburban populations (Anas, Arnott & Small, 1998; Arribas-Bel & Sanz-Gracia, 2014; Bertaud, 2003). Australian cities are experiencing high levels of residential decentralisation but relatively low levels of employment decentralisation (Burke et al., 2010). Highly concentrated, particularly office, employment in central city areas has been associated with long, mono-directional commutes, congestion, high levels of public transport subsidy, jobs–housing imbalances, distorted housing markets, high rents in inner areas and socioeconomic disadvantage for those living on the periphery (Badcock, 1997, 2000; Burke et al., 2010).

It is not surprising then that a common long-term vision in strategic spatial plans of Australian cities is to limit suburban expansion, creating a strong multi-nuclear structure with high-density housing around activity centres and corridors, infill and densification in inner and middle suburbs and residents living close to work in largely self-contained suburban labour sheds, with public and non-motorised transport trips having increased significantly (Forster, 2006). As part of the implementation strategies for these plans, some councils have set employment self-sufficiency targets for sub-regions and others have initiated planned employment decentralisation through programs to move government offices to suburban centres (Biermann & Martinus, 2013; Burke et al., 2010). But does employment decentralisation result in less congestion and commuting in practice?

It is by no means a clear-cut case in the empirical literature that polycentric urban forms yield reduced levels of commuting when compared to monocentric structures, with 'mixed' results reported in some cases (Handy, 2005; Yang, 2005). As indicated, it is the contention of some urban researchers that decentralised urban structures offer little potential to reduce commuting to any significant with some empirical studies showing that polycentric development hardly ameliorates urban congestion in metropolitan areas.

In practice, these mixed results have largely been attributed to the realities of increasingly complex patterns of and interrelationships between economic development, labour force participation and journey-to-work (Curtis & Olaru, 2010; Forster, 2006; O'Conner & Healy, 2004; Yigitcanlar, Dodson, Gleeson & Sipe, 2007). These complexities relate to a range of household-side, travel and employment-side factors (Biermann & Martinus, 2013). The result of these complexities playing out in cities is that workplace and place of residence of workers do not necessarily neatly co-locate in urban sub-regions and therefore, commuting is not necessarily reduced even if employment decentralisation occurs.

Indeed, monocentric city structures have continued to persist even in contexts of growing suburban populations (Arribas-Bel & Sanz-Gracia, 2014) and their benefits espoused in relation to, amongst others, rail patronage and maintaining unified labour markets (Bertaud, 2003; Ding, 2007). Even where strong plans and policies exist for increasing levels of employment decentralisation to suburban activity centres and corridors and with targets and monitoring in place, polycentric structures do not necessarily materialise (Hui & Lam, 2005; Kemp, 1997; Newton, Britchie & Gipps, 1997; Yigitcanlar et al., 2007). In addition, there are different forms of polycentric structure in terms of level of concentration, number, scale location and relative strength of sub-centres attracting workers from different parts of the city; all affect resulting commuting patterns (Bertaud, 2003; Ding, 2007; Ingram, 1997; Lin et al., 2012).

Sydney has been held up as the Australian city with the most concentrated employment decentralisation, attributed by some to good public transport accessibility and planned decentralisation of public sector employment to sub-regional centres (Burke et al., 2010). Others have attributed decentralisation not so much to planning success but rather to CBD flight in response to push factors which make CBD environments less attractive, such as expensive parking and increased inner city congestion (Giuliano, Redfearn, Agarwal & He, 2012; Rodríguez-Gámez & Dallerba, 2012). Still, Freestone and Murphy (1998) conclude that suburban office employment centres in Sydney are modest in scale in relation to the clear dominance of the CBD with its adjacent CBD fringe areas. In 1995, Sydney CBD and its fringe areas (inner city and North Sydney) had 285,000 employment places while Parramatta had the next highest concentration of 30,000 and St. Leonards, North Ryde and Chatswood had each between 16,000 and 21,600 (Freestone & Murphy, 1998, p. 289). Despite being considered the Australian city with the highest level of concentrated decentralisation, it must be noted that Sydney has the highest level of congestion of all Australian cities (Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2015). For the purposes of this chapter, the two Sydney centres are used simply as examples of decentralised concentrations of employment and not because of any proven impact on congestion reduction.

THE SYDNEY EXAMPLE – PARRAMATTA AND CHATSWOOD

The problems associated with a very large city, both geographically and in population terms, relying on a single central hub for jobs, services and activity was recognised in Sydney in the 1960s when Parramatta was designated as a second CBD, as a ‘major suburban centre closer to where the bulk of people live…[to enable access to] a range of jobs, health and educational services, cultural, entertainment and recreational activities and shopping without travelling long distances' (New South Wales Government, 2007, p. 7). Planning policies over the last forty years or so have encouraged Parramatta as the second CBD with employment growing from 5,000 in 1971 to around 50,000 in 2012 (Parramatta City Council, 2012). It is designated as a regional city in the Metropolitan Plan for Sydney 2036, with a targeted growth to 70,000 jobs for the Parramatta CBD (New South Wales Government, 2010). Parramatta is located some 23 kilometres west of the CBD and 35 kilometres east of Penrith, the western extent of Sydney. It is close to the geographical and population centre of Greater Sydney and therefore well located to serve the Greater Sydney area.

North of the CBD, Sydney extends some 25 kilometres (compared to the 60 kilometres to the west), constrained, at least in part, by the Ku-ring-gai Chase National Park. Chatswood has, nevertheless, developed over the last thirty years or so as the primary north shore employment centre and as an alternative location to the CBD, particularly for businesses with a strong employee and client/customer base on the North Shore. It is located 11 kilometres north of the CBD and 15 kilometres south of Hornsby, the northern extent of Sydney (and the terminus of the Northern suburban railway line). Its location meets the transport objectives although, at more than halfway in to the CBD from Hornsby, it is possibly closer in than ideal to minimise travel distances and maximise the potential for contraflow traffic. In the Metropolitan Plan for Sydney 2036, Chatswood is designated as a major centre and is currently the fourth-largest centre in Sydney after the CBD, North Sydney and Parramatta. In 2008 Chatswood CBD employment was 23,000 with a target of 30,000 by 2031 (Willoughby City Council, 2008). This fairly modest growth target reflects the maturity of the existing centre and the limited available land to expand.

These two centres demonstrate Sydney's ability to reduce its dependence on a single central hub and provide an example to Perth in what may be achievable. The next part of this chapter considers the Perth context, followed by a comparison of commuting for a base case, predominantly a monocentric scenario with two alternative, more polycentric future scenarios: employment decentralisation to two suburban activity centres, roughly modelled on the experience of Sydney's Parramatta. More specifically, this chapter considers a hypothetical alternative employment scenario where the projected growth in employment in the CBD occurs instead in two alternative secondary CBDs: one north of the river and one south of the river.

METHODOLOGY

Selecting the Alternative Employment Centres

In selecting alternative employment centres, the key transport objectives are to:

- reduce the distance and time people need to travel from home to work;
- reduce the load on the main road and public transport links into the CBD; and
- increase the traffic flow in the contraflow (i.e. non-peak) direction.

Choosing the right locations is crucial to achieving these transport objectives. Ideally, they should be located on or close to the main road and public transport routes into the CBD and at the points where those routes would be approaching capacity. That way, they would make the most of the existing infrastructure upstream of the centre, then 'capture' trips that would otherwise be heading to the CBD, reducing the demand downstream of the centre.

They should also be far enough out from the CBD to encourage contraflow movement, i.e. to attract workers living between the centre and the CBD to travel away from the CBD to work. These workers would utilise the spare capacity in the non-peak direction rather than adding to the peak direction flow.

Joondalup in the north and Rockingham, and as an alternate Cockburn, in the south, were selected as the hypothetical decentralised employment centres (Figure 1). Together, with six other centres, these three centres are classified as strategic activity centres in the current *Draft Perth and Peel@3.5million and Beyond* (Western Australian Planning Commission (WAPC), 2015b). Joondalup and Rockingham were the only two centres proposed in the *Draft State Planning Policy – Activity Centres for Perth and Peel* (WAPC, 2009) as primary centres.

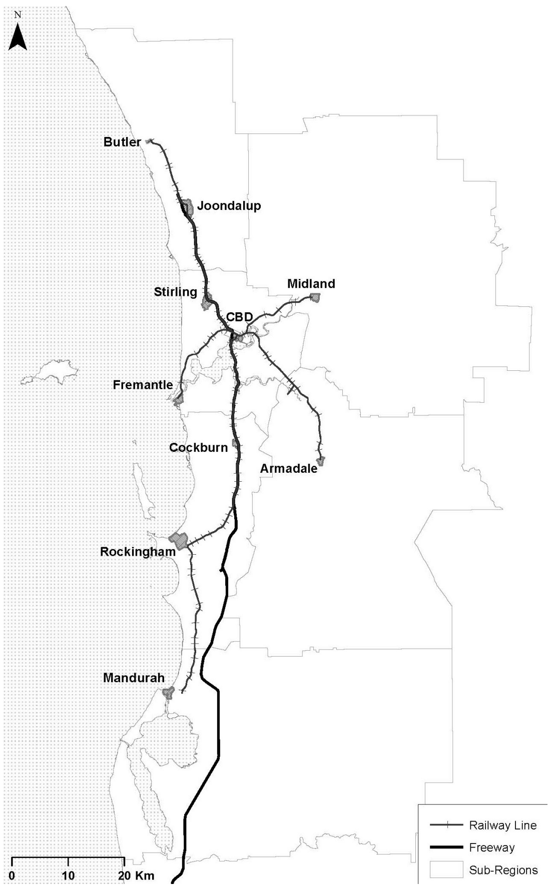

Figure 1: Perth and Peel with Main Centres and Rail Lines.

In the north, Joondalup would appear to meet the above locational criteria. It is immediately adjacent to the Mitchell Freeway and close to Wanneroo Road. The railway line has been pulled out of the Mitchell Freeway median at Joondalup providing the potential for significant development directly around, and even above, the train and bus station. Joondalup is located 27 kilometres north of the CBD, which should be sufficient to encourage contraflow movements. It is 40 kilometres south of Two Rocks, the extent of proposed development within the 3.5 million frameworks for the north west sub-region.

In the south, Rockingham appears less-well-suited to meet the locational requirements of an alternative employment centre. It is within a kilometre or so of a major arterial, Ennis Avenue, but around 10 kilometres from the Kwinana Freeway. It is also 1 to 2 kilometres from the Rockingham train station, requiring a bus transfer for those arriving by train. Realignment of the railway line to directly serve the activity centre may be required or, alternatively, the centre may need to be developed adjacent to the train station. Rockingham is 47 kilometres from the CBD, nearly twice the distance of Joondalup from the centre. This raises the question of whether or not it is too far south to be effective as a southern alternative CBD. The distance issue is compounded by residential development between Cockburn and Rockingham being fairly sparse and potential growth being limited due to heavy industrial uses, although some residential development is taking place. Cockburn is 22 kilometres from the CBD, i.e. closer to the CBD than it is to Rockingham. This means that workers living north of Cockburn transferring from a job in the CBD to one in Rockingham would need to travel further, although workers living close to or south of Rockingham would obviously travel a shorter distance.

Rockingham was nevertheless selected as the initial south-of-the-river location based on its existing and well-established multifunction nature and because it was identified by the Western Australian Planning Commission (WAPC) as a potential primary centre in its draft activity centres policy. The question is whether Rockingham is in the best location to minimise total travel distance and cost. To answer this question, and to address Rockingham's other locational issues, an alternative location has also been assessed: Cockburn. Cockburn has the advantages of being adjacent to the Kwinana Freeway and on both the Mandurah rail line and the future extended Thornlie line. As outlined above, it is 22 kilometres from the CBD, making it closer than the CBD for workers living south of Bull Creek.

This chapter therefore considers a hypothetical scenario where the projected employment growth in the CBD between 2011 and 2050 is assigned instead to Joondalup and Rockingham or Cockburn.

Assessment Methodology

The Department of Planning's Strategic Transport Evaluation model (STEM) has been used for this assessment. STEM is a four step (generation, distribution, mode split and assignment), multimodal model of the Perth and Peel regions (divided into ~500 zones). Population data (including number of households, workers, school-aged children) and employment data (for fifteen employment types) are input for each zone to generate trip productions and attractions. STEM considers travel by car as driver, car as passenger, park & ride, kiss & ride, bus, train, walk and cycle. It models seven trip purposes: white collar work, blue collar work, primary/secondary education, tertiary education, home-based shopping, home-based other and non-home based. It models four time periods: AM peak (7am to 9am), inter-peak (9am to 4pm), PM peak (4pm to 6pm) and off-peak (6pm to 7am). Highway travel times are calculated for the intersections (using delay formula) and for the road sections between intersections (using speed/flow curves). Highway travel times are therefore responsive to changes in traffic volumes; higher volumes resulting in longer travel times (increasing congestion). This congestion may then result in a mode shift or change in destination. The model iterates through the four steps until equilibrium (convergence) is reached, i.e. until no traveller can change his/her trip destination, mode or route to reduce his/her trip cost (disutility).

The STEM model produces global transport indicators, such as total travel times (by travel mode), distances and costs as well as total vehicle kilometres and mode splits, for each of the four modelled time periods. It also provides indicative traffic volumes on roads and on public transport routes. Different population and employment scenarios produce differing transport results in the model. The results for the two alternative employment decentralisation scenarios are compared with the *Draft Perth and Peel@3.5million* framework as the base case results to determine potential transport benefits. The scenarios assessed are outlined next.

Developing the STEM Scenarios

The *Perth and Peel@3.5million* framework, together with its five more detailed sub-regional planning frameworks, were released for comment in June 2015 (WAPC, 2015b). Underpinning *Perth and Peel@3.5million* is a spatial distribution of population and employment, including greater levels of infill, higher densities and increased concentrations of employment and other activities, including residential, in activity centres. Employment in the CBD and its immediate vicinity is given as 125,000 in 2011 in the *Draft Central Sub-regional Planning Framework* (WAPC, 2015a, p. 16). *Perth and Peel@3.5million* only provides employment projections for the larger Central sub-region and not specifically for the CBD. *Perth and Peel@3.5million* forecasts that employment in the Central sub-region will grow by just over 52 per cent from 546,121 in 2011 to 831,958 in around 2050 (WAPC, 2015b, p. 35). For the purposes of this study, a slightly higher growth rate for the CBD of 60 per cent has been assumed, i.e. the CBD employment is forecast to grow from 125,000 in 2011 to 205,000 in around 2050. This increase of 80,000 employment places in the CBD forms the 2050 base case.

Two STEM scenarios were developed and compared with the 2050 base case:

- Scenario 1 – Joondalup and Rockingham Decentralised Employment Scenario (JR)
- Scenario 2 – Joondalup and Cockburn Decentralised Employment Scenario (JC).

Scenario 1 (JR) allocates the assumed CBD employment growth between 2011 and 2050 (i.e. the 80,000 additional jobs) evenly between Joondalup and Rockingham activity centres. Scenario 2 (JC) allocates the 80,000 additional jobs evenly between Joondalup and Cockburn activity centres. The resulting assumed employment distributions are shown in Table 1.

Centre	Employment Numbers			
	2011	*Perth and Peel@3.5million* (+/– 2050)		
		Base Case	Scenario 1 (JR)	Scenario 2 (JC)
CBD	125,000	205,000	125,000	125,000
Joondalup	13,000	20,000	60,000	60,000
Rockingham	7,000	12,000	52,000	12,000
Cockburn	1,800	6,000	6,000	46,000

Table 1: Assumed Employment Distributions. Note: 2011 and Base Case Perth and Peel@3.5million – CBD 2011 from Draft Central Sub-regional Planning Framework and Base Case assumes 60 per cent growth, Joondalup from Draft North-West Sub-regional Planning Framework and Rockingham & Cockburn from Draft South Metropolitan Peel Sub-regional Framework (WAPC, 2015a)

All three scenarios use the same population numbers and distribution, consistent with the base case, i.e. *Perth and Peel@3.5million*.

As outlined earlier, the Rockingham activity centre is somewhat remote from the train station. This would mean that for the centre to be served efficiently by public transport, it would need to be relocated to the train station or the train line realigned and the station relocated to better serve the centre. In this hypothetical assessment, the latter has been assumed, simply by assuming the centre is close to the train station in the STEM model.

Road and Public Transport Networks

Very similar road and public transport networks have been assumed for the three scenarios. The 2050 base case used the road and public transport networks assumed previously in the STEM model for 2031. Minor changes have been made to the roads around the centres for the two alternative employment scenarios to, at least partially, accommodate the higher employment levels. In practice, improvements/changes to the road network and public transport services serving the centres would be required to accommodate these levels of employment. This hypothetical assessment does not consider these at this stage but they would need to be considered should further assessment be undertaken. The distances from the zone centroids to the train stations have also been reduced to reflect the high intensity of future development around the train stations, i.e. to reflect reduced average distances between the station and surrounding employment.

The STEM model currently has constraints on parking in the CBD (supply and cost), but none at Joondalup, Rockingham or Cockburn. In practice, should these centres grow significantly, parking is likely to be limited and incur a charge. This would impact on mode splits and would also need to be considered in further work. In STEM, peak-period traffic volumes are allowed, in theory at least, to exceed the physical capacity of a section of road or an intersection, but travel times increase significantly. In practice, where other options such as public transport are available, road volumes tend to be limited to capacity, as travellers transfer from car to public transport. The public transport networks have no capacity constraints in the model, i.e. overcrowding does not impact on the utility of public transport.

RESULTS

Outputs in the form of travel distance and time, trip numbers and mode splits, traffic volumes on the Mitchell and Kwinana Freeways and patronage levels on the Joondalup and Mandurah train lines were extracted from STEM for the base case and each of the scenarios and compared.

Daily Travel Distance and Time

Table 2 compares the daily total vehicle and public transport passenger kilometres and total access hours for the base case and two alternative scenarios.

Indicator	2011	*Perth and Peel@3.5million* (+/– 2050)		
		Base Case	Scenario 1 (JR)	Scenario 2 (JC)
Total car distance (million vehicle kms /day)	33,200	62,100	62,900	63,000
Total public transport distance (million passenger kms/day)	5,850	17,150	15,500	15,600
Total travel distance (million person kms/day)	51,400	105,200	104,100	104,500
Total travel time (million person hrs/day)	1,650	4,250	4,150	4,200
Average time per trip (min/day)	15.7	20.7	20.1	20.3

Table 2: Daily Travel Distance and Time Comparison

The global results indicate that the transfer of the 80,000 job growth from the CBD to Joondalup and Rockingham/Cockburn could result in a small reduction in total travel distance comprising a small increase in car distance offset by a slightly larger reduction in public transport distance. This is indicative of longer distance train trips to the CBD being replaced by shorter car trips to Joondalup and Rockingham/Cockburn. The total travel time savings are around 50,000 hours per day for the Cockburn scenario and 100,000 hours per day for the Rockingham scenario, or around 1 per cent and 2 per cent of total travel time respectively.

The difference between the base case and Scenario 1 (JR) is an increase of 1.3 per cent in car distance travelled per day, but a decrease of 9.6 per cent in public transport distance travelled, 1.1 per cent in total travel distance, 2.4 per cent in travel time and almost 3 per cent decrease in average trip time (Table 2). At first glance, these travel distance and time savings may seem relatively small, but assuming a time value for travel to work of $15 per hour and 250 travel days per year, they equate to $200 million and $400 million per year respectively. Were these travel times savings to be achieved by a potential transport project, road or rail, an investment of up to $4 billion to 5 billion could be justified – based on an 8 per cent rate of return.

This level of potential investment, if directed to achieving the employment growth at these centres, would provide significant seed funding to 'make it happen'. These savings relate just to travel time. There would be additional savings for travellers due to shorter trip lengths resulting in reduced car costs or public transport fares. The latter would mean reduced public transport revenue, but this is likely to be more than offset by the savings in transport infrastructure provision and rolling stock requirements, as outlined later.

These small overall travel time and distance savings must also be viewed in the context of the scale of the change modelled. The 80,000 relocated jobs equate to just 5 per cent of total 2050 employment, and work trips equate to around 25 per cent of total trips. In this context, changes of 2 per cent to 3 per cent can be considered significant. There is also the scope for a more 'aggressive' employment redistribution that could potentially have even greater benefits.

Daily Trip Numbers and Mode Splits

The above results are further explained by the trip numbers and mode splits shown in tables 3 and 4. Table 3 considers all trips for all trip purposes. Table 4 considers work trips to the CBD only.

Travel Mode	Number of Daily (One-way) Trips (mode share %)			
	2011	*Perth and Peel@3.5million* (+/– 2050)		
		Base Case	Scenario 1 (JR)	Scenario 2 (JC)
Car trips (driver + passenger)	5,100,000 (81.5%)	9,700,000 (78.5%)	9,800,000 (79%)	9,800,000 (79%)
Public transport trips	340,000 (5.5%)	850,000 (7.0%)	800,000 (6.5%)	800,000 6.5%
Walk/cycle	800,000 (13.0%)	1,800,000 (15.0%)	1,800,000 (14.5%)	1,800,000 (14.5%)

Table 3: Daily Trips (one-way) and Mode Splits – All Trip Purposes. Note: The trips numbers in this table are one-way trips, i.e. a trip from home to work is one trip, the trip from work back to home is a second trip. For example, the 340,000 public transport trips in 2011 are made by 170,000 people taking public transport from home to their destination and then public transport back home again.

The overall results show a small increase (around 1 per cent) in the number of car trips and a comparable reduction in public transport trips. This implies that some of the longer distance trips to jobs in the CBD by public transport would be replaced, in part, by car trips to those jobs when relocated to Joondalup or Rockingham/Cockburn.

Long distance trips to work in the CBD are the trips that are most likely to be made by public transport. As trip lengths shorten, public transport generally becomes less attractive. It should also be noted, as outlined earlier, that these hypothetical scenarios have not applied any parking constraints or charges at Joondalup or Rockingham/Cockburn. These would be likely and would result in some transfer back to public transport.

The additional 80,000 jobs in the 2050 base would have a significant impact on trip numbers and mode splits to the CBD. Car trips are projected to be slightly lower than in 2011, even with an increase in jobs. This is due to increasing congestion on the roads feeding into the city, in particular the Mitchell and Kwinana

Travel Mode	Number of (One-way) Trips			
	2011	*Perth and Peel@3.5million* (+/– 2050)		
		Base Case	Scenario 1 (JR)	Scenario 2 (JC)
Car trips (driver + passenger)	73,500 (44%)	71,000 (26.5%)	53,000 (31%)	52,000 (30.5%)
Public transport	87,500 (52%)	180,000 (67.5%)	109,000 (63.5%)	110,000 (64%)
Walk/cycle	7,500 (4.5%)	15,000 (6%)	9,500 (5.5%)	9,500 5.5%
CBD car park occupancy	78%	60%	44%	44%

Table 4: Daily Trips (One-way) and Mode Splits – Work Trips to and from CBD Only. Note: The trips numbers in this table are one-way trips, i.e. a trip from home to work is one trip, the trip from work back to home is a second trip. For example, the 87,500 PT trips in 2011 are made by 43,750 people taking public transport from home to their work in the CBD and then public transport back home again.

Freeways, and the availability of high quality public transport to the CBD as an alternative. Public transport trips to the CBD more than double in the 2050 base; a function of both the change in mode and the increasing demand of the extra 80,000 jobs. The reduction in car trips is much greater in the two alternative scenarios, at nearly 30 per cent lower than the 2011 number. This is a function of the increase in general, non-CBD bound traffic (i.e. due to the doubling of the population) on the freeways 'pushing' CBD-bound car traffic onto public transport. Public transport trips are significantly reduced compared to the 2050 base, as expected with the removal of 80,000 jobs, but are still above 2011 levels. This is simply the result of the mode shift from car to public transport. The changes in trip numbers and mode splits would have an impact on the Mitchell and Kwinana Freeway corridors, both road and rail, as discussed in the next two sections.

Impact on Mitchell and Kwinana Freeway Traffic Volumes

Table 5 presents a comparison of the AM peak hour period volumes at key locations on the Mitchell and Kwinana Freeways for the 2050 base and two alternative scenarios, as well as for 2011. [Note that STEM provides volumes for a two-hour AM peak. These volumes have been multiplied by 0.55 to produce the estimated peak hour (peak within the peak) volumes in the tables. This 0.55 value is consistent with the observed 2011 traffic count data and has been retained for 2050 for consistency and comparative purposes. In reality, by 2050 the peak hour within the peak two hours in STEM is likely to be closer to 0.5 due to peak spreading.]

As expected, traffic is likely to increase between 2011 and 2050 on all sections, with greater increases appearing in the non-peak direction. This reflects the capacity constraints in the peak direction limiting the increase in peak hour volumes.

Transferring the projected growth in CBD jobs to Joondalup and Rockingham/Cockburn would have fairly minor impacts on the two freeways (Table 5). Overall, flows could be a little lower in the peak direction and a little higher in the non-peak direction, reflecting the transfer from driving to the CBD to driving to Joondalup or Rockingham/Cockburn.

This shows equilibrium at work within the system. Removing car trips to the CBD, by relocating the CBD jobs, initially reduces congestion on the freeway. This then attracts some travellers on the train to transfer to car. It could also encourage those drivers that were avoiding the freeway (either by using alternatives routes or going to alternative destinations), to now use the freeway.

Although the traffic volumes, or the total vehicle kilometres driven, do not directly indicate any great benefit, there are, of course, the opportunity benefits of being able to travel further and/or at less cost, i.e. to access a greater range of destinations that are not quantified or identifiable in the above results. In other words, freeing up the freeway allows other travellers to use the freeway to reach locations that they otherwise would not have travelled to or would have travelled to but by costlier means. Thus the freed up capacity is quickly ‘consumed’ by others.

Road	Location	Direction[3]	Volume[2]			
			2011	*Perth and Peel@3.5million| (+/– 2050)*		
				Base Case	Scenario 1 (JR)	Scenario 2 (JC)
Mitchell Freeway	South of Glendalough Station	N	4,400 (4)	6,300 (5)	6,600 (5)	6,700 (5)
		S	7,400 (4)	8,600 (4)	8,500 (4)	7,900 (4)
	North of Stirling Station	N	4,200 (3)	4,800 (3)	4,900 (3)	5,000 (3)
		S	5,600 (3)	6,300 (3)	6,400 (3)	6,200 (3)
	South of Joondalup Station	N	2,500 (2)	4,700 (3)	5,000 (3)	4,900 (3)
		S	3,100 (2)	5,000 (3)	4,700 (3)	4,700 (3)
Kwinana Freeway	Narrows Bridge	N	8,300 (4)	8,900 (4)	8,700 (4)	8,600 (4)
		S	5,800 (5)	7,600 (5)	7,600 (5)	8,000 (5)
	North of Bull Creek Station	N	5,000 (3)	5,300 (3)	5,300 (3)	5,200 (3)
		S	3,900 (3)	5,200 (3)	5,300 (3)	5,300 (3)
	North of Cockburn Station	N	3,400 (2)	5,700 (3)	6,100 (3)	5,600 (3)
		S	2,900 (2)	5,300 (3)	5,700 (3)	5,800 (3)

Table 5: AM Peak Hour Road Volumes [1] Peak hour volumes have been estimated by multiplying the STEM peak two-hour volumes by 0.55. [2] Numbers in brackets after the volumes are the number of lanes. [3] N=northbound; S=southbound

Impact on Joondalup and Mandurah Rail Patronage

Table 6 presents the AM peak-hour train patronage levels at similar locations on the Joondalup and Mandurah rail lines.

The impacts on train patronage are significantly greater than the impacts on the freeways. In the 2050 base, patronage levels towards the city are two to three times higher on the Joondalup line and 1.5 to two times higher on the Mandurah line compared to 2011. This mirrors the results in Table 4 (work trips to the CBD) and is a function of effectively all of the increase in demand to the CBD having to be carried by the train; the roads already being congested in 2011. In the non-peak direction, percentage increases in patronage are even higher, at four to five times or more. This is a function of the 3.5 million spatial distribution of employment, with more jobs located in the outer sub-regions and at locations with good public transport access.

In the two alternative scenarios, train patronage is higher than in 2011. When compared to the 2050 base, patronage is much lower towards the city and much higher towards Joondalup and Rockingham/Cockburn. The results again mirror those of Table 4. The biggest impact therefore appears to be to peak-hour, peak-direction patronage on the Joondalup and Mandurah rail lines and hence on the number of train carriages required. The section with the highest demand is between Glendalough and Leederville. Peak-hour, peak-direction demand could reduce from around 20,000 in the 2050 base to 15,000 in the alternative scenarios. This equates to 25 per cent less trains (rolling stock) being required and could also remove the potential for any new tracks being required. The cost savings to government for the rolling stock would be substantial, but even this would be relatively small compared to the savings if new track were not required. The transport benefits for Rockingham and Cockburn seem very similar overall. Rockingham would appear to give the larger travel-time saving while Cockburn may have the higher potential for contraflow movements.

Rail Line	Location (Station)	Direction[2]	Patronage (Number of passengers)			
			2011	*Perth and Peel@3.5million* (+/– 2050)		
				Base Case	Scenario 1 (JR)	Scenario 2 (JC)
Joondalup Line	South of Glendalough Station	N	800	3,200	3,800	3,700
		S	7,900	19,700	14,700	14,900
	North of Stirling Station	N	800	3,200	3,900	3,900
		S	6,800	18,100	13,500	13,500
	South of Joondalup Station	N	900	4,400	6,000	6,000
		S	2,600	9,600	7,700	7,500
Mandurah Line	Narrows Bridge	N	7,000	11,300	8,200	8,700
		S	900	3,600	4,600	4,400
	North of Bull Creek Station	N	7,400	12,100	9,000	9,600
		S	600	3,400	4,500	4,300
	North of Cockburn Station	N	6,500	12,600	9,900	11,000
		S	300	2,200	3,400	3,300

Table 6: AM Peak Hour Train Patronage [1] Peak hour volumes have been estimated by multiplying the STEM peak two- hour volumes by 0.55. [2] N=northbound; S=southbound

DISCUSSION

This hypothetical analysis has produced some interesting and potentially unexpected results. The higher total car-travel distance may seem counter-intuitive considering that jobs have been moved much closer to where many people live. This could, at least in part, be explained by longer public transport trips transferring to shorter trips by car. The total travel time and distance benefits also appear rather modest. There could be several reasons for this. The first is that the STEM model is a very dynamic model with a lot of interacting components, as indeed is travel in a large city like Perth. This means that removing car trips to the CBD (by relocating jobs) reduces trips initially on the congested sections of the Mitchell and Kwinana Freeways. Less congestion makes the freeways more attractive to cars, encouraging a transfer back to car and longer car trips. An equilibrium is therefore reached where the freeways are used to their maximum benefit. This is simply the model reflecting reality. This provides a benefit to travellers, being able to reach destinations that they otherwise would not reach or would reach at a higher cost. The resulting opportunity benefit is not fully reflected in an assessment of travel time and distance savings, per the numbers presented here.

A second reason for the apparently low benefits could be that, whilst changing the location of 80,000 jobs may seem a significant change, these jobs represent 5 per cent of total jobs and would generate less than 1 per cent of the total trips that would be made per day in 2050. They would have a greater impact on the network that the 1 per cent suggests as they tend to be longer distance trips in the peak periods travelling on the more congested sections of the road and public transport networks. Nevertheless, their contribution to total travel times and distances overall would remain relatively small.

The biggest benefit to relocating the 80,000 jobs appears to be in the reduction in peak-hour, peak-direction public transport trips to the CBD and the increase in the non-peak direction. This would reduce the requirements to purchase additional trains, with a significant saving to government.

CONCLUSION

Does employment decentralisation to two centres in Perth reduce commuting and congestion? Concurring with much of the literature, this research has also shown 'mixed' results, with significant results for some indicators but with less significant results for others. Car travel distance increases slightly with concentrated decentralisation. There is an almost 10 per cent reduction in distance travelled using public transport and less significant reductions (less than 3 per cent) in total travel distance, total travel time and average trip time. Converting these travel time savings to a time value for travel to work, however, yields some potential overall benefits. Numbers of car trips (all trips, all purposes) increase slightly by 1 per cent, but with a comparable reduction in public transport trips. The slight increase in car travel distance and time and in the overall number of car trips is indicative of increased intrazonal travel by car. Considering the difference in the number of work trips to and from the CBD between the base case and Scenario 1, there is a significant reduction in the number of trips to and from the CBD by all modes: 25 per cent less by car, 39 per cent less by public transport and 37 per cent less by walking/cycling. However, car mode share increases from 27 per cent to 31 per cent and public transport share decreases from 68 per cent to 64 per cent.

There are fairly minor impacts on the two freeways. Overall, flows could be a little lower in the peak direction and a little higher in the non-peak direction. The most significant impact appears that when compared to the 2050 base, public transport patronage in the concentrated, decentralised employment scenarios is much lower towards the city but much higher towards Joondalup and Rockingham/Cockburn, i.e. contraflow benefits and fewer additional train carriages required to accommodate peak hour, peak direction patronage on both rail lines. On the other hand, reduced patronage, especially over the longer distances to the CBD, has implications for patronage income.

Some of these findings are related to the way the model operates and its constraints. There is insufficient evidence, from this initial and hypothetical analysis, that in the Perth metropolitan area concentrated decentralisation of employment in two suburban centres would significantly, and for all indicators considered, result in reduced levels of commuting. There is nevertheless enough evidence to indicate some potential benefits that make this hypothetical proposal worthy of further consideration.

It is recommended that the global results in this paper be dissected into smaller areas to determine more localised effects. The benefits in some key areas may be significant whilst in other areas there may be no impacts. The global results may be diluting these area specific benefits.

ACKNOWLEDGEMENTS

The contribution of the WA Department of Planning through the secondment of Gary McCarney to conduct the research on which this chapter is based and for the use of the STEM model is acknowledged. The views expressed are those of the authors and do not necessarily represent the position of the Department of Planning. The constructive comments from two anonymous reviewers are also gratefully acknowledged. The research presented in this chapter was supported by the Planning and Transport Research Centre (PATREC).

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