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# Integrated Transportation and Land Use Activities for Mass Housing to Increase Non-Motorized Trips - A Review Paper

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**Abstract**

A new mass housing in any city generates demand for mobility. This mobility can be through motorized or non-motorised modes. This paper is the review of existing literature regarding the interrelationship between mass housing and generated motorized and/or non-motorized trip share and how can land use planning and integrated transportation improves it. Though non-motorized transport provides sustainable & affordable solution to short length trips; the proportion of Non-motorised trips is dependent on suitability of road infrastructure for non-motorised as well as motorized trips apart from land use planning and accessibility to various services. To have higher share of non-motorised trips, a mass housing needs to plan shorter trip lengths by providing maximum facilities in neighborhood area supported by suitable road infrastructure. To have this, a master plan is required for every new mass housing scheme for incorporating as many local facilities (educational, medical, shopping, recreation, sports, etc.) within the area. Such master planning supported with suitable road infrastructure influences the travel behavior as desired.


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*Keywords:* Integrated transportation; Non-motorized trips; Land use.

## 1. Introduction

Land use and transport are integrated to ensure a mix of uses (retail, commercial, employment, residential, leisure, education and public spaces) are concentrated around transport nodes. These nodes are accessible by high quality

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pedestrian and cycle paths and people friendly traffic calmed streets. The neighbourhoods are permeable and well connected, with access and priority measures given to pedestrians and cyclists to create safe and attractive environments to encourage the uptake of active transport modes. A mix of uses are planned within catchment of transit stops such as housing, shops, services and employment opportunities to create healthy and vibrant communities.(Hume City Council, 2011).

Transportation and land use planning decisions interact and important to increase non-motorized trips, where places (e.g. shops, work and other services) are located in relation to where people live is a significant factor in determining how much people actually need or want to travel. In the early stages of local planning, sustainable transport is a central consideration – for example whenever new houses or retail areas are being developed. Achieving sustainability in transport requires us to look differently at travel. It addresses a city or region's longer term challenges, working to a shared vision of what a city or region aspires to be in the future and coordinating investments and policy decisions to achieve that vision in an optimal manner. However, by shaping the pattern of development and influencing the location, density, scale, design, and mix of land uses, planning can help to facilitate an efficient transport and land use system by reducing the need to travel, length of journeys, impact of transport on communities and making it safer and easier for people to access services. We need to focus on the movement of people and of goods, rather than the movement of vehicles, and maximising accessibility (the ability to undertake a range of daily activities with a minimum of travel), rather than mobility (the ability to move freely).

This paper explains the relations between - land use and transportation, housing and transportation, land use and NMT and housing and NMT. The way we plan for transport and land uses can increase the proportion of trips that can be taken by foot, bicycle and public transport as people go about their daily tasks. When we plan for transport choice, we also help to manage the demand for travel by minimising the number and length of individual trips people need to make.

**Nomenclature**

| | |
|---|---|
| NMT | Non-motorised transport |
| MRT | Mass Rapid Transit |
| TDM | Transportation Demand Management |

## 2. Land Use and Transportation

Land use mix refers to locating different types of land uses (residential, commercial, recreational, institutional, etc.) close together. This can occur at various scales, including mixing within buildings (like ground-floor retail, with offices and residential above), along streets, and within neighborhoods. It can also include price ranges and mixing housing types that accommodate different demographic and income classes. In cities such mixing is normal and is a key feature of New Urbanism. Mixed development can affect travel in several ways like shorter travel distances increase walking and cycling mode shares; improved public transit access increases transit mode shares; shorter travel distances reduce total vehicle travel; and together these factors can reduce per capita vehicle ownership (Litman, 2018). Land use aiming to mainly 'forward' policies ("city of tomorrow") which create new centres or regenerate brown-field sites, changing the urban fabric and limiting the sprawl of dwellings, workplaces etc.; and 'backward' policies ("city of today") taking the existing urban fabric as a datum, and changing the transport system in order to improve accessibility by alternative transport modes (public transport, walking and cycling, flexible transport services, car sharing etc.) and stimulating the revitalisation of high-density and mixed-use neighbourhoods within the city. For smaller cities the monocentric urban form is much more sustainable than a polycentric urban form. Combine "push-and-pull" strategies which means "Pushing" residents from excessive car use through restrictions such as parking management and at the same time "pulling" users towards environmentally friendly modes by providing an efficient public transport system and favorable conditions for walking and cycling (Macário, R., Carvalho, 2003).

An integrated land use - transport model (LUTI) provides a useful decision-making tool for local authorities to allow for urban sustainability, reducing the use of private transport by encouraging the use of the mass transit system. They concentrated on a procedure to reduce the residual capacity of the mass transit system by the relocation of activity

volumes. This residual capacity is the main variable that indicates location and intensity of activities to be moved. The model permits to evaluate the expected increase of the transit modal share after the relocation of the activities: the application of the procedure for the city of Rome permitted to reach an average residual capacity reduction of the metro network equal to -33%, subtracting the 5% of trips made by private transport from actual modal split in Rome 66% private transport, 34% public transport to the following final modal split, 38% public transport and 62% private transport (Brandi, Gori, 2014). (Wadhwa, 2004) examined in detail the integrated transport and land use planning in the three largest Australian cities Brisbane (2002-16), Melbourne (2030) and Sydney (2010). These recent plans are based around the integrated transport-land use framework. Sydney 2010 plan will focus new developments in existing transport corridors and at major centres. Sydney will reserve corridors for new transport facilities and guide future urban growth. Melbourne 2030 proposes to integrate land use and transport policies around activity centers to create a balanced and workable city. The focus has shifted from expansion on city's perimeter, requiring major new infrastructure, to urban consolidation and better use of existing transport resources. Making jobs and community services more accessible, giving priority to cycling and walking, and promoting the use of sustainable personal transport options Brisbane has now planned to year 2016 to provide a reliable and efficient transport system. The Transport Plan sets focused targets for public transport patronage and an acceptable level of service on roads. It is aimed to provide for increased accessibility to employment, entertainment, medical, education and community facilities. To this end, Brisbane will be providing the community with more travel choices – flexible, high quality public transport services, more bike and walking paths, and better connected roads as part of an integrated transport solution.

Having consumer services like grocery stores within 300 feet of one's residence is found to encourage commuting by mass transit, walking and bicycling. Controlling for such factors as vehicle ownership and residential densities. When retail shops are beyond 300 feet yet within 1 mile of residences, however, they tend to encourage auto-commuting, ostensibly because of the ability to efficiently link work and shop trips by car. The presence of nearby commercial land-uses is also associated with relatively low vehicle ownership rates and short commuting distances among mixed-use neighborhood residents. Overall, a stronger influence of residential densities have on commuting mode choices than levels of land-use mixture, except for walking and bicycle commutes. For non-motorized commuting, the presence or absence of neighborhood shops is a better predictor of mode choice than residential densities (Cervero, 1996).

Residents of neighborhoods with higher population density, proximity to commercial destinations and good public transportation are more physically active than residents of less walkable neighborhoods often deemed ‘‘suburban’’ (Frank, 2005).

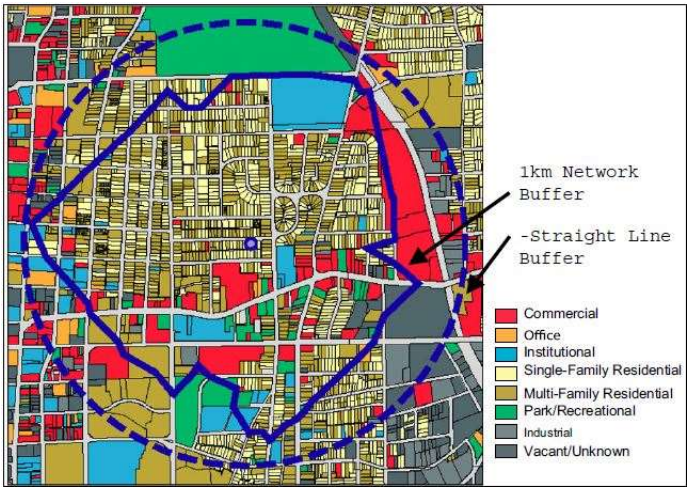


Fig. 1. Measuring urban form (Lawrence D. Frank et al., 2005)

If a greater density (housing and mixed use development) is created around public transport nodes, and high quality transport corridors (with fast, frequent and reliable services), it is likely that more people will be encouraged to use public transport (Hume City Council, 2011). Vehicle travel are about 9% lower for households that reside in mixed land use neighborhoods with good network connections (Wang, 2016).

People in developing cities live in tight quarters leads to high urban density and also there vehicle ownership rate is low as they are close to everyday activities. But as incomes have risen, urban densities not follow the lockstep pattern and copying the sprawling settlement patterns of developed cities. More than rising wealth is spawning sprawl in developing cities. In Greater Cairo and Mexico City informal housing settlements is the reason of sprawling while on the outskirts of Mumbai and Delhi, new towns and employment subcenters have been the largest consumers of once exurban land (UN-Habitat, 2011).

In emerging economies like China, India, and Brazil, sprawling is fuelled by land speculation as developers build outward to serve the rapidly increasing population of middle-income households and expansion needs of an enlarged corporate sector. In India, zoning policies have been blamed for inducing sprawl in recent decades as it suppress permissible densities by means of decongesting central cities (Suzuki, 2013). (Meyer, 1999) identifies several strategies for improving the effectiveness of TDM actions in the context of regional transportation planning, including: incorporating TDM as part of the solutions for regional transportation planning, linking TDM to land use decisions.

## 3. Housing and Transportation

Housing costs are often evaluated alone, which encourages development on cheaper land at the urban fringe. However, such locations tend to have poor accessibility, they are far from services and activities such as education and employment, and often have poor walking conditions and public transit services. Housing affordability is an important policy goal. However, if housing is located in an inaccessible area with high transportation costs, it is not truly affordable. Increasing affordable housing supply in accessible locations helps achieve multiple planning objectives: it reduces transportation costs, improves economic opportunity for disadvantaged groups, reduces accident risks, conserves energy and reduces pollution emissions. Study applies this type of analysis in Qom City, Iran indicates that suburban-area households spend more than 57% of their monthly income on housing and transport, significantly more than the 45% spent by households in the central district (Isalou et al., 2014).

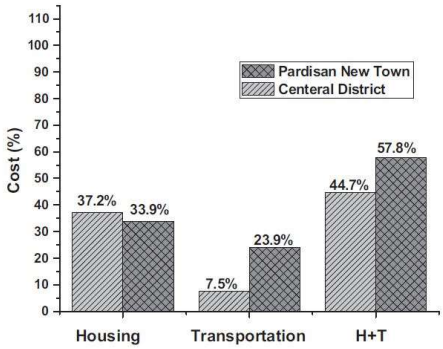


Fig. 2. Housing affordability (H+T = Housing + Transportation) (Isalou et al., 2014)

CNT (Center for Neighborhood Technology) recommends that 45% of Area Median Income (AMI) be established as the affordability target for combined housing and transportation costs in the U.S. In almost every metro region of the U.S., the number of communities affordable to households earning the AMI shrinks when the conventional definition of housing affordability at 30% of AMI is replaced by the H+T benchmark of 45%. Under the traditional definition of housing costs at 30% of income, seven out of ten communities (69%) are considered affordable. When housing and transportation costs are combined and a 45% affordability benchmark is applied, drops to four out of ten communities (39%). This shrinkage eliminates 25.9 million dwellings in 48,000 communities where the typical resident can afford to live. Affordability Index = (Housing Costs + Transportation Costs) / Income (Guerra, 2016).

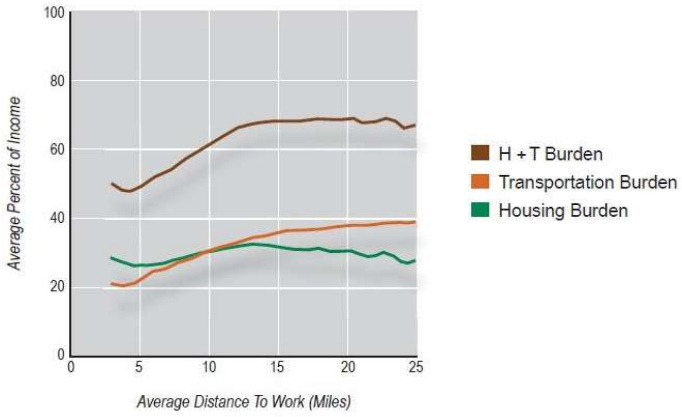


Fig. 3. H +T Burden on Income (Guerra, 2016)

The portion of household income spent on housing was greater in compact areas, but the portion of income spent on transportation was lower. Each 10% increase in a compactness score was associated with a increase of 1.1% in housing costs and a decrease of 3.5% in transportation costs relative to income. As the compactness score rose, the combined cost of housing and transportation declined. As metropolitan compactness increased, transportation costs decreased faster than housing costs increased, creating a net decline in household costs (Hamidi & Ewing, 2015). Deborah (2016) estimates the financial burden of housing and transportation for households in Los Angeles County. In particular, the authors examine how the Housing + Transportation expenditure burden varies by the poverty rate, racial composition, and local access to opportunities for neighborhoods in Los Angeles. The authors find that absolute housing and transportation costs are lowest in the poorest neighborhoods in Los Angeles, but the burden of these costs measured as a percent of household income is highest in these same neighborhoods. There are, however, some illuminating differences between the housing and transport cost burdens. Specifically, it is clear that while housing costs are closely linked to incomes, vehicle transport costs depend on a combination of neighborhood incomes and the accessibility of the neighborhood.

A study found that the maximum density permitted by the master plan is only marginally correlated with the distances to MRT stations. Instead, the average unit size tends to be smaller, and the share of small-sized units tends to be higher in new private projects that are close to MRT stations after the new lines are in operation. This indicates that developers, who act mainly in response to the market, intentionally place more housing units in developments closer to MRT stations (Zhu & Diao, 2016).

## 4. Land Use and NMT

NMT i.e. walk, bicycle and cycle rickshaw modes are green modes of transport that belong to the low carbon path, do not consume energy or cause pollution and in addition provide social equity besides employment. Presently these modes are neglected in the planning process. Facilities for NMT i.e. dedicated cycle lanes and footpaths should be developed on priority. These should be citywide to assure the commuter that he can complete his journey all the way by walk or bicycle if he so chooses (Ministry of Urban Development (MoUD), 2012).

Neighborhood comparison and correlational studies with nonmotorized transport outcomes are considered, with evidence suggesting that residents from communities with higher density, more land use mix and greater connectivity report higher rates of walking/cycling for utilitarian purposes than low-density, poorly connected, and single land use neighborhoods (Saelens, Ph, Frank, Ph, & Med, 2003). Study in China reveal how changes in built environments fundamentally change travel in rapidly growing settings. Paralleling China's shift to a market economy have been dramatic transformations of urban environments—from a traditional high-density, pedestrian and cyclist oriented urban form to an increasingly spread-out, auto-oriented one (Pan, Shen, & Zhang, 2009). Increased land use mix can reduce commute distances, particularly if affordable housing is located in job-rich areas, and mixed-use area residents are more likely to commute by alternative modes (Pratt H et al., 2003). Residents living within a half-mile of a cycling trail are three times as likely to bicycle commute as the country average (Morris, 2004). A more pedestrian-friendly

residential and commercial environment in Austin, Texas neighborhoods reduces automobile travel and increases walking for errands such as local shopping for example about two-thirds of walking trips to stores replaced automobile trips. A short walking or cycling trip often substitutes for a longer motorized trip. For example, people often choose between walking to a neighborhood store or driving across town to a larger supermarket, since the additional distance is accessible once they decide to drive (S. Handy, 1996) and (S. L. Handy & Clifton, 2001).

Transit-oriented neighborhoods, with mixed land use and good transit, have far lower vehicle ownership and use, and more walking, cycling and public transit use than other areas. Residents of areas with high quality public transit and mixed land use drive 43% less and, residents of areas with high quality transit drive 23% less than elsewhere in the region, indicating that transportation and land use factors have about the equal impacts on travel activity. The average amount of time spent walking tends to increase as an area becomes more urbanized (Lawton 2001).

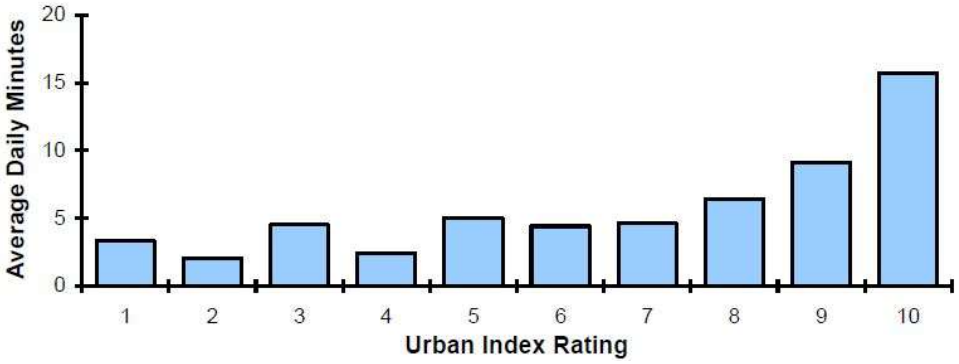


Fig. 4. Urbanization Impact On Daily Minutes of Walking (Lawton 2001)

Also community design factors (land use density and mix, street connectivity, sidewalk supply, street widths, block lengths, etc.) and a subjective walkability index rating (based on residents' evaluation of various factors) affect walking and biking activity, and health outcomes (hypertension and diabetes) in 16 diverse British Columbia neighborhoods (Tomalty & Haider, 2009).

Mixed-use development is more important than density in affecting non-motorized work trip mode shares (Cervero, 1996). Cities which have high proportions of mixed land use and high residential densities ensure smaller trip lengths and maximise non-motorised transport modes for commuting (Transport & Policy, 2013).

Neighborhood selection and preference controls and isolates the effect of the built environment on walking, car use, and obesity. Individuals who preferred and lived in a walkable neighborhood walked most (33.9% walked) and drove 25.8 miles per day on average and those who preferred and lived in car dependent neighborhoods drove the most (43 miles per day) and walked the least (3.3%). Individuals that do not prefer a walkable environment walked little regardless of where they live. About half as many participants who prefer and live in walkable environments were obese (11.7%) than participants who prefer car dependent environments (21.6%). Findings suggest that creating walkable environments may result in higher levels of physical activity and less driving and in slightly lower obesity prevalence (Frank, 2007).

Diverse housing types, mixed land use, housing density, compact development patterns and levels of open space are the five smart growth factors that were associated with increased levels of physical activity, primarily walking. The findings from this review suggest that for promoting physical activity, especially walking smart growth planning principles should be adopted (Durand, 2011).

## 5. Housing and NMT

Walking and cycling are often overlooked as means of transport but are the most efficient and emission free form of transport due to their low cost, low impact, wide suitability and significant health benefits. A significant percentage of car trips in housing each day are for short distances, which could be easily replaced by foot or by bicycle. Block

size in housing is very important factor for non-motorized trips. Design features like smaller city blocks encourage foot travel in developing cities. In Ahmedabad, only 13 percent of trips made by those living in a neighborhoods with an average block size of 4 hectares, were by foot, compared to 36 percent for an otherwise similar neighborhood with much smaller average block sizes of 1.2 hectares (Swamy et al. 2012). Another study found that, accounting for other demographic and geographic factors, non-motorized commute mode share increases as block size declines, with approximately 10% of commuters using these modes in areas with the smallest block size (under five acres per block) are four times higher than the overall average. Commute time follows U-shape response to block size, meaning that average commute time declines first and then rises as block size increases. Tracts where workers average the quickest commutes, less than 25 minutes, have six to 20 acre block size (Emrath and Siniavskaia, 2009). In a typical urban neighborhood, a change from a pure small-block grid to a fused Grid (a modified grid, in which pedestrian and cycling travel is allowed, but motorised traffic is blocked at a significant portion of intersections) that increases the relative connectivity for pedestrians by 10% would typically increase home-based walking trips by 11.3%, increase the recommended level of physical activity through walking in their local travel by 26%, and vehicles miles of local travel decrease by 23%. On the other hand, roadway supply and vehicle mileage are positively correlated. This may partly reflect other factors that also affect road supply, such as population density (Frank and Hawkins, 2007).

People drive less and walk more in areas with traditional pedestrian-oriented commercial districts where building entrances connect directly to the sidewalk than in areas with automobile-oriented commercial strips where buildings are set back and separated by large parking lots, and where sites have poor pedestrian connections (Pratt H et al., 2003). Improved provision of walking and cycling environments will help to enhance the mobility and independence of young people who have limited transport options (nearly 30% of Hume's population). Therefore, to design new livable and connected neighbourhoods that promote and encourage walking and cycling as attractive and legitimate transport options (Hume City Council, 2011).

## 6. Conclusion

This paper investigates the impacts of various land use factors (generally called smart growth, new urbanism or compact development), and integrated transportation on non-motorised trips at achieving planning objectives. This suggests that Smart Growth land use policies are likely to have greater impacts in walking and cycling in compacted residential areas. Conventional planning analysis generally ignores these indirect impacts and so underestimates the potential of non-motorized transport improvements to achieve benefits such as reduced traffic congestion, accidents and pollution emissions. Considering these indirect impacts tends to increase estimated benefits by an order of magnitude, justifying much greater support for non-motorized transport. The characteristics of the built environment in which one lives was found to impact the choice of transportation. So the affordability is function of both housing and transportation cost and we can reduce it by minimising transportation cost by assuring smart growth.

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