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Is practice aligned with the principles? Implementing New Urbanism in Perth, Western Australia

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Abstract

New Urbanism is a recent American reform approach to urban development, which attempts to reduce car dependence through traditional design qualities such as connected streets with paths, higher density and mix with local centres. The Western Australian State Government has developed 'Liveable Neighbourhoods', which is a context-specific design code based on New Urbanist principles. This design code has been applied in the development of several dozen new neighbourhoods in Perth over the last decade. This paper shows that these developments do create more local walking but are no different to conventional suburban development in their regional car dependence. The causes of this are pursued in terms of a gap between principles and practice.

1. Introduction

New Urbanism is posited as a new approach to suburban development, which could reduce car dependence by creating pedestrian-friendly environments (Duany et al, 2000; Farr, 2008; Flint, 2006). Liveable Neighbourhoods (LN), an operational development policy in use in Perth, is a Western Australian interpretation of New Urbanism. It is intended to replace conventional design codes that have facilitated car dependence and sprawl over the last 50 or so years.

This paper presents the findings of new research that has evaluated the transport sustainability of new neighbourhoods designed in accordance with the LN policy compared with conventionally designed neighbourhoods. Moreover, it critiques the application of LN by analysing inconsistencies between the principles that underlie the policy and practice. The research was premised by two of the key objectives of the LN design code: to reduce car

dependence by providing for local access to jobs, services and recreation, and to better integrate new development with existing urban infrastructure (particularly public transport services).

The following section provides a brief background to New Urbanism and the influence of this urban reform approach on the development of the LN policy. Section 3 describes the study methodology, which included a travel survey and environmental analyses. The key results of the study are presented in Section 4 and are subsequently discussed in Section 5.

2. Background

In 1993, the Congress for the New Urbanism was founded by six architects: Peter Calthorpe, Andrés Duany, Daniel Solomon, Elizabeth Moule, Elizabeth Plater-Zyberk and Stephanos Polyzoides. The movement advocates design qualities reflective of small US cities *circa* 1900 to 1920 (Beatley, 2004; Frank et al, 2004). These qualities include local street network connectivity, provision of sidewalks, mixing of uses and increased development densities, all of which are argued to counteract sprawl and reduce car dependence. In principle, New Urbanism anticipates a high degree of regional integration (including integration of new neighbourhoods with regional transit services), such that people are not beholden to cars to fulfil their transport needs.

New Urbanism has spread globally, particularly to car dependent cities like Perth in Western Australia where the State government has recognised the need for redress of conventional development policy. In February 1998, a trial began of a design code called 'Liveable Neighbourhoods' (LN), a version of the *Australian Model Code for Residential Development 1995* that was amended to be more closely aligned with New Urbanist principles. Key

components of this code are shown in Table 1. It was formulated and reviewed by a steering committee representing government and industry, and public submissions were invited. From 1998 to 2008, the design code could be voluntarily adopted by developers, however it is now mandatory. The code can be applied at a variety of scales, from subdivisions to district structure plans encompassing a large cluster of neighbourhoods.

The LN code is intended to be a performance-based vehicle to meet the objectives of the State Planning Strategy. As part of the vision for Western Australia 2029, the code is intended to facilitate the development of more sustainable communities. It is anticipated that LNs will facilitate use of active modes of transport (e.g. walking and cycling), be well-linked to existing public transport services and feature higher relative densities and increased lot diversity, with development focused around activity centres and public transport nodes (Western Australian Planning Commission, 2004). The code is to be applied to development proposals on *greenfields* sites encompassing two or more lots and larger infill sites (Western Australian Planning Commission, 2004).

Table 1 – Guiding principles of the Liveable Neighbourhoods design code

Town Structure	The town structure should be compact and well-defined. It should consist of a clustering of highly interconnected neighbourhoods, which are mutually supportive of both neighbourhood centres and the town centre.
Neighbourhood Structure	A neighbourhood is typically defined as a 400-450 metre radius circle (5 minute walking distance) with a shop supplying daily needs, or another type of community focus, at its centre.
Neighbourhood Walkability	Walking is the most energy efficient mode of travel. It can be encouraged by an interconnected street network that provides pedestrians with a choice of routes at intersections to enable access to neighbourhood facilities via a safe and attractive environment.
Walkability to Facilities and Public Transport	As a measure of efficiency, at least 60% of the dwellings in a neighbourhood should be within a 400-450 metre walk of a neighbourhood centre or bus stop, or 800 metres of a rail station.
Safety and Surveillance	To reduce opportunities for crime, a clear definition is required between public places and private backs. Development should provide frontages with windows and entrances onto the public realm.
Choice/Flexibility/Variety	The urban lay-out should respond to the current and future needs of society. Buildings and lots should be designed to be adaptable in order to accommodate either changes in land use or additions over time.
Environmentally and Culturally Responsive Design	Key environmental and cultural features should be identified and protected within the design.
Site Responsive Design – Character and Identity	Local identity should be complemented or created by responding to site features, context, landscape and views.
Cost and Resource Efficiency	The development should promote neighbourhood sustainability in terms of the efficient use of infrastructure, the promotion of affordable and energy efficient housing, and satisfying the daily needs of the residents through access to appropriate types of community facilities.

(Source: Jones, 2003; Western Australian Planning Commission, 2004)

The code is strongly focused on improving street network connectivity and encouraging increased walking trips through the provision of pedestrian friendly infrastructure. It aims to facilitate residential development at a range of densities, land use mix and local employment opportunities. The guidelines target densities of at least 15 dwellings *per urban hectare* (i.e. 15 dwellings per hectare of urban land) in most new areas. In terms of residential land, the target is a density of 22 dwellings *per site hectare* (i.e. 22 dwellings per hectare of residential land, excluding areas reserved as roads or public open space, and non-residential land). Densities of between 20-30 dwellings per site hectare are anticipated within 400 metres of local centres and public transport stops.

In 'strategic' areas in the vicinity of town centres and rail stations (800 metres radius), a housing density of 30-40 dwellings per site hectare is preferred. In comparison, many suburban areas in Perth are characterised by R20 density or lower (R20 being equivalent to 20 dwellings per site hectare). Moreover, many Town Planning Schemes still retain ordinances restricting density to lower levels under assumptions that higher densities would compromise residential amenity and generate undesirable volumes of traffic.

It is intended that local centres will be provided within each new LN. Local centres should be designed as community anchor points with the provision of amenities to meet the daily needs of local residents. Amenities may include a post box, transit stop and small-scale shops, such as a delicatessen. The provision of daily shopping needs in the local centre is very important because it provides an opportunity for residents to walk or cycle rather than drive to pick up consumables. Research has found that grocers and similar food service facilities are important neighbourhood anchor-points for adults, while recreation and education facilities are not (Moudon et al, 2006).

The code very clearly anticipates coordination of new neighbourhoods, to integrate land use and transport at a district and potentially regional scale. This reflects research that has found that many people have regional transport patterns and local design is likely to have a minimal impact on transport behaviour (Ewing and Cervero, 2001; Stead et al. 2001). Such coordination is intended to provide people with opportunities to conduct regional trips by public transport with journey times being relatively competitive with the car.

Town centres are intended to be the anchor-point for clusters of neighbourhoods (see Figure 1). These centres should be built to a much larger scale and feature a range of shops, including a supermarket. LN assumes there will be some provision of jobs for locals, although it can be expected that those in specialised occupations will have to leave the neighbourhood for work. Local jobs will likely be few in number - relative to how many residents are of working age - and require fairly generic skills. A rail stop in a town centre is desirable but difficult to provide, given the limited extent of Perth's rail network.

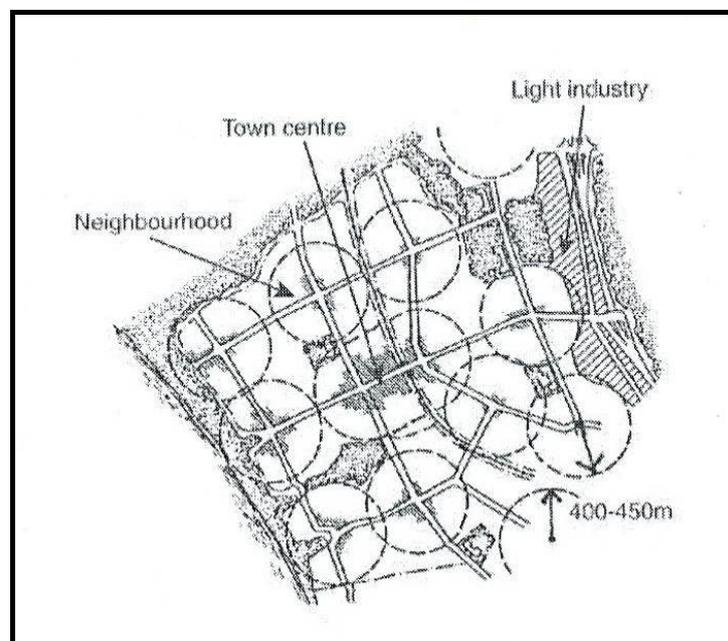


Figure 1 – District-level design schematic

(Source: WAPC, 2004: p26)

Since implementation of the trial LN code, a significant number of suburbs have been designed and a number built in accordance with its provisions. The RESIDential Environments (RESIDE) project was initiated in 2003 to evaluate the impact of the LN code on walking, cycling, public transport use, sense of community and mental health (Giles-Corti, 2008). With a longitudinal study design, RESIDE is studying residents moving into neighbourhoods developed according to the LN code, compared with other neighbourhoods. Three surveys will be conducted: (1) before study participants move into their new home, and (2) then 12 and 36 months later. The present paper reports on a sub-study of the RESIDE Project (hereafter referred to as the Transport Sustainability Study, or TSS) at the 12 month follow-up stage of the main study.

The TSS had a cross-sectional design, as the data collection phase was limited to around one year. It assessed transport sustainability in a sample of 11 Liveable Neighbourhoods (LNs) compared with 35 conventionally-designed 'sprawl' neighbourhoods (CNs): neighbourhoods that were developed using the typical code that New Urbanism criticises.

Showcase New Urbanist projects elsewhere, such as Seaside in Florida and Kentlands in Maryland, are lauded for their local design quality and local walkability, but are also criticised for being too exclusive and insufficiently integrated into regional transportation networks (Flint, 2006). Rather than being a failing of the New Urbanism, these shortcomings may reflect that the New Urbanist code is not being fully implemented and developments are not being pursued at a sufficient scale and with a sufficient degree of coordination.

Despite various critiques of the extent to which New Urbanism can reduce car dependence, little research has evaluated the impacts of the code on residents in more than one or two individual neighbourhoods. Moreover, there is little research that has addressed the principles and practice gap in any great detail. Significantly, this is because there are a

relatively small number of New Urbanist developments in any one context. Thus, Perth with its 11 New Urbanist developments offers a chance to evaluate a relatively large sample.

3. Methodology

3.1 Neighbourhood selection

The RESIDE study neighbourhoods were selected from a pool of new development applications lodged with the Western Australian Planning Commission. RESIDE conventional and liveable neighbourhoods are shown in Figure 2.

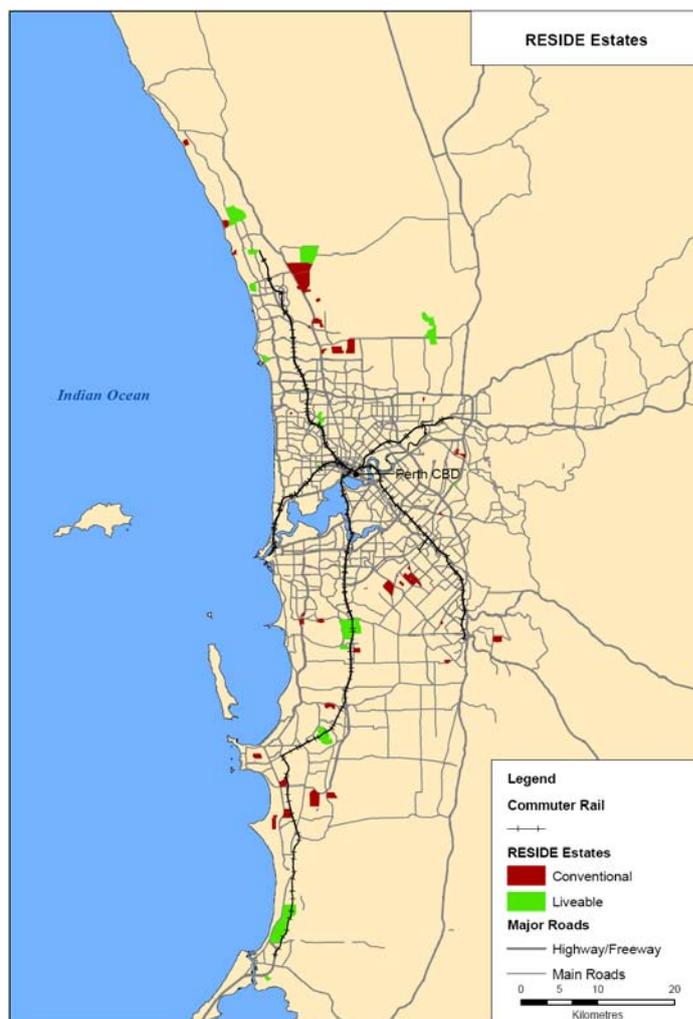


Figure 2 – Distribution of conventional and liveable neighbourhoods in RESIDE sample

The selection procedure is discussed in greater detail elsewhere (Giles-Corti, 2008). The differentiation of LNs from CNs depended on how individual development applications were assessed by the Department for Planning and Infrastructure (DPI): when neighbourhoods were selected, the LN code was still voluntary. Generally, the LN approval process is more onerous than the approval process for CNs and the LN applications are assessed against the LN code. Therefore, it is possible that some developers applied certain LN principles to their outline plans, but applied for conventional processing through the DPI. In such cases, the officers assessed these developments as ‘hybrid’ developments.

This study has limited the sample to neighbourhoods that were either wholly assessed against the CN (conventional) or the LN (Liveable Neighbourhoods) design code. Selection was constrained by the sampling procedure for a subsequent traffic survey (see Section 3.2.1).

Briefly, 46 neighbourhoods were represented in the TSS; 11 of which were LNs and 35 CNs. The number of CNs relative to LNs reflects the fact that there were many more of the former being developed in the metropolitan region than the latter at the time of the sub-study. The northernmost neighbourhood is *Ocean Lagoon*, a CN, which is around 50 kilometres from central Perth. The southernmost neighbourhood is *Mariners’ Cove*, an LN, which is about 65 kilometres from central Perth.

3.2 Study components

The TSS utilised a multi-methods approach. The study assessed key differences in design characteristics (environmental analyses) and used these to interpret self-reported travel behaviour provided by residents. For example, distances between homes and everyday facilities such as convenience stores were related to self-reported mode choices and VKT.

The environmental analysis was conducted using Geographic Information Systems (GIS) and applied to all sample neighbourhoods in the TSS study (i.e. 46 neighbourhoods).

3.2.1 Travel survey

A total of 211 people from 103 households, grouped in two cohorts, completed travel surveys. In the first cohort, participants were recruited from RESIDE study households (there is one participant in RESIDE per study household) that were not otherwise scheduled to receive a questionnaire in 2006. This was intended to minimise participant overburden. In total, 497 RESIDE households were eligible for the TSS. It was anticipated that a high recruitment rate would be achieved based on the participants' disposition to complete complex questionnaires and the likelihood that other family members would also complete a travel survey if invited.

Participants were recruited by an initial mail-out and two subsequent follow-up letters. Prospective participants were advised that they would be entered into a prize draw for a bicycle when their involvement was completed. The travel survey was a seven day trip and activity diary, which was based on those used for the Perth Regional Travel Surveys 1976, Perth and Regions Travel Survey 2002-2006 and Burke's (2004) research into gated communities in the city of Brisbane. These are, in turn, representative of the innumerable similar household travel surveys that have been conducted around the world over the last 50 years as part of major land-use and transport studies. The types of activities that participants were asked to report included the return journey to work. Participants were also asked to specify details of their trips including start and end times, and mode used. The travel diary incorporated a range of socio-demographic (control) questions, including occupation, age, education and gender. Household income data was also collected.

The recruitment phase began in early autumn and the diaries were posted and completed in late autumn, which is a relatively mild period for weather in Perth. In practice, recruitment of participants was disappointing and eventually only 110 completed travel diaries were returned by 52 households. Based on the response rate, a second cohort was planned.

To avoid overburdening other RESIDE participants who were already completing surveys in 2006, the second cohort was recruited from the neighbours of RESIDE households. All of these neighbours were also located in the TSS study neighbourhoods. Given the proximity of households in the second cohort to RESIDE households, environmental variables such as distances to local shops could be used as proxy. All target households were within the TSS study neighbourhoods. Around 850 immediate neighbours were identified, of which some addresses were assumed to be non-residential. Members of these households were recruited by an initial mail-out and three subsequent follow-up letters. They were offered small inducements for participating (a free video hire voucher) and entry into a second prize draw for a bicycle when their involvement was completed. In this instance, the trip and activity diary was shortened to two days in an effort to improve the response rate.

The recruitment phase began in early spring 2006 and the diaries were posted and completed in mid/ late spring, which is again a period of relatively mild weather. In practice, only 101 completed diaries were returned by households. There was no recourse to recruit a third cohort.

While the overall travel survey sample size and use of both seven and two day diaries are acknowledged limitations of the TSS – 55 residents of LNs and 156 residents of CNs were surveyed¹ - the multi-methods study design was adopted to allow comparison of self-reported with objective environmental data. Transport energy use and emissions levels were

¹ The disproportionate representation reflects there being about three times more CNs than LNs in the study sample.

subsequently generated from the travel survey data using a power-based model (Leung and Williams, 2000).

3.2.2 Environmental study

The objectives of the environmental analyses were to explain why there were any differences in self-reported transport behaviour and concurrently, to evaluate whether LN developments were being designed as intended; to mitigate car dependence. The key environmental indicators of mitigated car dependence were hypothesised to be:

- (a) Provision of local land use mix;
- (b) Provision of a range of development densities with average density being significantly higher than in conventional 'sprawl' suburbs;
- (c) High transport network connectivity (i.e. little difference between straight line and network measures of horizontal distance);
- (d) Regional transit accessibility (i.e. could households access transit and could it be a viable alternative to the car for regional trips?); and
- (e) Coordination of individual new developments into towns/ larger development areas.

In practical terms, (e) could be qualitatively assessed through scrutiny of where in the metropolitan region new neighbourhoods were being built, how big they were and how they were integrated with the surrounding urban fabric: i.e. were new neighbourhoods clustered into towns?

Four specific sets of environmental measures were derived to reflect indicators (a) to (e). These are described below.

(a) Accessibility of common, daily destinations

The first set of measures related to network access to common, daily destinations (i.e. the geo-coded network distance between homes and destinations including local shops). The measures were derived for RESIDE households who, as of May 2007, both had a family member who had completed RESIDE's first follow-up questionnaire and were situated in one of the TSS neighbourhoods (n=992: 323 in LNs and 669 in CNs)².

The method and choice of common destinations was informed by similar work by Holtzclaw (1994). Holtzclaw's (1994: p15) neighbourhood shopping index (NSI) measured "the fraction of the community's population which has five critical local commercial establishments within ¼ mile [402 metres] walking distance".

Holtzclaw (1994) found that five destinations formed a credible measure of daily access: including fewer destinations was found to be a significantly less reliable measure. Six destinations were chosen for analysis in the present study as all could be anticipated to help anchor new neighbourhoods. Increasing the number of destinations from five to six also made the measures of access both more robust and a better proxy for land use mix. The selected destinations included:

- Local shopping (a supermarket, deli or local general store)
- Post facility (post box or post office)
- Daycare centre
- Newsagent
- Medical (doctor or pharmacy)
- Public transport stop (bus or rail)

² That there were more than twice as many households in CNs than LNs included in the analysis is indicative of there being more RESIDE participants in CNs overall and many more CNs than LNs in the RESIDE neighbourhood pool.

Notably, a measure of green-space was not included in the study. Other studies have found that walkable neighbourhoods tend to be anchored by basic daily retail and food activities (Moudon et al, 2006). Moudon and colleagues also found that access to open space, such as parks, may be associated with increased physical activity, but were not important as anchor points in the walkable neighbourhood.

Common destinations (such as grocery stores) tended to be those associated with necessary rather than discretionary spending (Moudon et al, 2006). The LN code is not very prescriptive about the type of retail activities that should be in local centres. Rather, the code states that:

A small retail store with a bus stop and post box, with some associated home-based business opportunities and some higher density housing...[would be the minimum components] of a neighbourhood centre under LN (WAPC, 2004; p122).

(b) Network connectivity

The second set of environmental measures related to network connectivity. These used the access-related data discussed above, being the transport network distance divided by the Euclidean distance to destinations. Connectivity is a crucial factor in improving design to encourage more sustainable transport behaviour as it has the potential to significantly reduce the distance between homes, jobs and key facilities.

(c) Residential lot density

The third set of measurements related to residential lot density in the sample neighbourhoods. These were interpreted alongside the proxy measures of land use mix (access measures) to help evaluate activity intensity in the sample neighbourhoods. The measures of density were

derived from information provided by and with the permission of the Western Australian Land Information Authority (Landgate) (2007).

GIS was used to identify neighbourhood boundaries and hence their sizes, and individual lot boundaries. Non-residential land uses and road reserves were identifiable in the dataset provided by Landgate and in the few instances where multi-unit residential lots were found, estimations of units per lot were made based on the underlying land zoning (i.e. R30). In this latter instance, for example, a multi-unit lot of 1,000m² with an underlying zoning of R30 was assumed to yield three dwellings.

The principal reason for calculating residential lot density rather than population density was that census data, which is organised according to census collection districts (CCDs), could not be matched with households in the study neighbourhoods, because the CCDs and neighbourhoods had different boundaries.

Residential lot density was measured both with and without control for the size of the sample neighbourhoods and both with and without the inclusion of a neighbourhood with exceptionally large residential lot sizes (i.e. four summary tables of findings were generated). In each of the analyses, average lot sizes, lots per site hectare (equivalent to an *R* standard, which is the common density prescription used in statutory planning policies) and lots per urban hectare were calculated, depending on neighbourhood type.

(d) Work trip substitutability

The fourth and final set of measures related to work trip substitutability: the viability of substituting public transport for car driver trips for the journey to work. Work trips were selected for analysis because of data availability and the understanding that they are regular

bounded trips. These measures were developed for those of the 992 RESIDE participants who reported that they drove to work in RESIDE's first follow-up questionnaire. The participants also had to provide complete origin and destination data and reported working inside the metropolitan region. A total of 480 people (170 in LNs and 310 in CNs) met these criteria.

In addition to the self reported work trip travel times provided by this sample, MRWA's Regional Operations (traffic) Model was used to estimate people's work trip time by car, based on weekday peak hour traffic conditions. These two sets of travel times were compared with a substitute trip by public transport, calculated by assuming peak hour travel demand and inputting the origin and destination into Transperth's online Journey Planner tool, which uses both electronic timetable data and predictions for walking legs of journeys to estimate travel time. Critically, the analyses were focused on *time sacrifice*: the *monetary cost* of work trip substitution was not assessed.

From a sustainability perspective, it is important that people can undertake longer trips (for which it is not feasible to walk or cycle) by public transport without significant burden (measurable as a time sacrifice). As previously discussed, the LN code intends for residents to have relatively good access to public transport (measured by a low average distance to public transport stops) and for new neighbourhoods to be well integrated with regional public transport (measurable by assessing differences in work trip substitutability depending on the design code used).

In summary, the following environmental measures were developed:

- Access to 'key' (i.e. common utilitarian) destinations (as a proxy for land use mix)
- Movement network connectivity

- Residential lot density
- Work trip substitutability

3.3 Statistical analyses

Descriptives and bivariate statistical tests (chi squares for categorical data and t-tests for independent means for scale data) were undertaken on the self-reported travel data, including mode split, vehicle occupancy, car ownership, trip distance, daily VKT, and the derived transport energy use and emissions information. The purpose of the analysis was to compare results between the residents of liveable and conventional neighbourhoods. Some multivariate (discriminant) analyses were also conducted to validate patterns of differences between LNs and CNs. Similarly, descriptive and bivariate tests were run on the environmental data to ascertain differences depending on neighbourhood classification (LN or CN).

4 Results

4.1 Trip characteristics

It is acknowledged that the travel survey sample size was small so the following results should be considered in this context. There were some clear patterns of difference in trip characteristics by type of neighbourhood - particularly relating to mode use - although these were most distinguishable at the trip level (see Table 2). Residents of LNs reported a significantly higher proportion of walking trips (21% compared with 12%, $p < 0.01$), whilst residents of CNs reported a significantly higher proportion of motor vehicle trips (81% compared with 72%, $p < 0.01$), with differences especially evident when trips were for leisure

purposes. This is despite average motor vehicle trip occupancy being lower when reported by residents of LNs ($p < 0.01$). Consistently, there were no significant differences in public transport use and cycling. Furthermore, residents of LNs were much more likely to travel shorter distances ($p = 0.018$) and for less time ($p = 0.011$), relative to residents of CNs. These findings notwithstanding, the data show that the residents of both areas used their cars for the great majority of trips regardless of the type of neighbourhood they lived in and had regional travel patterns that were indistinguishable. The shorter trips reported by residents of LNs typically related to leisure-related walking. Overall, residents of LNs and CNs reported similar daily VKT.

4.2 Energy use and emissions

There were no significant differences in energy and emissions by type of housing development. This can be attributed to the length of car trips, the characteristics of vehicles, driving speeds and vehicle occupancy, which together mean that the increase in local walking trips in LNs are overwhelmed by the energy and emissions associated with the regional travel patterns. Based on these results it is not possible to conclude that residents of LNs are less car dependent than residents of CNs.

4.3 Environment study- access, connectivity and residential lot density

The findings from the environmental study showed that access to a range of facilities, most notably local shopping was better in CNs than LNs, contrary to the intentions of LN. Consistent with the LN policy, access to public transport and street network connectivity was better in LNs compared with CNs.

Evaluation of the residential lot density data revealed some differences by type of neighbourhood. Higher relative residential site densities were observed in LNs, however as shown in Table 3 low residential lot densities were observed overall. The density data showed that contrary to the intentions of the LN code, recommended densities have not been adopted and this will contribute to suburbs remaining highly car dependent.

4.5 Work substitutability analyses

The work trip substitutability analyses found a heavy burden for residents of all neighbourhoods if they changed from motor vehicles to public transport (see Table 3). In relative terms, it would take the average resident about three times longer to conduct a work trip by public transport in both areas under study. In absolute terms, their daily work travel time would increase by about 80 minutes. No significant differences were found depending on type of neighbourhood.

Table 2 – Main findings from the travel survey

Characteristic	Finding	
	Liveable Neighbourhoods	Conventional Neighbourhoods
Other control variables	No significant differences	
Trip level modal split	Motor vehicle 72% Public transport 4% Walking 21% Cycling 3%	Motor vehicle 81% Public transport 4% Walking 12% Cycling 3%
Individual level modal split	Motor vehicle 72% Public transport 4% Walking 21% Cycling 3%	Motor vehicle 82% Public transport 4% Walking 12% Cycling 2%
Proportion of single-occupancy motor vehicle trips	49%	41%
Car ownership per person	0.82	0.78
Car ownership per household	1.83	1.97
Average trip distance	11.34	12.10
Short trips (<1.5km) as a proportion of an individual's travel	21%	15%
Short trips conducted by walking	69%	58%
Average daily private VKT	42.59	43.05
Energy use and emissions	Inconsistent pattern of difference	
Daily reported transport-related physical activity	20.41 minutes	12.39 minutes

Table 3 – Main findings from the environmental study

Characteristic	Finding		<i>p</i> value
	Liveable Neighbourhoods	Conventional Neighbourhoods	
Distance to daily shopping (mean)	3.3km	2.8km	0.000
Distance to newsagency (mean)	5.3km	3.3km	0.000
Distance to childcare facility (mean)	2.8km	2.8km	0.930
Distance to medical facility (mean)	1.4km	2.0km	0.000
Distance to postal facility (mean)	1.7km	1.4km	0.000
Distance to a public transport stop (mean)	510 metres	649 metres	0.000
Average network distance to a key destination (mean)	2.5km	2.2km	0.001
Average street network connectivity (mean)	1.37	1.41	0.002
Average residential lot size* (mean)	603.44m ²	820.21m ²	0.000
Lots per site hectare*# (mean)	16.67	14.88	0.000
Lots per urban hectare* (mean)	8.81	8.64	0.000
Average residential lot size^ (mean)	603.44m ²	646.62m ²	0.000
Lots per site hectare^# (mean)	16.67	15.58	0.000
Lots per urban hectare^ (mean)	8.81	9.01	0.000
Work trip substitutability (proportional time sacrifice) (mean)	2.86	3.03	0.826
Work trip substitutability (real time sacrifice) (mean)	42.43 minutes	41.99 minutes	0.226

*with control for neighbourhood size

^with control for neighbourhood size and outlying conventional neighbourhood excluded

#equivalent to an *R* standard

5 Discussion

The research has answered the key question posed at the outset. LN is not achieving outcomes as intended. This is the fundamental reason why there were few observable differences in either self-reported environmental characteristics or environmental indicators.

The results suggest that LNs facilitate a small gain in local walking. The additional 9% walking trips observed in LNs are presumably assisted by the development of straighter roads, provision of footpaths, shorter block lengths and hence, overall greater network connectivity. However, the purpose of 'local' walk trips is undoubtedly for leisure. As this study showed, at this stage of development, the LNs have not delivered any local utilitarian destinations, such as delis or other services. Instead, they are anchored by phenomena such as public open space and water features.

Despite the observed mode use differences, individual-level analyses showed little evidence of reduced transport energy use or fewer vehicle emissions. This is likely to be attributable to the lower car occupancy rates, which means that people in LNs are driving just as much as CNs when total vehicle kilometres travelled is considered. Moreover, energy and emissions analyses showed no real differences depending on neighbourhood type. Thus, the small local advantage of more walkable streets is overwhelmed by the regional transport and land use context in which the LNs are set. While the travel survey sample was small, the TSS was designed with a multi-methods approach. The travel survey findings should therefore be considered in the context of the more robust environmental analyses.

The environmental analyses confirmed that the LN code is not delivering the built form that is intended. While street network connectivity was found to be consistently better in LNs than CNs, access to destinations was significantly better in CNs: i.e. the average distance to key destinations was significantly lower in CNs compared with LNs. Despite residential lot

densities in LNs mostly being higher than in CNs (depending on which controls were used), the levels of density observed in both LNs and CNs was simply not high enough to contribute to transport sustainability. Residential densities around nine dwellings per urban hectare are not supportive of high-quality, high-frequency transit and present a low population base to support mixed use neighbourhood centres (see Newman and Kenworthy, 1999; 2007).

It is therefore understandable that few residents of the study neighbourhoods have a viable public transport option. The findings of the work trip substitutability analyses revealed significant time burdens for people using public transport rather than motor vehicles for the journey to and from work, irrespective of the neighbourhood they live in. With the average burden being around 40 minutes (one way) it is unlikely that people will willingly switch from motor vehicle travel to public transport. Overall, the environmental data showed that the sample LNs and CNs both score poorly in relation to sustainable transport opportunities, with there being a lack of walkable destinations (other than recreational) and deficient access to efficient transit.

Ultimately, the differences in self-reported transport behaviour were not associated with differences in the design of neighbourhoods. Furthermore, the results found a large gulf between the intentions behind the LN code (and hence the delivery of New Urbanism) and practice.

Two major factors contributing to this problem are that the code neither prescribes the coordination of neighbourhoods into districts nor that new development must be targeted in strategic areas around the city where regional integration with existing urban systems (i.e. rapid public transport) would be possible. LN aspires to facilitate both of these outcomes, but is not calibrated to achieve them due to a lack of regional or corridor-based structure planning. This is despite the presence of a strong metropolitan regional planning scheme.

A related problem is that the code allows for small subdivisions, which does not provide the scale of development required to master plan significant public transport servicing improvements – such as the extension of train lines – or provide diversity (or any great density) of development. This notwithstanding, even in relatively larger developments, real increases in activity intensity are not being achieved - as the results show – which is an outcome of the flexibility of standards in the LN policy. The policy is non-specific regarding provision of non-residential land uses in new developments and the development densities it advocates are not significantly different to conventional allowances. While development and infrastructure are still unfolding in many of the neighbourhoods studied, there is little reason to believe access and alternative transport opportunities will eventuate because few local utilitarian transport opportunities are being provided, and neighbourhoods are very limited in size and typically surrounded by sprawl.

Together, the findings do not show that the principles behind LN and more generally, New Urbanism, are flawed. Rather, they suggest a significant gap between the principles and practice, which is at least in part a function of how sustainable transport principles have been translated into the LN policy. If our cities are to respond to the serious challenges of peak oil and climate change the implementation of sustainability in the planning system will need to be taken much more seriously (Newman, Beatley and Boyer, 2009).

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