

Strategies for Achieving Sustainability through Integrated Transportation and Urban Development in the USA and Asia

Ghim Ping ONG ^a, Kumares C. SINHA ^b, Tien Fang FWA ^c

^a *Department of Civil Engineering, National University of Singapore, 10 Kent Ridge Crescent Singapore 119260; E-mail: cveongr@nus.edu.sg*

^b *School of Civil Engineering, Purdue University, 550 Stadium Mall Drive, West Lafayette, IN 47907-2051, USA; E-mail: ksinha@purdue.edu*

^c *Department of Civil Engineering, National University of Singapore, 10 Kent Ridge Crescent Singapore 119260; E-mail: cvefwatf@nus.edu.sg*

Abstract: There has been much concern on the need for integrated transportation planning and urban land use development to promote sustainability in metropolitan areas. An integrated transportation-land development framework is critical to explicitly address concerns on sustainability in urban areas. This paper shall examine the various options that can be used by transportation and urban development agencies to promote sustainability. A number of cases studies in the United States are presented and lessons are drawn from the implementation of these strategies. Examples of efforts in Asian countries to integrate transportation and urban development are then discussed.

Keywords: *Sustainability, Transportation policy, Urban planning, Urban development.*

1. INTRODUCTION

In recent years, there has been much interest among urban and transportation planners to integrate urban transportation and land development planning. This is very much driven by concerns about climate change and sustainability. The 1987 report by the World Commission on Environment and Development, also known as the Brundtland Commission, provided a formal definition of sustainable growth: “Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs”. Coupled with the call for reduction in carbon dioxide emission in the Kyoto Protocol and other regional and international agreements, sustainability has grown to become an overarching concept involving environmental quality, social equity and economic development. Today, sustainable development is widely viewed as development that improves the standard of living and quality of life, while at the same time protecting and enhancing the natural environment and preserving local culture and history. Numerous efforts have been made globally to increase the sustainability of development patterns.

Urban sprawl has been a trend that many countries face as they develop. America started to experience urban sprawl as early as the beginning of the 20th century with the emergence of affordable personal transportation (starting with the mass production of the Ford Model T in 1908) and the growing middle-class. Post World War II transportation and housing policies greatly accelerated the process of urban sprawl, resulting in the decentralization of metropolitan areas which profoundly affects the way transportation systems are planned and designed. Today, the legacy of urban sprawl is prominent in America –single use zoning, low-density land use, excessive dependence on automobiles, soaring automobile ownership and the decline of public transportation. This, in turn, has led to serious consequences in terms of

congestion, declining road safety, the depletion of non-renewable energy sources and the specter of climate change.

Congestion not only results in the loss of economic productivity, but also results in excessive energy consumption. It is estimated that congestion costs the United States economy \$78 billion annually in the form of 4.2 billion lost hours and 2.9 billion gallons of wasted fuel (Texas Transportation Institute, 2008). Congestion also results in increased air pollution (in terms of emissions of carbon monoxide, sulfur oxides, nitrogen oxides and particulate matters) and carbon dioxide emission (which contributes to global warming) (TRB, 1997).

Another consequence of heavy use of automobiles is the dependence on imported petroleum. The USA consumed approximately 20.7 barrels of oil domestically in 2007 and approximately two-thirds of this was spent on transportation (Bureau of Transportation Statistics, 2008). Out of the total transportation petroleum consumption in the USA, highway transportation accounts for 92% - significant majority of the overall domestic demand for oil. With continued dependence on oil, the recent increase in fuel prices has hit USA and the rest of the world hard. For the first time in decades, auto travel demand dropped and the use of public transportation increased (FHWA, 2008a).

Urban sprawl and high auto ownership and usage have adverse impacts on health and quality of life. There may be a significant connection between sprawl, obesity, and hypertension in an automobile centered setting as people are forced to drive, thus walking far less than they would otherwise (McKee, 2003). In terms of quality of life, some researchers have argued that the proximity of the workplace to retail and restaurant space (which provides cafes and convenience stores for daytime customers) is an essential component to the quality of urban life – a key component missing in the current environment. Furthermore, the closeness of the workplace to homes also gives people the option of walking or riding a bicycle to work or school and promotes more interaction between individuals (Frumkin, 2002; McKee, 2003).

Data of the past few decades from cities around the world indicate that while there are significant differences in socioeconomic and technological characteristics among cities, a remarkable similarity exists in trends in urban transportation (Kenworthy et al., 1999; Sinha, 2003). The current growth in the use of automobiles in many cities of developing countries follows similar trends experienced several decades earlier in the United States and other developed countries. Even though there is much awareness of and knowledge about sustainability, private vehicle ownership and use continue to grow at an accelerating pace as personal incomes rise and the desire to experience faster and more reliable transportation spreads.

Urban density, expressed in the number of people and/or jobs per unit of land, is the key indicator of the level of automobile ownership and use, and of associated parameters of sustainability (Sinha, 2003). As personal incomes rise, an individual's choice of residential and job location increases, causing a decrease in urban density and affecting the relative use of private transportation and mass transit. Even a small increase in urban density can have profound impacts on sustainability of urban area by slowing or reversing the growth in private automobile use and making transit and other modes attractive and viable (Table 1).

It is therefore imperative for transportation and urban planners to develop new approaches in transportation and urban planning, emphasizing integration to achieve sustainability. This paper discusses some of the strategies that have been considered in the USA to integrate urban transportation and development and potential lessons learnt from the implementation. Some of the transportation-land use strategies implemented in Asia are then discussed. Lastly, the paper discusses the future prospects in urban development to achieve sustainability.

Table 1. Relationships between urban density and sustainability parameters (Sinha, 2003)

Independent variable (y)	Dependent variable (x)	Equation	R ²	Elasticity (at mean)	Semielasticity (A) Elasticity (B)
Urban population density (persons/hectare)	Cars per 1000 people	$y = 627.58 e^{-0.0106x}$	0.838	-0.0106x (-0.57)	(A) An increase of 10 persons/hectare in population density decreases the number of cars per 1,000 people by 10.6%.
Urban population density (persons/hectare)	Transit boardings per capita per year	$y = 5138.37\ln(x) - 2273.54$	0.705	$[\ln(x) - 1.9769]^{-1}$	(A) A 10% increase in population density increases transit boardings per capita per year by about 14.
Urban population density (persons/hectare)	Transportation energy consumption by private modes (MJ/capita)	$y = 277,345x^{0.6358}$	0.797	-0.636	(B) A 10% increase in population density decreases transportation energy consumption by private modes per capita per year by 6.4%.
Urban population density (persons/hectare)	Car kilometers of travel per capita per year	$y = 65,743x^{0.7351}$	0.827	-0.735	(B) A 10% increase in population density decreases car kilometers of travel per capita per year by 7.4%.
Urban population density (persons/hectare)	Carbon dioxide emissions from transportation (kg/capita/year)	$y = 18,189x^{0.5992}$	0.812	-0.599	(B) A 10% increase in population density decreases carbon dioxide emissions from transportation per capita per year by 6%.
Urban population density (persons/hectare)	Transit cost recovery factor	$y = 0.2696\ln(x)^{0.3511}$	0.622	$[\ln(x) - 1.3023]^{-1}$ (0.35)	(A) A 10% increase in population density increases transit recovery factor by 0.027.

Source: Sinha (2003).

2. STRATEGIES FOR SUSTAINABLE TRANSPORTATION AND URBAN DEVELOPMENT PLANNING IN USA

2.1 Transportation Policies and Measures

There are many opportunities and options that have been adopted or considered to promote sustainability through various transportation policies and measures as listed in Table 2.

Overall, strategies can be classified as transportation supply/demand measures or specific transportation policies targeted at improving sustainability. These approaches primarily aim to relieve congestion and to promote the use of alternative transportation modes. Some of these strategies are discussed below.

- **Public transit investment/construction:** This has been one of the most popular measures adopted in metropolitan areas and large cities in the United States. Examples are the existing metro systems in large cities such as New York, Atlanta and Washington D.C. and the proposed light rail system in Seattle.
- **Road construction:** Road construction has been historically used to “relieve” congestion in the United States. However, this approach is no longer a viable alternative because we cannot build our way out of congestion. On the contrary, in recent years, the deconstruction of some sections of urban freeways has been used (in San Francisco and Milwaukee, for example) as a way to enhance community cohesion and improve quality of life.
- **Car pooling/sharing and high-occupancy vehicle priority:** In increasing number of urban areas, high-occupancy vehicle (HOV) lanes are being used for vehicles with multiple occupants including buses. In some areas, such as Atlanta, Southern California, Hartford, Seattle and Boston, HOV lanes are in operation full-time, while in others, such as the San Francisco Bay Area, Phoenix, Long Island, and Northern New Jersey, they are usable by other vehicles outside of peak hours.

- Congestion pricing: Congestion pricing creates a market for road use based on the willingness of drivers to travel during peak periods. Most of the congestion pricing schemes in the USA are implemented through the conversion of high-occupancy vehicle (HOV) lanes to high-occupancy toll (HOT) lanes. Active HOT lanes are in operation in the states of California (I-15 in San Diego, 91 Express Lanes in Orange County), Colorado (I-25 in Denver), Minnesota (I-394 in Minneapolis), Texas (I-10 and US-290 in Houston), Utah (I-15 in Salt Lake City), and Washington (SR-169 from Auburn to Renton). Several other HOT lanes are being constructed in northern Virginia and in other states as well.
- Pedestrian priority and provision of bicycle ways: Pedestrian priority and the provision of bicycle ways have been implemented in some areas in the USA to promote neighborhood accessibility and to improve safety and thus contributing to the community quality of life. The non-motorized transportation pilot program (NTPP) under the recent federal legislation is an example of this initiative (FHWA, 2008b). This program is providing funding to four communities (Columbia, MO; Marin County, CA; Minneapolis Area, MN; Sheboygan County, WI) to improve walking and bicycling networks and to increase rates of walking and bicycling.
- Targets and Standards: These can be used as performance measures for transportation planning and urban development efforts. Having performance measures as control parameters planners and developers have the opportunity to innovate and consider various options as long as the final outcomes conform to the stated performance goals. However, appropriate measures must be place to make sure that the targets and standards are being adequately met.

Table 2. Transportation policies and measures

Transport Supply Measure	Transport Demand Management	Targets and Standards
Road construction	Road pricing	Air pollution standards
Rail investment/construction	Toll charges	Noise level standards
Improved public transportation	Parking control	Road safety standards
Traffic management	Auto restricted zones	Fuel consumption controls
Provision of Park and ride	Goods traffic restraint	Emission standards
Pedestrian areas	Pedestrian/Bicycle/Bus priority	Carpooling policy
Bicycle and walk ways	Traffic calming	Public transit use policy
	Carpooling/Carsharing	

Source: Banister (2005).

2.2 Urban Development Policies and Measures

The key to achieving sustainable urban development lies in the implementation of an effective land use planning and management. Wheeler and Beatley (2004) suggested a definition for sustainable urban development as "development that improves the long-term social and ecological health of cities and towns." It was hypothesized that a sustainable city would include compact, efficient land use; less automobile use yet with better access; efficient resource use with less pollution and waste; the restoration of natural systems; good housing and living environments; a healthy social ecology; sustainable economies; community participation and involvement; and the preservation of local culture and wisdom. Table 3 shows some of the planning measures that have been employed in various urban areas in the USA and abroad.

- Zoning ordinances: The most commonly available land use development tool is local zoning ordinances. While traditional zoning regulations control land use types, lot sizes and site designs, there have been many innovations to adopt zoning powers to achieve sustainable growth by controlling density through planned unit development

measures, restricting new development to specific areas, and providing additional density incentives for “brownfield” and “greyfield” land. Zoning restrictions can also be used to reduce the minimum amount of parking required to be built with new development, and to require set-asides for parks and other community amenities.

- Environmental impact assessment: A tool to implement desirable land use development is to require prospective developers to prepare environmental impact assessments of their plans as a condition for state and/or local government approval for permission to build. These reports often indicate how significant impacts generated by the development will be mitigated, the cost of which is usually paid by the developer.
- Smart growth: Emerging policies and measures to achieve sustainable urban development are embodied in the concept of smart growth. As of 2006, mayors of 320 cities in the USA have committed their communities to actions to meet the Kyoto Protocol – one of which is to adopt smart growth principles for urban planning (Pew Center on Global Climate Change, 2008). The core principle of smart growth is to control urban sprawl. Basic elements of the concept are discussed below (Smart Growth, 2008):
 - Compact neighborhoods: Creating compact, livable urban neighborhoods is a critical element of efforts to arrest urban sprawl and to protect the climate. The efforts include adopting redevelopment strategies and zoning policies that channel housing and job growth into urban centers and neighborhood business districts, to create compact, walkable, and bicycle and transit-friendly hubs. Such policies often require local governments to implement code changes that allow increased height and density downtown and regulations that not only eliminate minimum parking requirements for new development but establish a maximum number of allowed spaces. Other strategies could include mixed-use development, inclusion of affordable housing, restrictions or limitations on suburban design forms (e.g., detached houses on individual lots, strip malls and surface parking lots), inclusion of parks and recreation areas.
 - Transit-oriented development: Transit-oriented development (TOD) is a residential or commercial area designed to maximize access to public transport, and mixed-use/compact neighborhoods tend to use transit at all times of the day. Other measures might include regional cooperation to increase efficiency and expand services, and moving buses and trains more frequently through high-use areas.
 - Walking and biking communities: In walkable communities, housing, offices, retail areas and services such as transportation facilities, schools, and libraries are located within a safe and easy distance to encourage pedestrian and bicycle transport. When pedestrian and bicycle facilities are available, they expand transportation options, and create a streetscape that better serves a range of users: pedestrians, bicyclists, transit riders, and automobiles. The benefits of a walkable community include lower transportation costs, greater social interaction, improved personal and environmental health, and expanded consumer choice. Land use and community design plays a pivotal role in encouraging pedestrian environments.
- Community quality of life: The community quality of life is enhanced with the preservation of open space and critical habitat; the reuse of land and the protection of water supplies and air quality; transparent, predictable, fair and cost-effective rules for development and historic preservation; the preservation of large areas where development is prohibited and nature is able to run its course, providing fresh air and

clean water. Expansion around existing areas allows public services to be located where people are living without taking away from the core city neighborhoods. This development around preexisting areas decreases the socioeconomic segregation allowing society to function more equitably, generating a tax base for housing, educational and employment programs.

Table 3. Urban land use development policies and measures

Planning Measures
Zoning ordinances (single use, mixed use, densities etc.)
Emphasis on economic growth of principal city centers
Designated cities or areas for growth/control over the pattern of development
Relocation of particular employment groups/sectors
Use of preferred locations for travel generating activities (i.e. town centers)
Fiscal inducements to relocate in designated areas
Growth boundaries around urban areas
Regeneration of brownfields and other decaying areas (inner city centers)
Improvement to housing and neighborhood quality/facilities
Parking standards for new developments
Environmental impact assessment
Smart growth provisions

Source: Adopted from Levy (2006).

3. INTEGRATION OF TRANSPORTATION AND URBAN DEVELOPMENT IN THE USA

Planning for sustainable urban development calls for the integration of land use and transportation, creating a compact city design which limits automobile use and encourages walking and the use of transit and bicycle. Livable communities also seek to provide options for those who cannot or who choose not to drive, for children and seniors who want more independence, and for people who might want to drive to work one day and bike the next. Four examples are discussed below to illustrate strategies used to implement successful integration of land use and transportation development.

3.1 Regional Authority to Coordinate Transportation Development and Land Use in Atlanta, Georgia

The Atlanta region (Figure 1) has an enormous diversity of population and communities with substantial economic, cultural, educational and infrastructure assets. The region has been a magnet for new jobs and residents over the last few decades with the area growing by more than a million people over the past ten years. The Atlanta transportation planning area covers nearly 4,000 square miles and is home to more than 3.7 million people and 2.5 million jobs. By 2030, the region is expected to grow to six million people and 4.2 million jobs. In addition to the new development created by the growth in the region, urban sprawl is expected to consume 600,000 acres to accommodate just over one million new residents if the current trends continue (Atlanta Regional Commission, 2008).

The Georgia Regional Transportation Authority (GRTA) was created by the Georgia Legislature in March 1999 with powers to “establish new transportation services, control regionally significant private and public developments and review transportation planning in the region” (GRTA, 2001). Under the law, GRTA has the authority “to manage, or cause to be

managed, transportation and air quality in areas of Georgia that are in non-attainment of federal air quality standards” (GRTA, 2001). The agency has also been granted broad powers “to impose transit systems and highways on local governments, to restrict development, and even to put pressure on cities and counties to raise taxes” (Cashin, 2000). More importantly, GRTA has the power to review and veto projects that do not conform to the regional transportation plan (RTP) in order to secure local government compliance with RTP (GRTA, 2001).

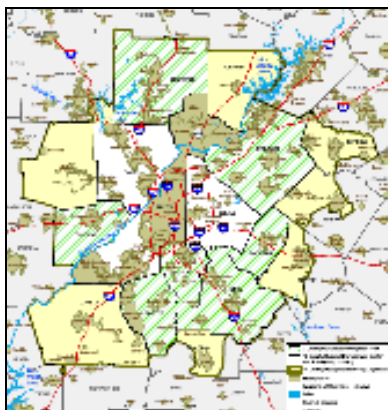


Figure 1. Atlanta region under the administration of the Atlanta Regional Commission

In May 2006, the GRTA/ARC approved a Unified Growth Policy Map, a new Regional Development Plan, a Place Type and Development Matrix and a Regional Strategic Transportation System for the Atlanta metropolitan area. These aim to promote sustainable land-use transportation development in the region (Atlanta Regional Commission, 2007). Key aspects of the plans include:

- Developed area policies:
 - Promote sustainable economic growth in all areas of the region.
 - Encourage development within principal transportation corridors, the Central Business District, activity centers and town centers.
 - Increase mixed use development, transit-oriented development, infill and redevelopment.
 - Design transportation infrastructure to promote a sense of belonging for communities.
 - Promote reclamation of brownfield sites.
- Housing and neighborhood policies:
 - Promote housing of varying styles, densities and price ranges to cater for individuals and families of different incomes and age groups.
 - Create communities with green spaces and neighborhood parks, pedestrian and biking options.
 - Promote sustainable and energy-efficient development projects.
- Open space and preservation policies:
 - Protection of environmentally sensitive areas
 - Increase amount, quality, connectivity and accessibility of green space.
 - Preserve and enhance historic resources.
 - Discourage growth in undeveloped areas through regional infrastructure planning.

3.1.1 Significant Lessons Learned

The GRTA has demonstrated that sustainable land-use transportation development has to be performed at a regional scale, as can be seen by the level of collaboration between different counties, or between elected officials and the public. This is an excellent example to illustrate how the metropolitan growth can be managed by proper land use-transportation planning and policy-making without compromising sustainability. The key item in this example is the veto power given to the regional authority on transportation and development issues in the region.

3.2 California Urban Sprawl Control Law

Transportation is California's largest source of greenhouse gas emission, accounting for 40% of emission by all sectors, and cars and light trucks representing almost 30% of the emission within the transportation sector. Long commutes and congested highways further aggravate the problem. It is recognized by the state government that imposing fuel-efficient vehicles and the Low Carbon Fuel Standard are not enough to reduce emission of greenhouse gases and it is necessary to reduce the number of miles driven by individuals. Thus in September 2008, a law requiring that transportation planners must adopt a "sustainable communities strategy" was enacted (Office of the Governor of California, 2008). The law offers local governments regulatory and other incentives to encourage compact new development and transportation alternatives.

The basics of the law (Chapter 728 of California Statutes, 2008) are summarized as follows:

- Transportation planning: The California Air Resources Board (CARB) will set regional greenhouse gas reduction targets after consultation with local governments. That target must be incorporated within that region's Regional Transportation Plan (RTP), the long-term blueprint of a region's transportation system. The resulting model will be called the Sustainable Communities Strategy.
- Housing planning: Each region's Regional Housing Needs Assessment (RHNA) – the state mandated process for local jurisdictions to address their fair share of regional housing needs – will be adjusted to become aligned with the land use plan in that region's Sustainable Communities Strategy in its RTP (which will account for greenhouse gas reduction targets).
- California Environmental Quality Act (CEQA) reform: Environmental review will create incentives to implement the strategy, especially transit priority projects.

Local governments will have to plan for sustainable growth by clustering homes, businesses, and transportation hubs together, and by providing citizens housing options near where they work and live. The land use plans are to be submitted to the CARB to ensure they meet regional emission reduction targets. The CARB will set the 2020 and 2035 targets for each region of the state by 2010, and regional authorities will be required to take these targets into account when developing regional plans. This legislation will also steer public funds away from sprawling development and projects that meet the climate goals will receive priority in funding.

3.2.1 Significant Lessons Learned

This law is first attempt in the USA to legislate mandatory land-use transportation planning with environmental and global warming considerations. It should be recognized that emission standards and fuel-efficient vehicle technologies are not sufficient to reduce greenhouse gas

emissions, and automobile use must be reduced. The land use-transportation plan adopted in California could become a model of what could follow in the rest of the states.

3.3 Transit Oriented Development at Pearl District, Portland, Oregon

The State of Oregon forbids the use of inclusionary zoning and requires compact infill development as an outcome of urban growth boundaries around all urbanized areas. These two conditions have helped set the stage for the remarkable redevelopment of the Pearl District, north of the downtown, and the South Waterfront area south of downtown. New mixed-use neighborhoods have rapidly developed with mixed-income housing, shopping, employment, and public open space uses. Portland’s efforts can provide some critical lessons for creating mixed-income communities around transit across the United States (Reconnecting America, 2007).

3.3.1 Portland Streetcar Construction and Operations

As a part of Portland’s broader strategy to improve mass transit throughout the region, the streetcar system was built as a downtown circulator. The initial 2.4 mile segment of the line was completed in 2001 and subsequently extended twice. The line now has 38 closely spaced stations, each a few blocks apart, allowing the streetcar to serve as a “pedestrian accelerator” and producing increased walking trips and less demand for parking (Figure 2). The average weekday ridership in 2006 exceeded 7,000, which is almost double the ridership number in 2001. Journey-to-work travel within the streetcar district consists largely of transit and walking trips (30%) without many auto trips (40% of total), verifying the circulatory role it plays both within the downtown area and between other transit options.

Portland used creative approaches to fund the streetcar construction. The cost of parking was increased from 75 cents to 95 cents per hour and the city issued bonds backed by future parking revenues to raise \$28.5 million. Property owners along the alignment agreed to form a local improvement district (LID), which provided another \$10 million. Tax increment financing contributed \$7.5 million, and a mix of other sources provided another \$11 million.

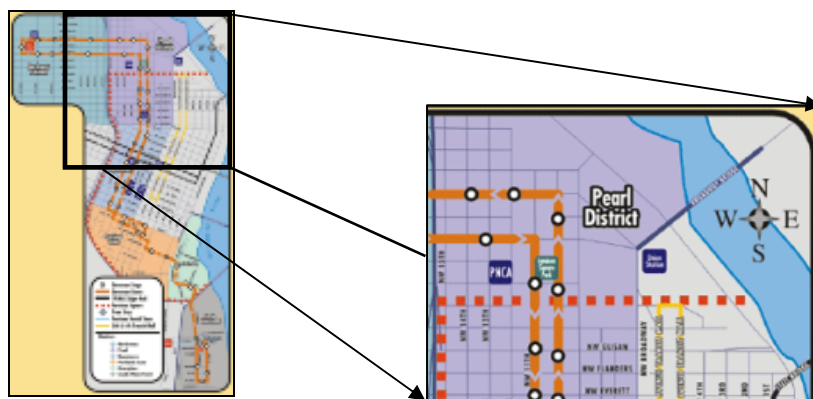


Figure 2. Portland streetcar route information (Pearl district in N-E corner)

3.3.2 Improvement to land development, housing and revitalization

A large amount of obsolete, industrial land had existed in large parcels close to downtown prior to the streetcar investment. The Portland Development Council worked to stimulate the private market by investing in new housing, commercial opportunities, and open space near the streetcar stations. The city also rezoned an additional 40 acres of industrial land that had served as a warehouse district to allow for more commercial and mixed-use development

(Table 4). The relatively small number of property interests in these areas allowed for master planning of whole new neighborhoods. It also allowed the City to leverage significant contributions to the construction of the streetcar and many other critical public infrastructure improvements necessary to create balanced, high-density areas. The high value of new development in these areas has produced a sizeable stream of tax increment funds and the revitalization of the Pearl District (Ohland and Poticha, 2006).

Table 4. Land use and density, Portland downtown in 2005

Type	Land Use (within 0.5 mile of stops)	Densities
Housing	25%	39.13 dwelling units per acre
Commercial	53%	1.41 floor area ratio
Industrial	11%	0.04 floor area ratio
Mixed Use	11%	-
Civic	N.A.	-

Source: *Reconnecting America's Center of Transit Oriented Development (2007)*.

Households living within the streetcar corridor transit zones also are more likely to use transit for commuting to work than households located elsewhere in the region. Most striking, and reflective of the urban environment and proximity to central business district, over 30% of the people in the district walk or bike to work and less than 40 percent commute by automobile. This is in contrast to the Portland region's modal split of 82% work trips by automobile, 6% transit and 4% walk/bike (Reconnecting America, 2007).

3.3.3 Significant Lessons Learned

One of the most significant findings is the powerful role that developer agreements can play in stimulating development that supports a range of community benefits, including the creation of transit-supportive development. It is clear that the levels of density could not have been achieved in the Pearl District without the streetcar, given the amount of parking that would otherwise have been necessary. Other lessons learned include:

- The extent of large, single-owner parcels with obsolete industrial uses adjacent to the downtown provided the opportunity to create whole new neighborhoods and to design new infrastructure and urban amenities accordingly. These parcels created the framework for developing public-private agreements that included affordable and mixed-income housing goals.
- Prior to the development of the Pearl District, very little housing existed in the downtown. The streetcar and coordinated redevelopment benefited from pent-up demand.
- One of Portland's significant opportunities in planning for and implementing new high-density downtown neighborhoods was the relative lack of population in the industrial areas that were being redeveloped. The lack of existing residents meant little or no community opposition to adjacent development projects or high residential densities, and also created no significant displacement of low-income households.

3.4 Walkable Communities along Rosslyn-Ballston Metro Corridor, Arlington, Virginia

Arlington's smart growth planning approach places dense, mixed-use, infill development at five Metro stations - known as the Rosslyn-Ballston Corridor - and tapers it down to residential neighborhoods (Figure 3) (Arlington County Government, 2008). Incentive zoning was used to attract private-sector transit-oriented development. The development plans within the corridor follow set goals for type of use, open space, infrastructure, and design. Each plan focuses growth within a walkable radius of the stations and preserves established

transportation choices available to commuters but also provide health benefits, safety, and an improved quality of life for its residents.

4. EFFORTS IN ASIA TO INTEGRATE URBAN AND TRANSPORTATION AND URBAN DEVELOPMENT

Demand for more mobility, accessibility and personal space is clearly unstoppable. It is up to planners and policy makers to devise the innovations necessary to render these demands compatible with sustainable development. Automobile-based public transportation must therefore be made safe and green, public transportation system should be designed to complement automobiles, and efforts must be made to minimize the need for travel. The case studies presented in the previous section yield useful lessons. It is important to implement an integrated land use-transportation planning system that minimizes the use of private automobiles in order to improve sustainability.

Some of the Asian countries have started to address urban sprawl by tightening their land use policies, such as that implemented in California as illustrated in the previous section. China, for example, has taken a strong stand against sprawl by approving the 2006-2020 land use plan to ensure proper use of arable land and guarantee a minimum of 120 million hectares of arable land, amid concerns of urbanization on grain security (Xinhua News Agency, 2006).

Demand for private automobile transportation is heavily influenced by the urban structure of cities. Cities that grow in a compact manner with high density development, concentrated about nodes, can support a larger share of public transportation than cities growing in a leapfrogging manner along radial highway corridors. Compact developments can only happen through well-coordinated integration of urban expansion management, land-use policies, transportation planning and management strategies.

In this respect, the Chinese government has formulated the “Priority Program for China’s Agenda 21” covering aspects of sustainable development, social equity, urban planning, transportation and the environment (China Agenda 21, 2009). Integrated land use-transportation planning can play an important role in this program. Furthermore, Chinese cities such as Beijing, Tianjin and Wuhan have recognized the need for integrated planning and have revised their urban development master plans to incorporate aspects of sustainability.

Another example is the integrated transportation and land use planning in the island state of Singapore. Singapore has 3.6 million people living in a total area of 646 square kilometers, making it one of the most densely populated and urbanized countries in the world. Roads currently take up about 12% of total land area. Given the scarcity of land, the land-use transportation plan is to develop a comprehensive rapid transit network with dedicated rights of way, transporting large numbers of people to their destination quickly and reliably. Transport considerations in Singapore result in two key land use planning strategies:

- Decentralizing commercial and other economic activities through the development of regional, sub-regional, and fringe centers of mass rapid transit stations. These centers aim for a proper mix of residential, industrial, and even institutional developments, allowing very high densities at and around the transit stations (Singapore Parliament, 1996).
- Reducing the need to travel by locating employment centers (industrial estates, business parks and commercial centers) near residential areas.

Central to the success of the Singapore model is high density urban development that is closely integrated around the transit system. Singapore’s basic urban structure plan shows a series of radial and circumferential mass transit and light rail lines with major and minor sub-

center nodes developed at high densities around the intersection of all these lines (Kenworthy et al., 1994).

In Thailand, Bangkok Agenda 21 was initiated in 1998 as the blueprint for development of the city's urban environment and quality of life. Within the agenda, the Metropolitan Master Catalogue plans for the physical development of Bangkok and is based on the strategic agenda, community regulations concerning land use, building and the environment, and a databank based on a GIS system. The Bangkok Comprehensive Plan further highlights targets and strategies on air pollution abatement. The agenda also emphasizes future efforts on the development of mass transit, establishing vehicle emission testing programs to identify polluting vehicles, promoting non-motorized transportation and the use of alternative fuels such as ethanol or natural gas (The Cities Alliance, 2007).

Despite the rapid growth in car ownership in developing countries in Asia, the majority of urban households in Asian cities are still car-less and likely to remain so for the next 15 to 20 years. Continued priority to public transportation and the creation of a walkable environment are thus needed. This is epitomized in China's Decree #46, approved by the Chinese State Council in October 2005 (State Council of the People's Republic of China, 2005). Similar initiatives are also established in Hong Kong, Singapore, Bangkok and Seoul. The current challenge for city planners and managers is to find ways in which cities can be designed and managed for people, not for cars. An efficient and affordable public transportation system (consisting of bus rapid transits and metro or light rails) is the key element of these initiatives. Also, instead of providing the same service to all travelers at a minimum fare, public transportation services should be made differential to cater for low-income users as well as users who value quality of service. Examples of differential pricing systems are found in bus and rail transit systems in Hong Kong, Tokyo and Singapore. In this manner, services of increasing quality can be offered with increasing fares (e.g. premium bus service in Singapore) so that revenues can be maximized, while at the same time keeping some users from shifting to automobiles. The feasibility of public-private partnerships in major public transportation projects such as new suburban rail or bus rapid transit systems in certain large cities should be explored.

Efforts to produce viable alternatives to petroleum use of transportation must be accelerated through various transportation and land use policies. With volatile oil prices, plug-in hybrids and cellulosic bio-fuels for automobiles and public transportation vehicles are becoming commercially feasible in the near term. Green buildings and the use of solar-power in transportation infrastructures would provide an aesthetically-pleasing environment for travelers and yet are sustainable in terms of energy consumption. Suitable zoning laws can be implemented to encourage the formation of green zones during the integrated transportation-land use planning process. An example can be found in the long term urban environmental development plans and the establishment of green and ecological areas in Seoul metropolitan area (Seoul Metropolitan Government, 2008).

5. A LONG TERM VISION OF SUSTAINABLE URBANIZATION

In an increasingly global world, we must think of a three-way relationship between land use, the Internet and transportation. Rapidly emerging information and communication technologies have started to change the traditional land use-transportation relationship. It is no longer tele-commuting but also tele-shopping, tele-entertaining and tele-schooling. The net effect is substantially reduced personal travel, profoundly affecting trip rates, distances and distribution of various trip purposes and further urban sprawling. These changes offer an

opportunity for transportation planners to think of a land use-transportation system that is not tied to a limited geographic unit such as an urban area, but to a vast region over large distances, spreading beyond state and national boundaries. By harnessing the potentials of emerging technologies, it is possible to create livable communities with sustainable transportation through proper integration of land use and transportation development supported with appropriate pricing policies. In the not-so-distant future, with a fully functioning information technology-oriented society, our cities can again become a collection of thriving neighborhoods where automobiles will still exist, but not as an absolute necessity. People will be able to choose to go safely and conveniently to neighborhood by foot, bicycles or public transportation, thus minimizing their parking needs. With the requirement for personal travel over long distances being reduced, public transportation can again regain its importance. When a good part of the daily long commute is eliminated, people will have time to engage in activities that add to the quality of life such as visiting museums, libraries, concert halls, botanical gardens and other places, resulting in the rebirth of the cities as cultural centers (Sinha, 2003).

6. CONCLUSIONS

This paper has presented a set of strategies adopted in the USA and Asian countries in integrating transportation planning and urban development to promote sustainability. Common strategies include the setting of environmental targets and measures, land use laws and urban boundaries, transit-oriented neighborhood planning, and the use of congestion pricing. While these strategies have been used both in North America and Asia, the level of success of their implementation has been particularly challenging for both continents. The primary obstacle stems from inadequate legislative provisions and jurisdictional structures at the regional and local levels. Successful integration of transportation and urban development plans requires at least three conditions. First, initiatives should be regional in scope and coordinating regional authorities should be empowered adequately to enforce proper land use-transportation planning and policy-making without compromising sustainability. Second, there must be a mechanism to ensure that targets and measures included in planning are in fact being met at the implementation level. Third, local jurisdictions within a region must recognize that sustainability is an essential ingredient for economic growth and it can only be achieved through regional cooperation. Through an active integrated transportation and urban development program at the local, regional and national levels, we can greatly reduce the use of non-renewable energy, improve the environment, reverse or arrest the process of climate change and thus achieve sustainability of the world around us.

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REFERENCES

Arlington County Government (2008) *WALKArlington*. Website: <http://www.walkarlington.com> (Last accessed: 26 October 2008).

- Atlanta Regional Commission (2007) *Envision 6: Regional Development Plan Policies 2007*. Atlanta, GA.
- Atlanta Regional Commission (2008) *Regional Development Plan Technical Report*. Atlanta, GA.
- Banister, D. (2005) *Unsustainable Transport: City Transport in the New Century*. Routledge.
- Bureau of Transportation Statistics (2008) *National Transportation Statistics 2007*. Federal Highway Administration, Washington D.C.
- California Statutes (2008) Chapter 728: Transportation Planning: Travel Demand Models: Sustainable Communities Strategy: Environmental Review. *California Statutes*. California State Legislature. Website: www.leginfo.ca.gov/statute.html (Last accessed: 26 October 2008).
- Cashin, S.D. (2000) Localism, self-interest, and the tyranny of the favored quarter: addressing the barriers to new regionalism. *Georgetown Law Journal*, 88, 1985-2015.
- China Agenda 21 (2009) *Priority Program for China's Agenda 21*. Website: <http://sedac.ciesin.org/china/policy/acca21/21desc.html> (Last accessed 31 January 2009).
- Dittmar, H., Ohland, G. (2004) *The New Transit Town: Best Practices in Transit-Oriented Development*. Island Press, Washington D.C.
- Federal Highway Administration (2008a) *Traffic Volume Trends*. FHWA Office of Highway Policy Information. Website: <http://www.fhwa.dot.gov/ohim/tvtw/tvtpage.cfm> (Last accessed: 26 October 2008).
- Federal Highway Administration (2008b) *Bicycle and Pedestrian Program - The Nonmotorized Transportation Pilot Program (NTPP)*. FHWA Office of Planning, Environment, and Realty. Website: <http://www.fhwa.dot.gov/hep/index.htm> (Last accessed: 26 October 2008).
- Frumkin, H. (2002) Urban sprawl and public health. *Public Health Reports*, 117, 201-217.
- Georgia Regional Transportation Authority (GTRA) (2001) *Georgia Regional Transportation Authority Annual Report*. Atlanta, Georgia.
- Kenworthy, J., Barter, P., Newman, P., Poboan, C. (1994) Resisting automobile dependence in booming economies: A case study of Singapore, Tokyo, and Hong Kong within a global sample of cities. *Proceedings of Asian Studies Association of Australia conference on Environment, State, and Society in Asia: The Legacy of the Twentieth Century*, 13-16 July 1994, Murdoch University, Perth, Australia.
- Kenworthy, J., Luabe, F.B., Newman, P. (1999) *An International Sourcebook of Automobile Dependence in Cities, 1960-1990*. University Press of Colorado, Colorado.
- Lehman, M., Boyle, M. (2007) *Healthy and Walkable Communities*. Institute for Public Administration, College of Human Services, Education & Public Policy, University of Delaware.
- Levy, J.M. (2006) *Contemporary Urban Planning*, 7th Edition. Pearson, Upper Saddle River, New Jersey, USA.
- McKee, B. (2003) *As Suburbs Grow, So Do Waistlines*. The New York Times, 2003-09-04. The New York Times Company. Retrieved on 26 October 2008.
- Office of the Governor of California (2008) *Governor Schwarzenegger Signs Sweeping Legislation to Reduce Greenhouse Gas Emissions through Land-Use*. Press Release. Website: <http://gov.ca.gov/press-release/10697> (Last accessed: 26 October 2008).
- Ohland, G., Poticha, S. (2006) *Street Smart: Streetcars and Cities in the Twenty-First Century*. Reconnecting America, USA.
- Pew Center on Global Climate Change (2008) *Climate Change 101: Understanding and Responding to Global Climate Change*. Arlington, VA. Website: www.pewclimate.org (Last accessed: 26 October 2008).

- Reconnecting America (2007) *Portland Streetcar Corridor, In Realizing the Potential: Expanding Housing Opportunities Near Transit*. FTA Report No. CA-26-2004, prepared by the Center of Transit Oriented Development for the Federal Transit Administration, 136-160.
- Seoul Metropolitan Government (2008) *Vision Seoul 2006: Major Policies*. Seoul, South Korea. Available: http://english.seoul.go.kr/gover/initiatives/inti_01vis_0101.htm
- Singapore Parliament (1996) *A World Class Land Transport System: White Paper*. Land Transport Authority, Singapore.
- Sinha, K.C. (2003) Sustainability and urban public transportation. *ASCE Journal of Transportation Engineering*, 129 (4), 331-341.
- Smart Growth Network. (2008) *Principles of Smart Growth*. Website: <http://www.smartgrowth.org/about/principles/default.asp> (Last accessed: 26 October 2008).
- State Council of the People's Republic of China (2005) *Decree Number 46 (2005): Priority in Urban Public Transportation Development*. Beijing, China. (in Chinese).
- Texas Transportation Institute (2008) *Mobility Report*. Texas Transportation Institute. College Station, Texas.
- The Cities Alliance (2007) *Liveable Cities: The Benefits of Urban Environmental Planning*. Cities Alliance, the International Council for Local Environmental Initiatives and the United Nations Environment Program, Washington D.C., USA.
- Transportation Research Board (1997) *Toward a Sustainable Future: Addressing the Long Term Effects of Motor Vehicle Transportation on Climate and Ecology*. Special Report 251. Transportation Research Board, National Research Council, Washington DC.
- Xinhua News Agency (2006) *China to Conserve 120 Million Hectares of Arable Land till 2020*. October 18, 2006. China.
- Wheeler, S.M., Beatley, T. (2004) *The Sustainable Urban Development Reader*. Routledge.