

Prototypes of Transportation Nodes with High Density and
Mixed-use to be Applied to Pearl River Delta Region

by

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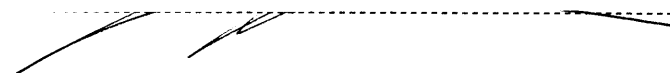
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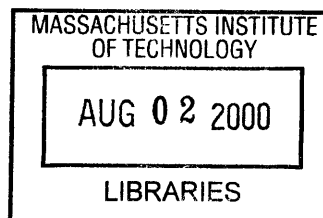
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Submitted to the Department of Urban Studies and Planning
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Abstract

The main objective of this study is to develop a number of adaptable prototypes of transportation nodes with high-density and mixed-use to be applied to the Pearl River Delta Region in China and analyze its implications and potential impacts on the region, in conjunction with the planning studio work that focuses developing different development scenarios and growth strategies for this region. This study is based on the premise that the mass transit can consistently bring people to a concentrated area, increasing the likelihood that they will patronize business and perhaps live or work in the vicinity. While there are many ways that the influence of transit may be realized, it is difficult to isolate and account for all transit-induced changes. Correspondingly, this thesis addresses a deliberate response to transit that is concerted efforts to reconnect transit with urban form and land use. In addition, this thesis also examines cases of transportation nodes that attempted to link transit and urban development.

From this study and the examination of other cases, it is concluded that efficient mass transit has positive impacts in urban realm; economic growth, better environment quality, more comfortable living conditions of people, reduced energy consumption, resource conservation and so on. Furthermore, transportation nodes are more efficient if they have high-density and mixed-use developments on top because mixed-use developments in the transportation nodes attract more people to the station and provide higher ridership which would increase fare box income. Equally important, as a rail system is very costly to build and also costly to operate and besides, few urban railway schemes are cost-effective in terms of the revenue generated by only passengers' fares, stations with developments on top would create revenue generated from land and air rights leases and also other forms of economic benefits that flow to the station properties. Hence, these wider benefits would allow government to subsidize investment in new railway projects, or to prop up existing lines.

Thesis Supervisor: Tunney Lee
Title: Professor of Urban Studies and Planning

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1. Introduction

1.1. Purpose and Scope of the Study

The main objective of this study is to develop a number of adaptable prototypes of transportation nodes with high-density and mixed-use to be applied to the Pearl River Delta Region in China and analyze its implications and potential impacts on the region, in conjunction with the planning studio work that focuses developing different development scenarios and growth strategies for this region.

This study is based on the premise that the mass transit can consistently bring people to a concentrated area, increasing the likelihood that they will patronize business and perhaps live or work in the vicinity. While there are many ways that the influence of transit may be realized, it is difficult to isolate and account for all transit-induced changes. Correspondingly, this thesis addresses a deliberate response to transit that is concerted efforts to reconnect transit with urban form and land use. Furthermore, this thesis will also examine cases of transportation nodes that attempt to link transit and urban development.

1.2. General Concepts of High-density and Mixed-use Development

1.2.1. Definitions

1.2.1.1. Definition of Mixed-use Development

In general mixed-use developments are the integration of multiple uses within a building or among buildings within an area in such a way to create a pedestrian atmosphere. Multiple uses may include commercial, industrial, and residential functions in various combinations.

There are several basic assumptions made for the mixed-use developments. First of all, the diversity of the city's development pattern is a major asset and should be fostered and protected. Secondly, the close proximity of a wide variety of uses and activities require careful

consideration of buffer and transition requirements. Finally, the wide diversity of land use in the city fosters the social and economic diversity that is one of city's enduring assets.

Increasingly, mixing different land uses in the same geographical area is seen as a positive contribution to planning policy. It is hoped that by increasing the mix of land uses, and especially residential uses, residents will lead more sustainable lifestyles, using their cars less. In addition, town and cities will become more attractive, viable and safer to live and work in.

1.2.1.2. Definition of High-Density Development

Density is a condition strongly associated with every form of built environment. Although density is a simple measure applied in land use planning, there are multiple definitions associated with it. Examples of simple definitions include density indexes such as the number of people per hectare and the number of dwelling units per acre of land, and related measures of land use intensity, like coverage and floor area ratios.¹

As Alexander R. Cuthbert has noted, "like the concept of 'land use' the word 'density' generalizes a multitude of technical definitions and subjective perception of space." These complex density terms however may be divided into two main categories. Firstly there are those which refer to abstract, objective measurements of land, buildings, dwelling units, floor area etc., where ratios are either created between categories or in relation to social units (persons, families, married couples etc.). Secondly there is the subjective experience of density in terms of stress, crowding, coping mechanisms etc.²

In the first category, there are a whole range of issues which are ignored when attempts are made to quantify the complexity of relationships which devolve spatially from the physical concentrations of people or building patterns within urban centers. For example, zoning plans employed by planners are two-dimensional. Hence, they are inadequate to deal with the four-

¹ Alexander, Ernest R., Reed, K. David, and Murphy, Peter. (1988). Density Measures and their Relation to Urban Form. Milwaukee: The University of Wisconsin-Milwaukee, p. 1.

² Cuthbert, Alexander R., (1985). Architecture, Society and Space – The High-Density Question Re-Examined. Oxford: Pergamon Press, p. 118.

dimensional spatial system represented by high density urban centers, and reduce such complexity to the level of 'residential', 'commercial', or 'mixed' use.³

In many societies there is a nature inclination to be apprehensive over the impact of high-density living on patterns of human behavior. For people with young families in Western cultures there is often a strong preference for an environment in which to live that facilitates ready access to ground-level open spaces. There is often an equal aversion to living in high-rise 'egg-crate' apartments where there may be exposure to security risks and a felling of being cooped up with few opportunities for casual chats with the next-door neighborhoods. Indeed, there are many examples in Europe and the USA where high-rise apartments have fallen into a state of dereliction.

But why is it that in many Asian cities the majority of people find living and working in a high-rise environment generally to be acceptable? The most significant factor that probably have induced positive responses to living and working in high-density environments in those places include the simple fact that the land suitable for urban use has always been in short supply relative to growing pressures of population, and also that, the traditional Eastern way of life has been very conservative in the use of space, with the result that crowded environments have become widely accepted pattern of life.

Although no single definition of the city relies solely on the phenomenon of high density as its essential characteristic, the concept of high-density development received important attention as early as 1900 in the work of George Simmel who thought that high density produces "a shift in the mediums through we orient ourselves in the urban milieu".⁴ Simmel viewed high density as a particular condition of cities that has the ability to compress information, energy, space and human contact and experience into increasingly concentrated forms. Moreover, much of the literature which focuses on the effects of population density on humans begins with the basic assumption that there is a direct relationship between an individual's behavior and the environments which he inhabits.

One of the first theorists to separate the concept of 'high density' (defined in terms of housing units per net acre) from 'overcrowding' (defined in terms of persons per room), was

³ Cuthbert, Alexander R., (1985). p. 118.

⁴ Cuthbert, Alexander R., (1985). p. 81.

Jane Jacobs in her controversial work The Death and Life of Great American Cities. Jacobs insisted that the correlation between high densities and urban problems was erroneous, maintaining that it was precisely the life style offered by high density living which made cities such exciting and interesting places to live.

After all, density is not a condition exclusively associated with the metropolis but it is at the origin of every form of human settlement where cities and villages were established in response to the human need to more closer together. And there is an increasing consensus that high-density developments contribute in many ways to solve some of serious urban problems we face today such as problems caused by urban sprawl, high levels of smog-producing emissions, traffic congestion, lost of social contact in shared public spaces.

Some of key density terms and definitions are as follows:

Table 1-1. Definitions of Density

| Term | Definition |
|---------------------------|---|
| Gross density | Number of persons per hectare |
| Net residential site area | The total land area devoted to residential facilities. Uses excluded: commercial and industrial areas, shopping and local business not directly beneath buildings, commercial garage space, public parks and playgrounds, vacant land reserved for future development, vacant unbuildable land, schools, churches, community facilities, etc. |
| Net dwelling density | The number of dwelling units per acre of net residential land (land devoted to residential buildings and accessory uses on the same lots i.e. informal open space, drives, service areas, but excluding land for streets, public parking, playgrounds and nonresidential buildings). |
| Gross dwelling density | Defined as an outmoded term; defined here as the number of dwelling units per acre of gross residential land including ½ bordering streets. Recommends that the term gross residential density be replaced by over-all neighborhood density, usually expressed as families or persons per acre of total neighborhood land. |
| District density | The number of persons, families, or dwellings per acre land within a whole district, regardless of land use. District density corresponds to the term “gross density” as used by many city planners. |
| Building coverage | The proportion of net or gross residential land taken up by buildings. |
| Plot Ratio* | Plot ratio is normally the only official recognition given to the fact that buildings are three dimensional. Plot ratio is usually calculated by dividing the gross floor area of the building by the area of the lot on which the building stands. |
| Neighborhood density | The number of dwelling units per acre of total neighborhood land (net residential land plus streets and land used for schools, recreation, shopping and other neighborhood community purposes); neighborhood land excludes non-residential uses and unusable land within the neighborhood boundaries. |

*The equivalent term for Plot Ratio is Floor Area Ratio (FAR).

Source: Density Measures and their Relation to Urban Form. (1988)

However expressing density in dwellings/acre such as net dwelling density is appropriate when development is only limited to one kind of dwelling. As mixed-use developments are common, this measure becomes useless. More appropriate to express density would be density as the number of persons living on an area of land, or the number of habitable rooms.

Following tables represent several examples of different density measures generally accepted in Singapore and in Hong Kong, the most densely populated area in the world where the land suitable for urban growth is a very scarce commodity. Hong Kong is one of the best examples in the world where the high-density form of urban development is compatible with and sustains the traditional way of life, which thrives on close community interaction. It economizes on the use of scarce, developable land resources and, as a corollary, helps preserve areas of landscape value that are within easy reach of city dwellers. It also creates a compact and convenient city structure that facilitates community and business activities, promotes pedestrian movements and sustains the viability of multi-model transport services and other essential services.

Table 1-2. An Example of Different Density Measures in Singapore

| Density Typology | Gross Density Range (ppha) | Number of dwelling units per hectare | FAR |
|------------------|----------------------------|--------------------------------------|-----|
| Low-density | 150 | 50 | 1.2 |
| Medium-density | 300 | 100 | 1.8 |
| High-density | 450 | 150 | 2.4 |

Source: Singapore Urban Redevelopment Authority

Table 1-3. Generalized Characteristics of Eight Housing Estates in Hong Kong

| ESTATE | AREA | DENSITY | FAMILIES | AUTHORISED POPULATION | RANGE OF STORE HTS. | COMPLETION DATE |
|---|-------------------|----------------------|----------|-----------------------|---------------------|-----------------|
| Kwai Chung (I) and (II) | 41.5 A 16.8 Ha | 1380 P/A 3400 P/H | 9,496 | 57,100 | 8 | 1965 |
| Lam Tin (I), (II) & (III) | 45.9 A 18.6 Ha | 2020 P/A 4980 P/H | 16,265 | 92,500 | 16 – 21 | 1974 |
| Lei Muk Shue (I) and (II) | 31.5 A 12.7 Ha | 1430 P/A 3540 P/H | 8,027 | 49,100 | 7 – 22 | 1975 |
| Ngau Tau Kok Lower (I) (II) + upper | 30.8 A 12.5 Ha | 2920 P/A 7200 P/H | 14,171 | 89,600 | 12 – 23 | 1969 |
| Pak Tin | 36.2 A 14.7 Ha | 900 P/A 1980 P/H | 5,320 | 32,400 | 7 – 16 | 1975 |
| Wah Fu | 34.2 A 13.8 Ha | 1290 P/A 3200 P/H | 7,714 | 44,200 | 10 – 27 | 1971 |
| Wang Tau Hom (I) and (II) | 30.9 A 12.5 Ha | 1940 P/A 4790 P/H | 9,728 | 59,900 | 7 – 8 | 1964 |
| Wong Tai Sin Lower (I) (II) (III) + upper | 35.8 A 14.5 Ha | 1910 P/A 4710 P/H | 16,306 | 99,200 | 7 – 20 | 1965 |
| Sha Tin – City One | 39.5 A 16 Ha | 1010 P/A 2500 P/H | 10,000 | 40,000 | 27-34 | 1990 |

* P/A = persons per acre
P/H = persons per hectare

- (1) Wong Tai Sin
- (2) Lam Tin
- (3) Wang Tau Hom
- (4) Lei Muk Shue

Source: Hong Kong Housing Authority

Figure 1-1. View of Sha Tin-City One



Source: Hong Kong Architecture: Aesthetics of Density (1993)

1.2.2. Relationship between Urban Density and Transportation

What does it take for public transportation to be well used, efficient and effective? The answer is quite simply moving people. The more people transit can move per vehicle, per hour or per mile of service, the more effective and productive it is. The more densely concentrated those people are whether at home, at work or out shopping, the more people transit is going to carry per unit of service offered, the more revenue it can bring in and the more productive the transit system is going to be.

There are two factors that are the two most critical land use/development factors that make transit productive and effective. They are residential density and employment density.

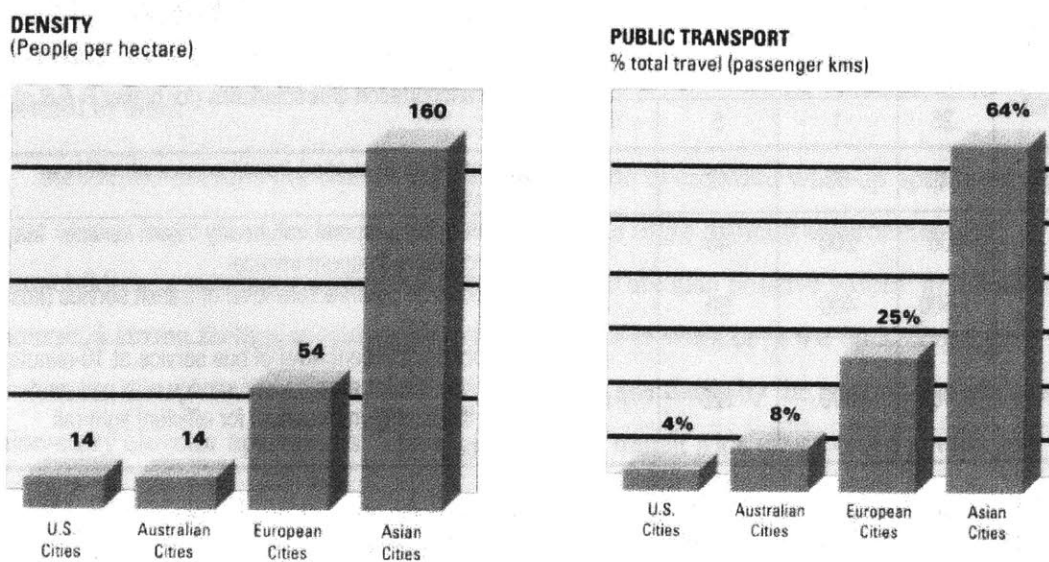
(1) Residential Density

This is usually stated and measured as net residential density per square mile or per acre. To support local neighborhood transit service, 1,500 ~ 2,500 persons per square kilometer should be present. When densities rise as high as 30 dwelling units per acre, transit usage has been found to triple; transit trips can outnumber auto trips at 50 dwelling units or more per

acre.⁵ But this does not mean that less dense areas should not be served. Instead, the people in these low density suburban developments can use bicycles or their cars to go to the transit system. To make the transit system productive when homes are not intensely concentrated, facilities like park-and-ride lots should be provided to encourage people to get themselves concentrated. In this way, a transit system can start out well loaded, offering reasonably fast, high quality service that will be productive, even in low density areas.

Better designs and layouts of housing developments that allow all residents to conveniently walk a short distance to the transit stops are possible and would vastly improve transit effectiveness.

Figure 1-2. Close Relationship between the Density of Cities and Public Transport



Source: Winning Back the Cities (1992)

⁵ Attoe, Wayne. (Ed.). (1988). Transit, Land Use and Urban Form. Austin: The University of Texas at Austin, p. 26.

(2) Employment Density

Whether the public will want to ride transit depends more on the density at the other end of the trip away from the home. The real payoff in urban form for a productive transit marketplace is activity centers – concentrations of employment or college students, whether they are in a downtown metropolitan core or in fringe areas or suburban activity centers. The minimum desirable employment/student concentrations for these centers to attract respectable transit ridership would be at least 50 employees per net employment acre and greater than 10,000 jobs in those centers.

Table 1-4. Employment Center Size and Travel Behavior

| Millions of Square feet ^a | Acres (approx) Needed at F.A.R. ^b | | | | Transportation characteristics (for higher F.A.R.s) |
|--------------------------------------|--|-----|-----|----|--|
| | .25 | 1 | 5 | 10 | |
| 2 | 240 | 60 | 12 | 6 | Lowest level to support transit service at half-hour intervals |
| 5-8 | 800 | 200 | 40 | 20 | Comfortably supports half-hourly transit service. May support more frequent service |
| 7-15 | 1,600 | 400 | 80 | 40 | Supports an intermediate level of transit service (bus only) |
| 20 | 2,400 | 600 | 120 | 60 | Supports a frequent level of bus service at 10-minute intervals, and/or express bus service with park-and-ride; the minimum threshold for efficient light-rail service |

a As a rough estimate, across all types of uses, there are an average of 2-3 employees per 1000ft².

b F.A.R. = floor area ratio = proportion of lot covered by building footprint. Assumes 30% of land goes to streets and other public facilities. Typical F.A.R.s for suburban office/industrial parks are about .25 to .5; for suburban city commercial or noncentral-city urban commercial, about 1 to 3; for the central city; about 5 to 15. The actual density of development is often less than the F.A.R.

Source: Cambridge Systematics, Inc., EcoNorthwest, and Pushkarev & Zupan (2)

1.2.3. Relationship between Urban Density and Travel Behavior

This chapter will look at briefly the relationship between urban residential density and its travel behavior as an extensive mass public transit system is only possible where there is sufficient ridership and as we examined in previous section, the more people are concentrated and use transit, more productive the transit system is going to be.

At the lower end of the scale we can think of a town with a density of about 2,000 persons per square kilometer. A city with this density means the inevitable problems of transportation, the impracticability of frequent bus service because of the population dispersal social cohesion. Only wealth and two cars per family can begin to overcome the difficulties.

At 7,000 persons per square kilometer, we reach an urban structure in which the dominant residential type is group housing. At this density, efficient public transport, even rail transit, can be supplied. However, in a land-starved nation such as China or Hong Kong, it may be wasteful of land.

At 13,000 persons per square kilometer we come to crowded walk-up apartments three and four stories high. Congestion begins here: it spells a more difficult environment for growing children, a surrender of light and air. Yet there are also positive values: better social intercourse, a strong feeling of 'urbanity', short journeys to work or to the open country, efficient mass transportation if one waives satisfy basic standards by the open use of six story and nine-story elevator apartments. Here, walking and transit trips may exceed automobile trips daily.⁶

At 40,000 persons or more per square kilometer, the upper end of the scale, we find the most congested parts of modern major cities. Such concentrations are formed by densely set elevator apartments or hopelessly dark and overcrowded tenements. There is loss of privacy, light, air, circulation, recreational space. Minimum standards cannot be met at this scale today without the use of 40 to 60-story buildings, suspended open spaces such as balconies and terraces, tiered circulation and parking areas. Such a metropolis may be tolerable at the center only for certain special individuals. However with this scale of residential density, over 40,000

⁶ Banerjee, Tridib and Southworth, Michael (Ed.). (1996) *City Sense and City Design*. Cambridge: The MIT Press, p. 39.

persons per square kilometer, high levels of mass transit system can be applied with extensive pedestrian activities.

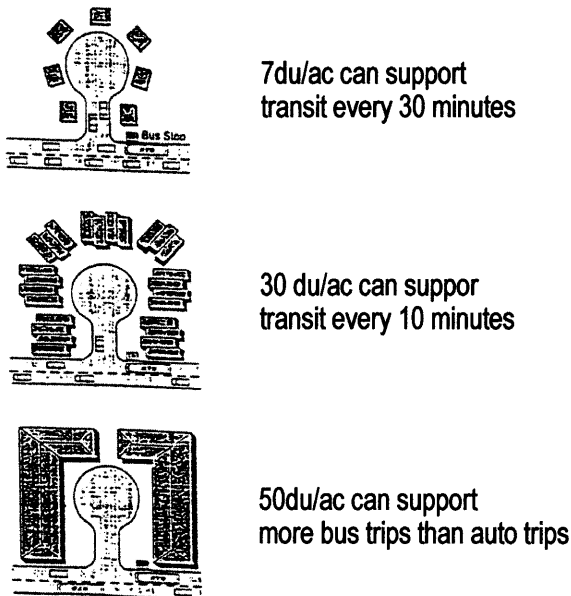
Table 1-5. Residential Density and Travel Behavior

| Units per Gross ² | Acre ² Net | Lot Size (ft ²) | People/ Sq. Km. | Transportation Characteristics | Example |
|------------------------------|-----------------------|-----------------------------|-----------------|---|---|
| 3 | 4.4 | 10,000 | 2,000 | Auto dependent; no transit support | Most new single-family subdivisions in suburban areas/Low-density development |
| 6 | 8.7 | 5,000 | 3,500 | Morning and evening work-oriented transit service; local transit service | As tight as detached housing can get |
| 12 | 17.4 | 2,500 | 6,500 | High level of transit service to employment centers, less for local trips | Low/Medium density development |
| 24 | 34.9 | 1,250 | 13,000 | Walking and transit trips may exceed automobile trips daily | Medium density development |
| 48 | 69.7 | 625 | 25,000 | High level of transit service; extensive pedestrian activity | The limit for density without high rise |
| 96 | 139.9 | 313 | 50,000 | High level of transit service; extensive pedestrian activity | High rise |

- The calculation of dwelling units (d.u)/net acre uses land in lots (i.e., in actual residential use) as the base. The calculation of d.u./gross acre uses all land (including land that is unbuildable or used for local roads, dedicated open space, or other purposes) as the base. Thus, d.u./net acre is always larger than d.u./gross acre. D.u./net acre is equal to a gross acre divided by lot size (e.g., 43,560 square feet per gross acre/10,000 square feet per lot(d.u.) equals approximately 4.4 d.u./net acre).
- Assuming roughly 20-30% of an acre is not in lots.
- Based on the assumed d.u./gross acre and 2.0 to 2.3 persons/d.u., and assuming 15%-20% of the square mile is outside of residential development (public facilities like schools, fire stations, sewage treatment plants, arterials and neighborhood commercial). Does not account for larger scale retail, office, or industrial uses.

Source: Cambridge Systematics, Inc., EcoNorthwest, and Pushkarev & Zupan (2)

Figure 1-3. Relationship of Density to the Level of Transit Service



Source: Suburban Mobility Design Manual (1993).

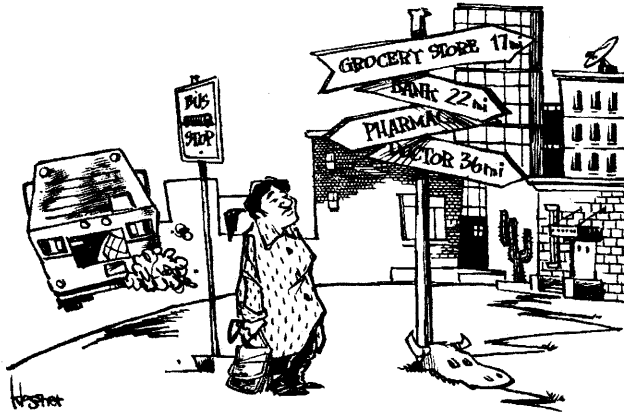
1.2.4. General Ideas of High-Density and Mixed-use Development

The way we plan the physical layout, or land use, of our communities is fundamental to sustainability. Two main features of land use practices over the past several decades have converged to generate inefficient and unsustainable urban sprawl. First feature is zoning ordinances that isolate employment locations, shopping and services, and housing locations from each other; and the second one is low-density growth planning aimed at creating automobile access to increasing expanses of land. Therefore by encouraging high-density growth planning with mixed-use, it is hoped that our communities would be more sustainable.

Moreover, the complex problems shared by cities are evidence of the impacts of urban sprawl-increasing traffic congestion and commute times, air pollution, inefficient energy consumption and loss of open space and habitat, inequitable distribution of economic resources, and the loss of a sense of community. Therefore, a transition from poorly managed sprawl to

mixed-use development with higher density growth planning is required to create and maintain efficient infrastructure and ensure close-knit neighborhoods and sense of community.

Figure 1-4. No Coordination in Transit and Development in Neighborhood



Source: City Routes, City Rights, (1998).

Commerce, industry, shopping and housing should be located together as they have been for centuries. It is those places where there is an absence of this mix which are notable, and these are a relatively recent phenomenon. Experience with the city's historic development pattern suggests that diversity in use and building form is a positive aspect of living in city. Concern to retain and enrich this mix of land uses is strong, and comes from a variety of sources.

At the same time, for various reasons the number of households continues to increase, creating a need for housing. Concerns about sustainability and the need to reduce car use -or at least to stop it increasing- have led to calls to stop the expansion of urban areas. This pressure has led to new proposals to increase urban densities and create new ways of getting more people living in existing centers. This debate has tended to focus on the concept of the 'compact city'. It is generally accepted that this cannot all go into green-field sites and new towns; much must go back into the cities, often in areas previously used for commerce or industry.

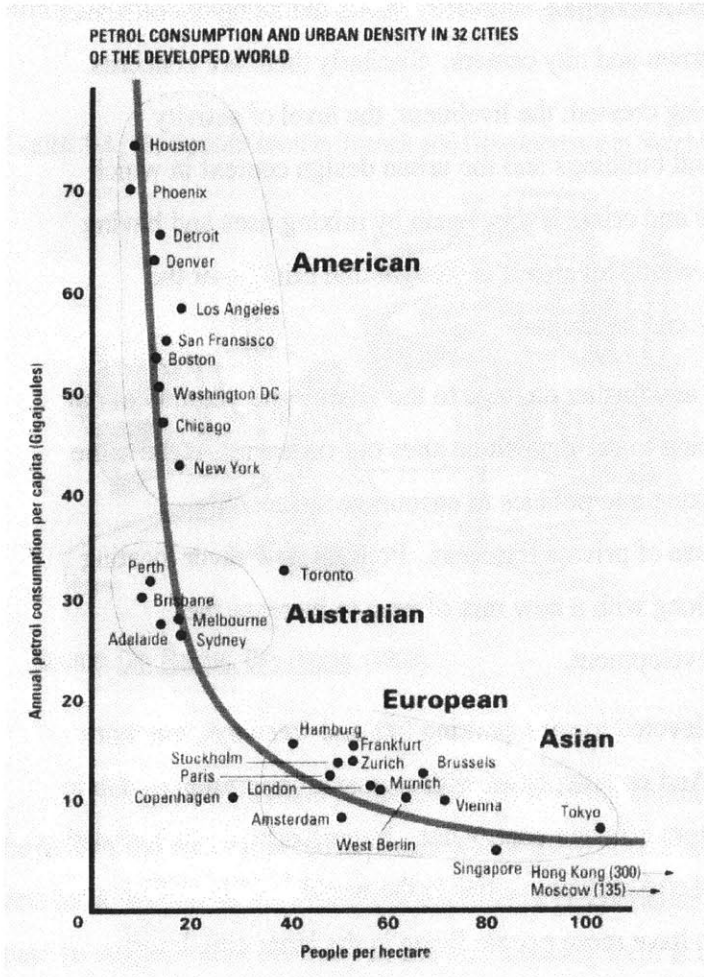
Further, government wishing to sustain and improve town and city centers has acted to prevent many new proposals for out-of-town shopping. Instead, efforts are being concentrated on improving the vitality and viability of town and city centers. Similarly there are concerns about the quality of the places that are being created: the liveliness; the level of activity throughout the day; the design of individual buildings and the urban design context in which they exist. A linked worry is about safety and crime levels; again by mixing uses and having greater activity and therefore observation within an area it is thought that crime – or the likelihood of certain crimes taking place – can be limited.

Equally, we now wish to prevent any further damage to the vitality and viability of our cities due to shopping and leisure uses going to car-dependent sites out-of-town. At the same time environmental concerns are crystallizing into policies to encourage sustainable development and limit damage from the use of private transport. Policies now favor locating these back in the town and city centers, along with a new mix of uses to increase the opportunities for city center residential development.

In simple terms, the more space devoted to cars, parking lots and freeways, the more sprawling and energy-wasteful the city. And equally, cities with a greater orientation to public transport have had higher densities and more efficient energy use. Importantly, these included some of the most economically successful and attractive cities in the world.⁷ Cities which are economical in land and energy use tend to have more people living in the inner city, lower levels of car ownership, less petrol use per person, fewer kilometers of road per person, greater use of public transport, and fewer parking spaces in the CBD relative to employment.

⁷ Norman, Peter, Kenworthy, Jeff and Robinson, Les. (1992). *Winning Back the Cities*. Leichhardt: Pluto Press Australia Limited, p.8.

Figure 1-5. Petrol Consumption and Urban Density in 32 Cities of the Developed World



Source: Winning Back the Cities (1992)

The characteristics about potential benefits of high-density and mixed-use development will be discussed more in detail in the next chapter.

1.3. Current Trends of High-density and Mixed-use Development

1.3.1. Transit Oriented Development

1.3.1.1. Concept of TOD

The concept of transit-oriented development, as promoted by architect Peter Calthorpe and other New Urbanism, provides alternatives to automobile-oriented urban patterns that have been prevalent in city planning since urban renewal and the height of the highway-building era. New Urbanism is a new approach to development that addresses issues of environmental sustainability and community building, while recalling more traditional architectural forms and street patterns.

In general and simple terms, transit-oriented development means development around a transit station that has buildings with varied activities within an easy walk of the station. By clustering development and a lot of different activities in buildings close to a transit station – where large number of people come and go on foot anyway – a community where people can easily meet their daily needs without a car can take shape.⁸

What sorts of activities should be clustered near transit stations will be different in every community, depending on what is already there and what people need and want. In general, TODs mix residential, retail, office, open space, and public uses in a walkable environment, making it convenient for residents and employees to travel by transit, bicycle, foot, or car. TODs offer an alternative to traditional development patterns by providing housing, services, and employment opportunities for a diverse population in a configuration that facilitates pedestrian and transit access.

They can be developed throughout a metropolitan region on undeveloped sites in urbanizing areas, sites with the potential for redevelopment or reuse, and in new urban growth areas. Their uses and configuration must relate to existing surrounding neighborhoods.

⁸ Burrington, Stephen H. and Heart, Bennet. (1998). City Routes, City Rights: Building Livable Neighborhoods and Environmental Justice by Fixing Transportation. Boston: Conservation Law Foundation, p.60.

They must be located on or near existing or planned segments of a trunk transit line or feeder bus network. Adequate auto accessibility is also important. These design guidelines establish standards for site selection and development to ensure that TODs succeed in providing a mix of uses, a variety of housing types, and a physical environment that is conducive to pedestrian and transit travel. Developing a network of TODs throughout the region will also serve to strengthen the overall performance of the regional transit system.⁹

The size of a TOD is determined on a case-by-case basis. The average 2,000-foot radius is intended to represent a “comfortable walking distance” (±10 minutes) for a majority of people. In some locations, comfortable walking distance is affected by topography, climate, intervening arterials or freeways, and other physical features. Therefore, their size will be greater or lesser depending on surrounding features.

A “walkable” environment is perhaps the key aspect of the concept. In order to develop alternatives to drive-alone auto use, comfortable pedestrian environments should be created at the origin and destination of each trip. No one likes to arrive at work without a car if they cannot walk comfortably from transit to their destination or run a mid-day errand on foot. TODs seek to bring many destinations within walking distance, allowing trips to be combined. Placing local retail, parks, day care, civic services, and transit at the center of a TOD reinforces the opportunity to walk or bike for many errands, as well as combine a trip to transit with other stops. Streets lined by trees and building entries also help to make the TOD environment “pedestrian-friendly.” Although focused on reinforcing transit, such land use configurations would equally support carpools and more efficient auto use. Given historic development trends and projections for the future, each of these travel modes can play an important role in solving a city’s or region’s increasing traffic problems.

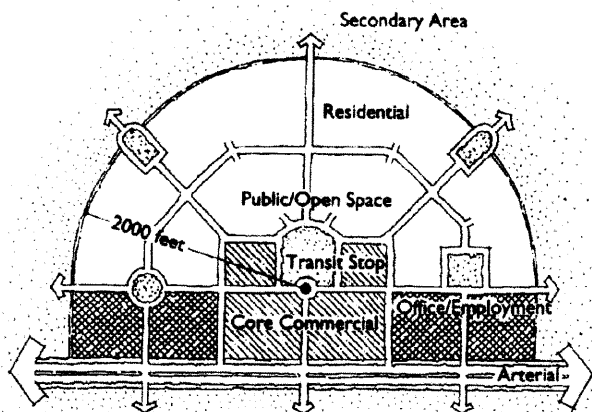
Transit-Oriented Developments can, and ironically should, develop without transit – with a justifiable focus on the pedestrian and a healthier community structure. More walkable, integrated communities can help relieve our dependence on the auto in many ways other than just transit. Reducing trip lengths, combining destinations, carpooling, walking, and biking are all enhanced by TODs. A healthy walking environment can succeed without transit, but a

⁹ Calthorpe, Peter. (1993). *The Next American Metropolis: Ecology, Community and the American Dream*. New York: Princeton Architectural Press, p.56.

transit system cannot exist without the pedestrian. The growth of such pedestrian-friendly developments, if coordinated at a regional scale, can form the armature for future transit growth. In fact, this type of development must precede, not just follow, the growth of our transit networks. TODs can exist without transit, but our transit systems have little chance of surviving in the low-density environment of sprawling suburbs without TODs.

The fundamental structure of the TOD is nodal – focused on a commercial center, civic uses, and a potential transit stop. This nodal quality is the result of the contemporary bias of retail to develop in distinct “packages,” the spacing requirements of transit stations, and the qualitative need for an identifiable social center in our neighborhoods and districts. This is in sharp contrast to the linear form which used to dominate the form of grid towns or strip commercial suburbs. Defined by a comfortable walking distance, the TOD is made up of a core commercial area, with civic and transit uses integrated, and a flexible program of housing, jobs, and public space surrounding it. The densities and mix of these primary uses, though controlled by certain minimums, is determined by the specifics of each site and economy. Surrounding the TOD is a Secondary Area for low-density uses, the large-lot single-family residences, schools, larger businesses, and major parks.

Figure 1-6. Transit Oriented Development



Source: *The Next American Metropolis: Ecology, Community and the American Dream* (1993)

In summary, the principles of Transit-Oriented Development are to:

- Organize growth on a regional level to be compact and transit-supportive;
- Place commercial, housing, jobs, parks, and civic uses within walking distance of transit stops;
- Create pedestrian-friendly street networks which directly connect local destinations;
- Provide a mix of housing types, densities, and costs;
- Preserve sensitive habitat, riparian zones, and high quality open space;
- Make public spaces the focus of building orientation and neighborhood activity;
and
- Encourage infill and redevelopment along transit corridors within existing neighborhoods.

1.3.1.2. Difference between Planned Unit Development and TOD

There are many “mixed-use” Planned Unit Developments and Master Planned Communities which speak of similar goals but employ fundamentally different planning principles. These strategies, which have dominated the “progressive” side of sprawl for some time now, differ from TODs in several significant ways. First, while they typically have a mix of uses, they unfortunately separate these uses into individual development zones segregated by major arterial roadways and property lines. This segregation often makes walkable connections weak.

Second, they tend to isolate the pedestrian from the street, either on greenways or designated paths, leaving the street solely for auto use. Third, they still employ a hierarchy of streets, focusing congestion by forcing traffic onto the arterial network. Fourth, they continue to design neighborhood streets for the convenience and speed of auto rather than for a mix of uses and slower traffic. And finally, they reverse the hierarchy of public and private space by facilitating an architecture of autonomous “objects” rather than an architecture which helps define and create memorable public places.

TODs not only promote alternates to auto use, but can be a formula for affordable communities – affordable in many senses. Communities are affordable to the environment when they efficiently use land, help to preserve open space, and reduce air pollution; they are affordable for diverse households when a variety of housing types, at various costs and densities, are encouraged in convenient locations; they are affordable to families with limited incomes when the mix and configuration of uses allow reduced auto dependence and auto-related expenses; they are affordable to businesses seeking to relocate when the workforce can be freed of the gridlock and high housing costs typical in many growing metropolitan regions; and they are affordable to the public taxpayer when infrastructure is efficient, and public amenities are well-used.

1.3.2. Sustainable Development

Recently, a wide range of issues have been addressed relevant to building sustainable communities, including economic development and jobs, social infrastructure, transportation, public participation and housing and land use. Of these various issues, in the area of land use, one of main approaches adopted in creating a sustainable community involves much of mixed-use development.

While it is not possible to day to point to a list and say, “These communities are sustainable,” the emerging ideal of sustainable communities is a goal many are trying to achieve. And while there is no single template for a sustainable community, cities and towns pursuing sustainable development often have characteristics in common.

In an aspect of community design planners design new communities and improve existing ones to use land efficiently, promote mixed-use and mixed-income development, retain public open space, and provide diverse transportation options to integrate the places in which people live and work with the natural environment.

In fact a variety of areas within planning have been steadily converging in their calling for development which would reunite land uses heretofore labeled once incompatible and

separated by modern zoning codes in an effort to cut down on the host of problems that have come accompanied our sprawling out over the landscape.

Apart from many well-known problems caused by sprawl, sprawl costs us our sense of intimacy with our community, our time spent in social contact with others. It is one of main perspectives that sustainable community development tries to overcome and recover the sense of community. For our current patterns of development are built in isolation between activities and isolation between individuals as we continue to eliminate the common space for interaction within our communities and replace them with impersonal auto strips and subdivisions. Isolating uses, and reliance on the auto has resulted in our lively shared spaces disappearing. Streets become not places of human interaction, but simply pedestrian hostile roads for us to zoom down in our cars.

The future of railways looks good too. International environmental agreements such as those made by many world governments at the Rio Summit of 1992, and the increasing imperative to move towards more sustainable patterns of urbanization, have fuelled a return to rail investment. The reasons are obvious: railways provide transport of goods and people at less energy cost than most other forms; new technology is making rail movement cheaper, faster and smoother; and roads take more land, cause greater pollution and are more dangerous than travel by train.

2. Concepts of Transportation Nodes with High-density Mixed-use

2.1. Functions of Stations and Urban Transport in Urban Realm

2.1.1. Roles and Function of Transportation Nodes in Urban Realm

Stations are one of the most important modern building types. They perform a variety of functions, besides giving access to trains: they are shopping malls, meeting places and urban landmarks. Like airports, stations are distinctive and complex places – helping to shape and define the cities they serve by their social, cultural and functional interactions. The transportation nodes can be defined as a simple formula below:

$$\text{Density} + \text{Mixed-use} + \text{Transit} + \text{Amenities} = \text{Transportation Nodes}$$

Major stations are great economic magnets, which draw investment to their hinterland. Unlike airports, railway stations promote the regeneration of town centers not city edges.¹⁰ And, as people travel from city center to city center by train, rather than from suburb to suburb, the effect is to reinforce town centers as hubs of culture and commerce, as against city edges, which car travel tends to support. Therefore, railway stations usually are in the center of the city, not the suburbs. And this effect is to make railways part of the fabric of cities, not appendages at the edge. This quality makes stations great gathering places, urban gateways for floods of arriving and departing passengers, who do not usually stay long in stations but experience them in passing.

From past to present, railway stations have been a vital part of what makes places into great cities. The magnificent passenger stations in Tokyo, Washington and Milan were built in response to economic and political ambitions in the nineteenth or early twentieth centuries, and gave their cities symbolic presence. The great masonry and glass railway stations converted otherwise worthless urban land (often slum-ridden, derelict areas) into highly desirable

¹⁰ Edwards, Brian. (1997). The Modern Station: New Approaches to Railway Architecture. London: E & FN Spon, , p.3.

locations. They were external magnets drawing enterprise to their doorsteps, and internal commercial centers with shops, hotels and bars grouped around a grand civic space.¹¹

The modern railway station is a place where tourists, commuters, salesmen, retailers, and train spotters converge. Just as the nineteenth-century termini attracted shoppers and political activists, today's railway stations recall retail malls and hotel foyers. They are the point in the city where the greatest variety of land uses coalesce in the smallest most intense enclosed area.

And also as the function of stations has shifted from single transportation function to multi-functionalism, this change in function has led to complex and diverse station forms. Stations are no longer isolated landmarks surrounded by a sea of parking, taxiing and service areas, but structures that stand in streets and form continuous frontages with housing, offices, shops and warehouses.

Figure 2-1. A Picture of Light Rail Station with Open Space: Center of Activity, Both Social and Commercial



Source: *City Routes, City Rights* (1998)

A traditional street offers a well-balanced set of conditions. It is not just a channel for movement but a social space, where people live over shops that front right onto streets and have the opportunity to meet each other frequently on street corners. It is very easy to imagine the series of daily routines that occur in that kind of setting. In this century, as a result of numerous

¹¹ Edwards, Brian. (1997), p. 21.

psychological, political and social changes, there has been a fundamental challenge to that kind of built form.

Transit modes can become such built form through a combination of land use policies, design initiatives aimed at strengthening the role of streets, and an emphasis on transit. Fortunately, the tall towers and large scale developments has tended to follow fairly rapidly on the heels of the subway development and then slowly the fabric has filled in with inter-mediate scale buildings that contain an almost equal ratio of people living and people working. Transit modes can play an important role in shaping urban spaces which possess the full range of rewarding urban characteristics, various activities and social contacts between people.

2.1.2. Function of Urban Transport in Urban Realm

The basic function of urban transport is to provide the link between residence, employment, and amenities and to link consumers and producers in urban commerce. The available evidence on the determinants of demand and supply in urban transport in developing countries suggests that transport demand and costs vary directly with city size; the correct design of urban transport systems and of urban land use therefore gains importance as cities grow.¹² The poor are particularly affected by transport policies because their adequate access to employment opportunities is critical and because they cannot afford to spend large shares of their limited income on transport.

As long as we continue to settle outside the boundaries of walking city centers, our dependence on mobility will remain constant or increase. The transportation is intrinsically a regional concern, intrinsically connected with urban form, and therefore, a key to shaping and guiding regional land use today.

As demand for travel grows, road congestion is forcing a realignment from motorway to railway construction. Because of greenhouse gas generation (mainly CO₂), such investment

¹² Linn, Johannes F. (1983). Cities in the Developing World: Policies for Their Equitable and Efficient Growth, London: Oxford University Press, p.xvi.

is justified in global warming terms alone. The wider case for rail, embracing a broader range of environmental and social factors, is also increasingly accepted by governments.

Transport is not a luxury but a product of economic growth. The movement of people and goods is essential for national prosperity. As motorways become more congested and air travel is restricted by community safeguards, rail emerges as the most benign of alternatives. Railways are not without their environmental and community impacts, but relatively speaking these are less than with competing systems.

In summary, transport is an essential prerequisite for modern life. The question is how to gain access to the benefits of contemporary civilization (employment, recreation, attractive housing, education) without destroying the environment of the planet, the health of city dwellers and the fabric of towns in the process. Much current policymaking at governmental level is concerned with establishing the right balance between public and private means of transport, between inter-urban and local journeys, between freedom of movement for the rich and the poor, and between able-bodied and disabled people. In urban areas, congestion is economically inefficient and environmentally damaging. Managing demand and use for road space (through pricing and traffic calming) coupled with improvement to public transport is the preferred strategy of many Western governments. Improvements to public transport entail, besides investment in various types of rail provision, support for connecting bus and tram services, and the notion of compact corridors of development along rail routes. As the switch to public transport gathers momentum, land-use planning and urban design policies will need to follow suit. Consequently, widespread low-density development will no longer be permitted or sustainable.

Not only transportation plays a key role in shaping the urban form, but also mass transit system can play a key role in diminishing some of urban problems caused by car-dependency. The next chapter will therefore talk about some of potential impacts mass transit has in urban realm.

2.1.3. Positive Impacts of Transit

Existing patterns of urban and suburban development seriously impair our quality of life. The symptoms are: more congestion and air pollution resulting from our increased dependence on automobiles, the loss of precious open space, the need for costly improvements to roads and public services, the inequitable distribution of economic resources, and the loss of a sense of community. By drawing upon the best from the past and the present, we can plan communities that will more successfully serve the needs of those who live and work within them.

The increasing imperative to move towards more sustainable patterns of urbanization has fuelled a return to rail investment. The reasons are obvious: railways provide transport of goods and people at less energy cost than most other forms (see table 2-1); new technology is making rail movement cheaper, faster and smoother; and roads take more land, cause greater pollution and are more dangerous than travel by train.

Table 2-1. Illustrative Costs of Urban Travel by Different Modes

| Mode | Speed (miles per hour) | Persons per foot-width per hour | Total cost per person (US cents per mile) |
|--|---------------------------|------------------------------------|--|
| Footway, 4 ft wide | 2.1 | 1,100 | - |
| Bicycle track, 4 ft wide | 8.0 | 450 | 0.3 |
| Urban street, 24 ft wide | | | |
| Car with driver only | 10.0 | 51 | 17.4 |
| Taxi with 4 passengers | 12.0 | 120 | 4.5 |
| Minibus with 10 passengers | 10.0 | 150 | 2.9 |
| Bus with 30 passengers | 8.6 | 300 | 2.1 |
| Urban street, 44 ft wide | | | |
| Car with driver only | 10.0 | 55 | 17.2 |
| Taxi with 4 passengers | 12.0 | 160 | 4.3 |
| Minibus with 10 passengers | 10.0 | 190 | 2.7 |
| Bus with 30 passengers | 8.6 | 410 | 2.2 |
| Urban expressway (capacity per foot- width is independent of width) | | | |
| Car with driver only | 40.0 | 180 | 16.4 |
| Taxi with 4 passengers | 40.0 | 720 | 4.1 |
| Minibus with 10 passengers | 40.0 | 1,200 | 2.6 |
| Bus with 40 passengers | 40.0 | 2,000 | 1.5 |
| Subway (22,500 passengers per hour) | 21.0 | 1,700 | 3.9 |
| Urban rail way (22,500 passengers per hour) | 30.0 | 1,700 | 2.2 |

Source: World Bank (1975)

Fundamental problems caused by heavy reliance on automobile are traffic congestion, its attendant air and noise pollution, and energy consumption. However, it is unfortunately true in most developing country cities that travel time and environmental quality are likely to be valued less at lower income levels than at high income levels. More important, they are likely to get worse in the years ahead without comprehensive planning with transit integrated and adequate provision of mass transit systems.

The primary transportation benefit of building places that are more friendly to transit users and pedestrians is that they could convert more automobile trips to transit trips. Such shifts would in turn likely produce a number of secondary benefits:

2.1.3.1. Better Environmental Quality

Smog in our cities is threatening our health. Increasing levels of respiratory disease, especially asthma, are being blamed on smog. By far the biggest source of smog-producing emissions is the motor vehicle. Therefore, excessive car use means high levels of photochemical smog and greenhouse gases. Both smog and greenhouse gas emissions are directly linked to the amount of fossil fuel energy used.¹³

Figure 2-2. Smog Emissions



Source: Winning Back the Cities (1992)

Ridership increase in mass transit systems could relieve traffic congestion along roads and reduce automotive tailpipe emissions. Communities with a mix of jobs, housing, and shops nearby as well as within walking distance of transit stops could further reduce air pollution to

¹³ Newman, Peter, Kenworthy, Jeff and Robinson, Les. (1992). Wining Back the Cities. Leichhardt: Pluto Press Australia Limited, p. 4.

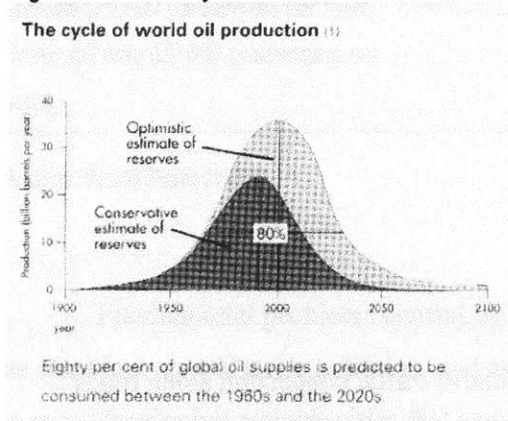
the degree there are fewer short automobile trips. To the degree transit-supportive development induces more walk access, it could yield important air quality benefits.

When one commuter leaves the car behind and uses transit to travel to and from work for one year, the health of millions of people can be improved through the removal of nine pounds of hydrocarbons, 63 pounds of carbon monoxide, five pounds of nitrogen oxides and one pound of particulates, annually.

2.1.3.2. Energy and Resource Conservation

Transit buses operate at about 125 passenger miles per gallon of fuel, commuter trains 200 passenger miles per gallon and private automobiles 32 passenger miles per gallon.¹⁴ A saving of ten to 15 gallons of gasoline is realized every time 40 single-passenger-car drives take a 10-mile trip to work on the bus. 30-40 million gallons of gasoline would be saved each day if average commuter-vehicle-occupancies were increased from 1.1 passengers per vehicle to 2.1 passengers per vehicle.

Figure 2-3. The Cycle of World Oil Production



Source: Winning Back the Cities (1992)

¹⁴ Lincoln, "Energy Conservation," *Science*, 13 April 1973, p. 157.

Private automobiles are relatively energy intensive and probably account for a significant share of the increase in gasoline consumption in many developing countries. Lack of adequate data prevents a careful analysis of this problem, but the recent policy switch to an emphasis of bus mass transit as the answer to the urban transport problem in Brazil has been motivated substantially by the objective of energy conservation (1978 World Bank data). Therefore, using transit and leaving car behind would be an important step in reducing oil use.

Moreover, transit-oriented developments also generally promote infilling and densification, thus helping to preserve natural resources, including open space and agricultural land. Physical and social infrastructure costs could also be contained to the extent that development is less sprawled.

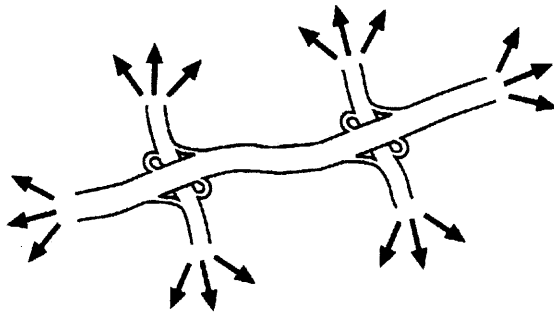
2.1.3.3. Economic Growth

Large number of people would be concentrated at specific spots, and activities would become linked to the stops. Public transport induces changes in station areas that often would not occur if no public transport were there. The permanence of rail transit lines and stations generates the developments.

Stations are important economic catalysts. Transit-oriented developments could also be a catalyst to urban redevelopment. When combined with other social programs like job training, developments with good transit services could encourage more private investments in decaying urban centers.

How rails concentrate developments can be best seen by comparing rail systems with freeways. Freeways usually lower the value of much land along their routes, and disperse commercial developments to their ends. Freeways outlets are favored sites for car-based shopping centers, malls etc.

Figure 2-4. How Freeways Disperse Development

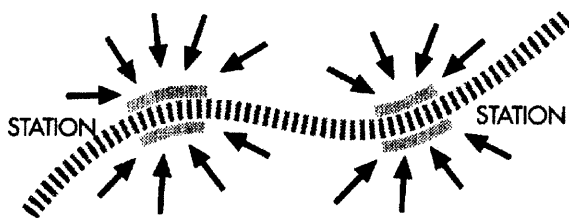


How freeways disperse development.

Source: Winning Back the Cities (1992)

Rail systems, on the other hand, increase land values all along their routes, and concentrate commercial development and compact housing around stations. In this ways, rail systems encourage more even development, with nodes of life, commercial activity and jobs clustering around each suburban stations, while freeways disperse development over wide areas usually only reachable by car.¹⁵

Figure 2-5. How railways concentrate development.



How railways concentrate development.

Source: Winning Back the Cities (1992)

Every \$10 million in transit capital investment supports 770 jobs; every \$10 million in transit operating investment supports 960 jobs. Every \$10 million in transit capital investment

¹⁵ Newman, Peter, Kenworthy, Jeff and Robinson, Les. (1992). Winning Back the Cities, Leichhardt: Pluto Press Australia, p. 22.

produces \$33 million in business revenues. Every \$10 million in transit operating investment produces \$30 million in business revenues.

2.1.3.4. Other Impacts

(1) Traffic Congestion Relief

Every bus full of passengers at rush hour removes 40 cars from traffic; every full rail car removes around 75-125 cars from traffic.

(2) Social Equity

Transit-oriented development would also provide more live-travel options for older people and empty-nesters, disabled persons, and other transit-needy groups. Rather than living in an auto-oriented suburbs, more people might opt to live or work in a transit-oriented traditional setting if given the choice.

Current urban transport policy in many developing countries benefits the wealthy groups, particularly those owning automobiles, while it fails to respond to the needs of the urban poor. Most of the transport policies suggested in this section on the grounds of efficiency would also improve the welfare of the urban poor.¹⁶

(3) Employment Generation

Little is known on the employment effects of alternative urban transport strategies, but on balance it would appear that de-emphasizing automobile ownership and use in favor of public transport, especially if the public transport does not involve high-technology rapid transit facilities, will increase employment.

¹⁶ Linn, Johannes F., (1983). *Cities in the Developing World*. London: Oxford University Press, p. 87.

In summary, transit-supportive development offers an opportunity to help redress some of the nation's most pressing urban problems, including air pollution, shortages of affordable housing, traffic congestion, inner-city decay, physical barriers to mobility, and costly sprawl. These secondary benefits will be limited, of course, by the degree to which residents, workers, and customers of transit-oriented developments actually patronize transit.

2.2. Case Studies of Transportation Nodes with High-density Mixed-use

2.2.1. Public Transport system in Hong Kong

“ The main objective of the internal transport policy is to maintain and improve mobility of both people and goods through an integrated, multi-modal transport system. ”

Commissioner for Transport: Hong Kong Annual Departmental Report, Transport Department, 1986.

In Hong Kong total area of land is 1,095 square kilometers with total population reaching almost 6 million. Population density is measured to be around 5,500 people per square kilometer. The urban land-use pattern is served by a high-capacity, multi-mode transport system with high-density development concentrated around major interchanges.

A major role of the Hong Kong government has been to maintain efficient infrastructures so that economic growth can be supported. The most important component of the infrastructure is undoubtedly an internal transport system which can provide a high degree of mobility for passengers and freight. In Hong Kong, the physical structure of a city, its size and spread, its way of life and character are all dependent on the nature and quality of its transport system. In other words, different types of land use can generate demands for different types of transport, and transport planning in turn has played an important role in shaping the land use development of a city.¹⁷

Hong Kong's hilly topography and highly fragmented land use configuration place a major challenge to transport system planning and traffic management in the area. Dispensing the usual *laissez-faire* attitude, the government has applied strong regulations to the transport

¹⁷ Lo, C.P., (1992). Hong Kong, R.J. Johnston and P. Knox (ed.), London: Belhaven Press, p.68.

sector. The policy objectives have been focused on the most efficient movement of goods and people to meet the region's needs of export-oriented industrialization and to copy with the great diversity of land use. Despite the topological constraints and large travel demand, Hong Kong's transport planning and traffic management have been regarded as successful, with efficient services through road, rail ship, air transport and telecommunication systems.

The public transport system has been heavily regulated by the government through its Transport Department. It has been government policy to give priority to public transport and to allow healthy competition among different modes of public transport to promote efficiency in order that no direct subsidy need be given.

Hong Kong has an efficiently operated multi-modal public transport system in various forms of rail, bus, ferry and taxi services. The rail carriers include the Mass Transit Railway (MTR, with a 43 km route and 38 stations by 1992), the Kowloon-Guangzhou (Canton) Railway (KCR, a commuter rail and freight carrier), Hong Kong Tramways, the Peak Tramways and the Light Rail Transit (LRT) system (with a 30 km route). Bus services are provided in the form of franchised bus companies by the Kowloon Motor Bus Company operating in Kowloon, the China Motor Bus Company operating on Hong Kong Island, Public Light Bus, and the Residents' Coach Services. Buses have been the most important means of public passenger transport and account for about 43 percent of the total 9.1 million passenger journeys by 186 figure. Ferry transport service providers are Star Ferry and the Hongkong and Yaumati Ferry Companies for both passengers and vehicles.¹⁸

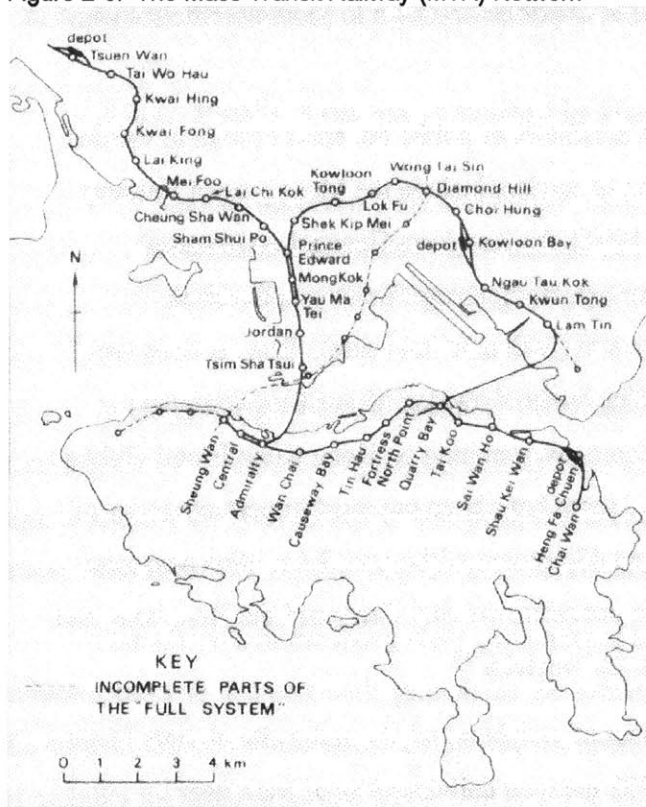
Every day Hong Kong, enormous masses of people travel about the city, mainly to get to and from work or to and from school. In 1992 the total daily number of passenger movements by all forms of public transport was a staggering 9.9 million, of which 4.1 million were by franchised buses and street trams, 0.24 million by ferries and 2.6 million by the MTR and KCR passenger rail systems. And, at some point, all these passengers have to walk to/from their destinations.¹⁹

¹⁸ Lo, C.P., (1992). p.70.

¹⁹ Lo, C.P., (1992). p.70.

The MTR has had a major influence on Hong Kong's pattern of life and economic activity. The reliability and high capacity of the system have made many station locations an attractive focus high-density residential and commercial development, some undertaken by the Corporation itself in partnership with private developers. Time is a valuable commodity in Hong Kong, and the certainty provided by the MTR is in great contrast to road-based forms of transport, which, at peak hours and during inclement weather, are delayed by congestion.

Figure 2-6. The Mass Transit Railway (MTR) Network



Source: [Hong Kong](#). (1992)

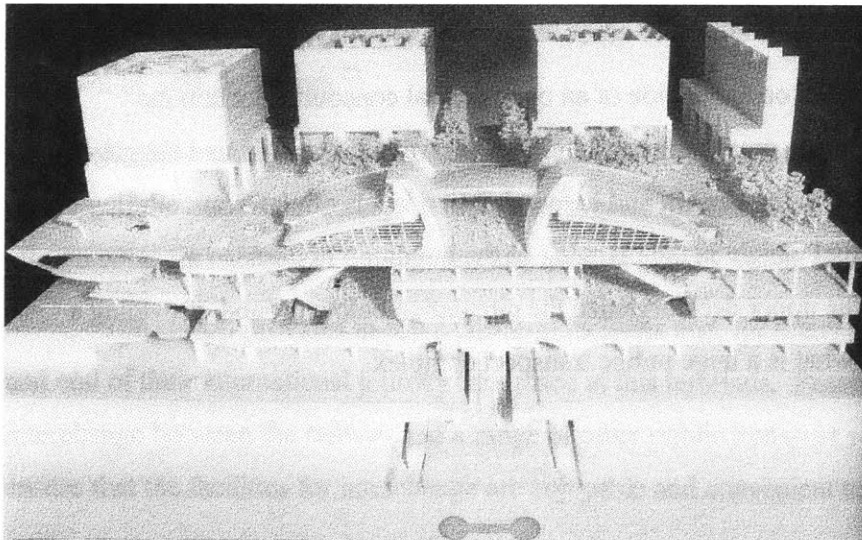
The high-density form of urban development in Hong Kong keeps close community interaction and economizes on the use of scarce, developable land resources. It creates a compact and convenient city structure that facilitates community and business activities, promotes pedestrian movements and sustains the viability of multi-mode transport services and other essential services. And it provides opportunities for urban designers to create visually exciting and innovative projects incorporating the latest technology.

It seems Hong Kong offers some valuable attributes for other urban societies to consider. City living is a growing destiny for people throughout the world and, since land suitable for urban growth is an increasingly scarce commodity, there needs to be an enhanced willingness to explore new approaches.²⁰

The stations on the new line are being designed in association with major, private property development schemes. These helps to optimize the benefits of rail travel, create new focal points for urban activities and, by value enhancement, help support the financial viability of the railway. Five development projects are currently being planned by the MTRC, totaling 62 ha. of land on which will be developed about 24,000 apartments; 1.33 ha. of this land will be for commercial/office uses. One of the key projects is a 14 ha. site on the newly formed West Kowloon reclamation, which will act as the principal rail terminal serving the Kowloon peninsula. That is Kowloon Airport Station.

2.2.2. Kowloon Airport Station

Figure 2-7. Model of the Station



Source: Architecture of Rail. (1995)

²⁰ Lampugnani, Vittorio Magnago (ed.), Hong Kong Architecture: The Aesthetics of Density, Munich: Prestel, 1994, p.139.

Table 2-2. Key facts about Kowloon Airport Station

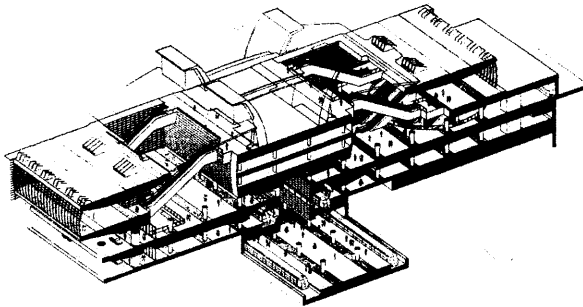
| | |
|---------------------|-----------------------------|
| Size of the station | 45,000 sq. meter |
| Total site area | 14 ha |
| Dwelling units | 4560 residential apartments |
| Office Spaces | 228,000 sq. meters |
| Commercial area | 126,000 sq. meters |
| Overall plot Ratio | 7.8 |

New stations are often multiple interchanges where heavy rail, light rail, bus and taxi facilities meet. Here at Kowloon Station, designed by Terry Farrell and Partners, commercial and public interests overlap, making the station a new mode of Hong Kong's economy.

The airport railway station at Kowloon, Hong Kong, seeks to integrate within a single megastructure a railway station, bus station and car parking. Designed by Terry Farrell and Partners, the station also includes the development of air rights over the station to include four hotels, apartments, offices and retail space. The design is of value as an illustration of the increasing diversification of land uses at modern stations. Not only is the station itself an array of different uses and functions, but the adjoining land has grown into a mini-city of disparate uses drawn by the magnet of the station.

A pair of large flat arches on either side of an open central concourse contain the ticketing and transport interchange areas of the station. Below ground, check-in and baggage-handling facilities are provided to the airport, and below that two levels of platforms. Railway and airport links are given equal weight in the planning of the building. Pedestrian movements and urban spaces placed on the upper deck organize the circulation below ground, providing a backcloth of civic values for what is a huge public transport complex.

Figure 2-8. Axonometric Section through Station Roof, Concourse and Rail Tracks



Source: Architecture of Rail. (1995)

The emphasis upon the airport station as a small city in its own right is reinforced also by the placing of eight tower blocks, which help to define the central civic space. The effect of the high buildings (containing hotels, offices, apartments, etc.) is to form the limits of a large square, into which the station sits.²¹

Light is taken down to the lowest levels of the station by clever manipulation of the building section. The complex program of functions is contained not within a single rectangular building but in an open framework of elements beneath the curved roof. Light is taken into the catacombs of the platforms via diagonal paths of deflected daylight. The arrangement benefits from the use of a central spine of station offices, whose curved glazed walls act as light deflectors.²²

Kowloon Airport Station promises to be one of the most ambitious stations of the latter decades of the twentieth century. It embodies greater functional complexity than almost any other station, and it does so with an unusual level of density of site occupation.

The station provides in-town check-in facilities and, for many air passengers, the start and end of their international journey take place at this terminus. Passengers are able to interchange between the railway and a range of other public transport services. One aim is to ensure that the facilities for interchange are enjoyable and convenient to use. This should

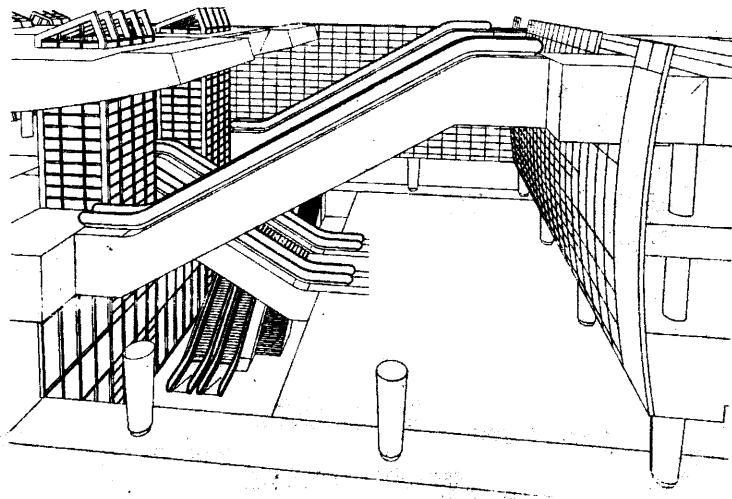
²¹ Edwards, Brian. (1997). The Modern Station: New Approaches to Railway Architecture. London: E & FN Spon, p. 143.

²² Edwards, Brian. (1997), p. 143.

encourage more people to travel to the airport by train rather than by road-based services, which at times have to contend with congestion and add to air pollution levels.

The station has separate arrival and departure halls linked by a mezzanine level in the center (see figure 2-9) that connects vertically to the main pedestrian entrance. The station forms the core of the entire project, which will contain a major new shopping center for Kowloon and residential blocks above a landscaped podium.

Figure 2-9. Separate Arrival and Departure Halls (Linked by a mezzanine level in the center)



Source: Architecture of Rail. (1995)

2.2.3. Public Transport System in Singapore

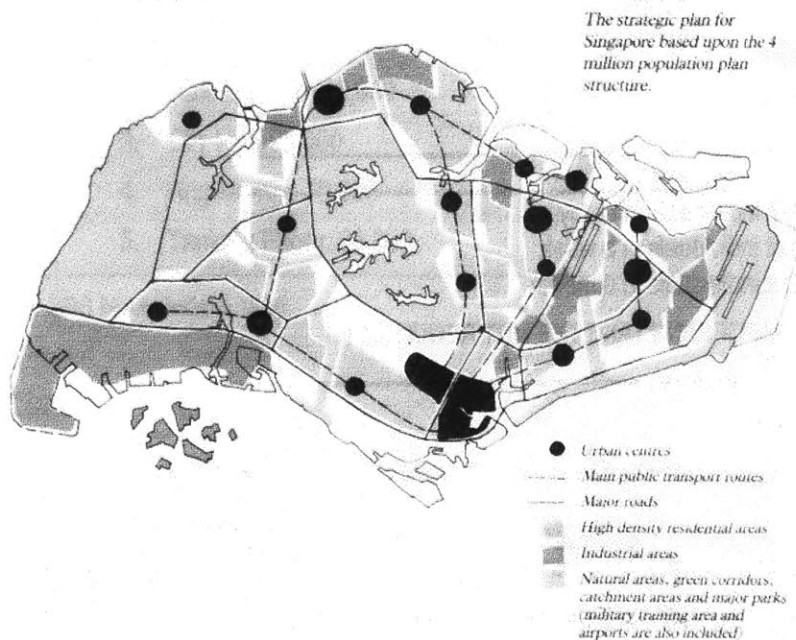
“ To provide a quality, integrated and efficient land transport system which meets the needs and expectations of Singaporeans, supports economic and environmental goals, and provides value for money. ”

Land Transport Authority of Singapore, 1995.

Singapore is a country where the demand for land is immense. Total area of land is only 585 square kilometers while total population reaches almost 4 million. Population density is around 6,800 people per square kilometer. Consequently planning policy in Singapore has been driven by the goal of land use optimization, intensifying site density by increasing the floor area ratios on individual land parcels upon development.²³

Singapore, one of the most densely populated islands in the world, boasts an excellent modern light rail network. The system is run by Singapore Mass Rapid Transit (MRT), a company which was incorporated in August 1987, and serves the city's major high-density travel corridors. This Company's Mission is to provide mass rapid transit passenger service along major high density travel corridors in Singapore in order to satisfy the needs of the traveling public for a safe, reliable and user-friendly MRT system at competitive fares.

Figure 2-10. Strategic Plan Map of Singapore



Source: Kampong Bugis Development Guide Plan (1990)

²³ Chan, Clare S. (1999. *Measuring Physical Density: Implications on the Use of Different Measures on Land Use Policy in Singapore*. Cambridge: MIT, p. 19.

1.673 million or 62% of the Singapore population travel on the MRT. Total MRT ridership has increased year after year, thus making MRT one of the fastest growing medium.

The MRT medium reaches out to a wide range of audience and enjoys the following audience ridership profile :

Table 2-3. Audience Ridership Profile of Singapore

| | Total population | MRT Audience Reach | % of total Population |
|---|------------------|--------------------|-----------------------|
| The young aged 15-34 years | 1,092,000 | 802,000 | 73 |
| Females | 1,350,000 | 895,000 | 66 |
| Males | 1,358,000 | 778,000 | 57 |
| Professionals, Managers or Executives | 459,000 | 284,000 | 62 |
| White-collar workers | 454,000 | 331,000 | 73 |
| Workers earning personal income above \$1,500 per month | 1,012,000 | 581,000 | 57 |
| Students | 294,000 | 250,000 | 85 |
| Holders of Diplomas/Degrees | 488,000 | 318,000 | 65 |

Source: SRS Media Index 1997

Ridership of Mass Transit in Singapore

- 560,000 distinct individuals in a day
- 1,240,000 distinct individuals in a week
- 1,673,000 distinct individuals in a month

EVERY 6 OUT OF 10 SINGAPOREANS TAKE THE MRT REGULARLY
Base: Adults 15+ (2,708,000)

Source: SRS Media Index 1997

Until late 1997, the system comprised a basic network of four lines, giving a total route mileage of 83km (50 miles). Of this, just over 60km (40 miles) is above ground, 19km (12.5 miles) underground, and 3.8km (2.2 miles) at street level. Before the extensions were inaugurated, the network had 48 stations, two-thirds of which were on the above-ground sections. In that year, two extensions to the network were announced, to take it to Dhoby Ghaut

in the north-east of the city, and from Xilin Avenue, again north-eastwards, to a new terminus at Changi Airport.²⁴

Table 2-4. Statistics about the Stations

Source: SRS Media Indexs 1999

Singapore's land transport strategy rests on four fundamental pillars.

(1) Integrated Land Use and Transport Planning

The first of these pillars is an increased emphasis on integrated land use and transport planning. In town planning, there is a conscious effort to minimize the number of trips needed for work and other activities. Basic amenities and facilities such as schools, shops and recreation centers are thus located within easy reach in every major housing estate. Transport

²⁴ Land Transport Authority, Singapore. (1997)

systems will also be planned and built to better integrate with one another so that transfers between different modes of transport are facilitated.

(2) A Comprehensive and Efficient Road Network

Currently, Singapore has a comprehensive network of some 3,000 kilometers of roads, expressways and tunnels to serve all parts of the island. The second pillar of the strategy is to further develop the road network and to optimize its efficiency through the use of advanced traffic management systems.

(3) Better Public Transport

The third pillar is to encourage greater use of public transport. Continual efforts to improve and expand the system such as the extension of the MRT network, the building of LRT feeder systems and the improvement of public transport related facilities are carried out by Land Transport Authority. The aim is to make public transport more attractive to commuters; to encourage motorists to make greater use of public transport and to ensure that public transport remains accessible, affordable and comfortable.

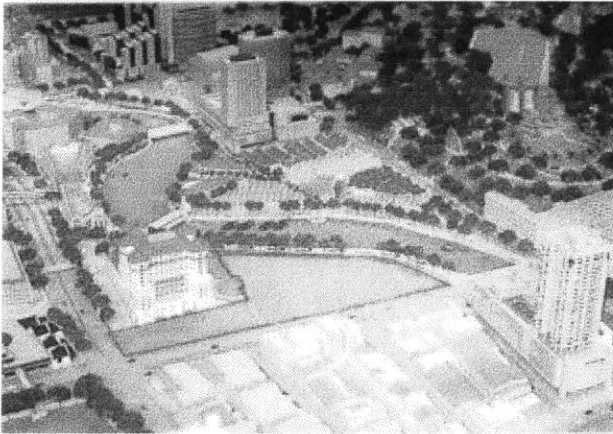
(4) Demand Management Measures

The fourth pillar is to manage a sustainable growth rate in the vehicle population. This is achieved by controlling traffic congestion through measures that allow the LTA to manage the demand for road space. Road Pricing and Vehicle Quota System (VQS) are the two key instruments used in this respect.

In summary, the Land Transport Authority aims to deliver an effective land transport network that is integrated, efficient, cost effective and sustainable to meet the nation's needs and to plan, develop and manage Singapore's land transport system to support a quality environment while making optimal use of our transport resources and safeguarding the well-being of the traveling public. LTA also aims to develop and implement policies to encourage commuters to choose the most appropriate transport mode.

2.2.4. Clarke Quay MRT station in Singapore

Figure 2-11. Site of the Clarke Quay Station in Singapore



Source: Land Transport Authority, Singapore (1998)

Table 2-5. Facts about Clarke Quay Station

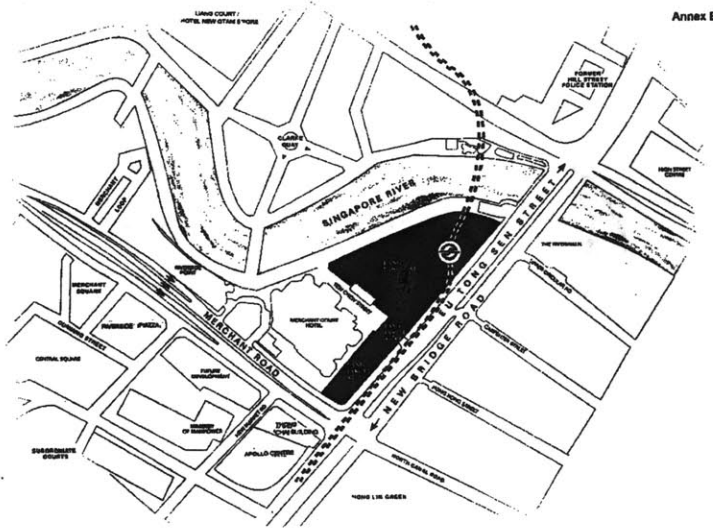
| | |
|------------------------------------|---|
| Total Site Area | 13,853.1 |
| Gross Floor Area (m ²) | 77,577.36 m ² |
| Total Building Coverage | 12,403.9 |
| FAR | 5.6 |
| Main Uses | Commercial residential transit and/or hotel |

Source: Land Transport Authority, Singapore (1998)

The Clarke Quay Station is located along the historic Singapore River having prime river and road frontages. The site being one of the last available development sites in the Clarke Quay area offer the enterprising developer the potential for a development with an exciting mix of commercial, residential and hotel uses.

Located close to the renowned Raffles Place and culturally rich Chinatown, well served by the major arterial roads and expressways and fully integrated with the North-Eastern MRT line, the site is easily accessible from all part of Singapore.

Figure 2-12. Site Map of the Clarke Quay Station



Source: Land Transport Authority, Singapore. (1998)

The 1.3 ha site of the station was sold as a “white” site to allow the successful developer maximum flexibility to decide on the best mix of commercial, residential and hotel uses. A high-rise landmark development with approximately 77,000 sqm of gross floor space is envisioned.²⁵

From the underground station, to the tree-lined river front promenade and the all-weather covered links to adjoining development, the pedestrian-friendly features of the development on the site hope to be endeared to users, thus promising a large catchment and tremendous opportunity for business.

With some 77,000 sqm of floor space, the site is zoned into “white zones” in which the developer has complete freedom in deciding on the best mix of commercial, hotel and residential uses for a successful development.

²⁵ Urban Redevelopment Authority (1998), Singapore.

Figure 2-13. Model of the Clarke Quay Station



Source: Land Transport Authority, Singapore. (1998)

3. Developing Prototypes of Transportation Nodes with High-density Mixed-use

3.1. The Main Idea of Design of Transportation Nodes

The main concept is to design transportation nodes in such a way to promote mixed-use development with high density, retain public open space, and provide diverse transportation options to integrate the places in which people live and work with the natural environment.

The ultimate goal is to build a new neighborhood. Transportation nodes would be centrally located, close to amenities and within walking distance of the city's major centers of employment, entertainment, and relaxation. Transportation nodes would contain the construction of both market-rate and affordable housing for city residents. It is hoped that the presence of the residents would help ensure that downtown of the city becomes a vibrant mixed-use district that would help meet the city's increasing demand for both market-rate and affordable housing.

3.2. The Critical Aspects of Form of Transportation Nodes

There are three vital factors to consider in judging adequacy of the form of transportation nodes in urban center. The first of all is the magnitude and pattern of the structural density (the ratio of floor space in buildings to the area of the city). This aspect can be illustrated on a map by plotting the locations of the various classes of density ranging from high concentration to wide dispersion.

A second factor is the capacity, type, and pattern of the facilities for the circulation of persons, road, railways, airlines, transit systems, and pathways of all sorts. Circulation and intercommunication perhaps constitute the most essential part of a city, and the free movement of persons happens to be the most difficult kind of circulation to achieve, the service most susceptible to malfunction in a large urban areas.

The third factor that makes up the spatial pattern of a city is the location of fixed activities that draw on or serve large portions of the population, such as large department stores, office and so on in the stations. The spatial pattern of a city made up of the location of fixed activities as well as the patterns of circulation and physical structure. However, the distribution of locally based activities, such as residence, local shopping, neighborhood services and education is for our purpose sufficiently indicated by mapping the density of people or of building.

When we come to analyze any one of these three elements of spatial pattern, we find that the most significant features of such patterns are the grain (the degree of intimacy with which the various elements such as stores and residences are related), the focal organization (the interrelation of the nodes of concentration and interchange as contrasted with the general background), and the accessibility (the general proximity in terms of time of all points in the region to a given kind of activity or facility).²⁶

It is often said that the metropolis today is deficient as a living environment. It has suffered from uncontrolled development, from too rapid growth and change, from obsolescence and instability. Circulation is congested, requiring substantial time and a major effort. Accessibility is uneven, particularly to open rural land. The use of facilities is unbalanced, and they become increasingly obsolete. Residential segregation according to social groups seems to be growing, while the choice of residence for the individual remains restricted and unsatisfactory. The pattern of activities is unstable, and running costs are high. Visually, the city is characterless and confused, as well as noisy and uncomfortable.

Yet the metropolis has tremendous economic and social advantages that override its problems and induce millions to bear with the discomforts. Rather than dwindle or collapse, it is more likely to become the normal human habitat.

²⁶ Benerjee, Tridib and Southworth, Michael (Eds.) . (1996). City Sense and City Design: Writings and Projects of Kevin Lynch. Cambridge: The MIT Press, p. 49.

3.3. Key Principles of Designing Transportation Nodes

They are shaped according to three general principles: first, that the regional structure of growth should be guided by the expansion of transit and a more compact urban form; second, that our ubiquitous single-use zoning should be replaced with standards for mixed-use, walkable neighborhoods; and third, that our urban design policies should create an architecture oriented toward the public domain and human dimension rather than the private domain and auto scale.

3.3.1. Land Use: Mix of Uses

- Mix transit-compatible land uses on single sites and near transit stops.
- Mixes may take the form of first floor retail with office and residential above, or it may involve integrating housing, office, retail, industrial, and recreational uses over a large area.
- Encourage densities that can support transit.
- Site high-density development over and close to transit stops and routes. Densities should gradually decline with distance from the stops, and non-transit-compatible uses should be located away from transit stops.
- Situate new development along transit routes in existing urban or suburban activity centers. These centers should be mixed-use and transit-oriented in nature (or they should be gradually converted if they are not).
- A quarter-mile is usually the maximum distance that a person will walk to a transit stop; thus, new developments should be located within a quarter-mile of a transit stop, and preferably much closer where possible.

All transportation nodes must be mixed-use and contain a minimum amount of public, core commercial and residential uses. Vertical mixed-use buildings are required (at least encouraged).

A certain minimum proportion of uses is required to stimulate pedestrian activity and to provide economic incentives for developing with mixed-use patterns. The proportion of uses is based on density or building intensity. It does not preclude additional, different uses on upper floors. At a minimum, retail, housing, and public uses are required in all transportation nodes. Employment uses within the core commercial area may be used to augment these minimum uses, as market conditions permit. The public use component should include land devoted to parks, plazas, open space, and public facilities.

The mix of land uses and appropriate densities should be clarified in a community or site-specific planning process, in order to address site-related issues such as context, market demand, topography, infrastructure capacity, transit service frequency, and arterial/freeway accessibility. Special care should be taken to respect the context of the site and the character of surrounding existing neighborhoods.

If a neighborhood or employment area has local destinations within convenient walking distance, residents and employees are more likely to walk or bicycle. Furthermore, if local destinations are accessible to drivers without requiring use of the arterial street system, congestion can be reduced. The required proportion of uses is designed to encourage pedestrian activity, yet allow flexibility to create neighborhoods with different use emphases, such as primarily residential neighborhood and transportation nodes which emphasize job-generating uses or commercial users.²⁷

For example, an individual living in one of high-rise residential units on top of the station would have following conveniences:

While in his apartment, he would enjoy the view and have maximum privacy. Walking out into his corridor, he would immediately encounter local facilities such as laundry machines, nurseries, etc. He would also meet his neighbors in the corridors. Taking the elevator to the underground level, he would then take subway to schools, jobs, or on the ground level, he would find local banks, or shops.

The next table shows how much portion of retail should be supported in response to various land uses.

²⁷ Calthorpe, Peter. (1993). The Next American Metropolis: Ecology, Community and the American Dream. New York: Princeton Architectural Press, p.63.

Table 2-6. Supportable Retail Development

| Type of Use | Amount | Amount of Retail Supported |
|-------------|-------------------------|---|
| Office | 100,000 ft ² | 5,000 ft ² |
| Housing | 1,000 units | 36,000 ft ² , up to 60% - 70% in planned shopping area |
| Housing | 4,000 units | 25 – 100,000 ft ² in a neighborhood retail center |
| Housing | 12,000 units | 100 – 400,000 ft ² in a community retail center |
| Housing | 40,000 units | 500,000 ft ² or more in a regional shopping mall |

Source: Cambridge Sysyematics, Inc.

3.3.2. Site Design

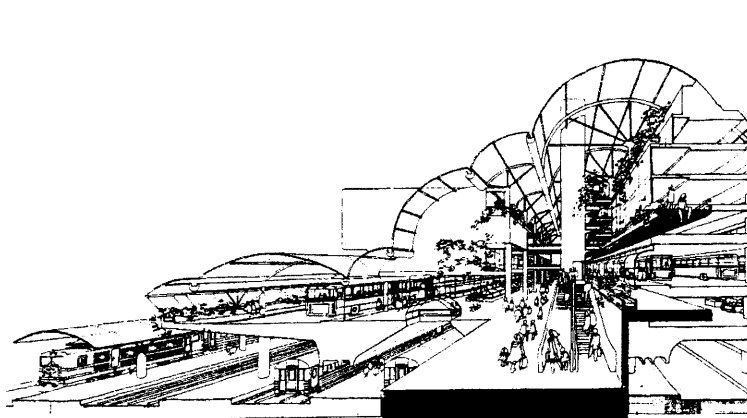
- Retail and office buildings should be located in the lower level of the transportation nodes or near the roadway (i.e. setbacks should be minimized) with parking in the back or underground.
- Pedestrian-oriented retail uses should be located along the roadway.
- Gridiron, or modified grid, street patterns are preferred to cul-de-sac or curvilinear streets. Street systems should have a clear functional hierarchy, including local, collector, and arterial streets.
- Connect neighborhoods and transit stops with direct pedestrian walkways. Where soundwalls surround a neighborhood, the wall surface should be staggered to create entrance/exit points. In the case of a cul-de-sac, walkway easements should be used to shorten the distance to nearby bus stops.
- Configure streets to allow for thorough and efficient movement of buses; avoid cul-de-sacs, branch roads, and excessive circuitry.
- Abundant free parking should be discouraged. Walking distances from parking facilities to buildings should be no closer than the nearest transit facilities.
- All buildings should be oriented toward transit stops. Front and rear lot setbacks should be modest.

- Non-connected, adjacent development parcels should be linked by pedestrian walkways or by buses when possible.

3.3.3. Pedestrian and Transit Facilities

- All geometrics on roads serving a development should be designed to accommodate transit. Special attention should be given to turning radii, road widths, and pavement depths where future bus routes are expected.
- To encourage walking, there should be generated landscaping, paved walkways, and safe street crossing.
- Link all buildings and transit stops with continuous sidewalks. Sidewalks should abut all roadways.
- Bike racks, lockers, and showers should be made available at work sites.
- Transit shelters and other transit stop facilities (i.e. route information stands, trash cans, and benches) should be appropriately sited.
- Locate bus stops at least every one-quarter mile. Also locate new developments within one-quarter mile of bus stops. Often one-quarter mile is treated as the maximum walking distance to a transit stop, although the more realistic 500-1,000 foot maximum walk for bus transit is sometimes mentioned.
- All buildings, walkways, and transit facilities should be accessible to the handicapped.
- Give transit passenger safety and security a high priority.
- Stations should link to bus interchanges and other types of modes.

Figure 3-1. Stations (linking to other types of transportation modes)



Source: Architecture and Design (April, 1985)

Comfortable waiting areas, appropriate for year-round weather conditions, must be provided at all transit stops. Passenger drop-off zones should be located close to the stop, but should not interfere with pedestrian access.

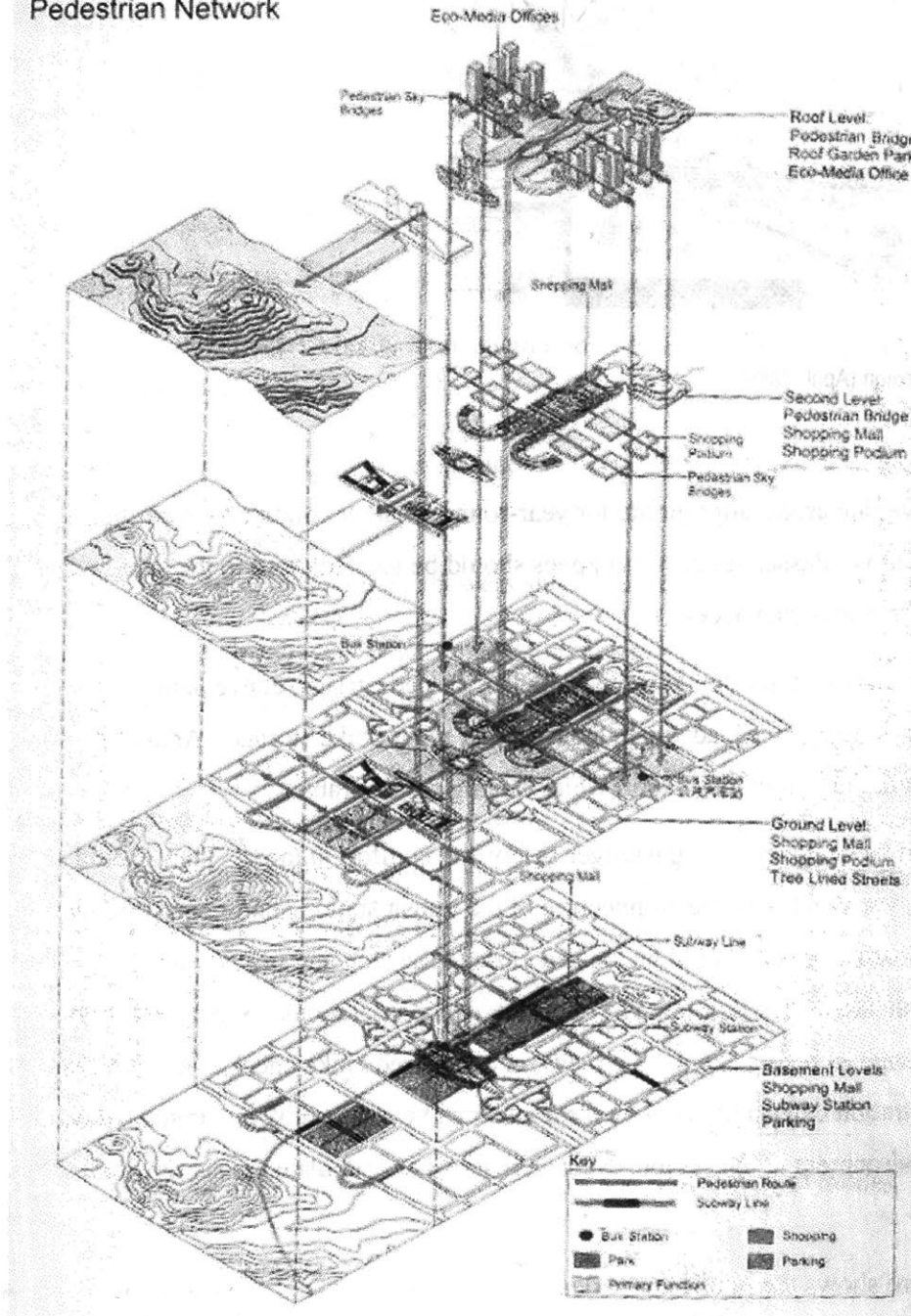
At a minimum, transit stops should provide shelter for pedestrians, convenient passenger drop-off zones, telephones, adequate lighting, and secure bike storage. Areas for vendors, small cafes, and other activities useful while waiting are desirable.

Shelters should be designed with passenger safety and comfort in mind. They should be easily recognizable, yet blend with the architecture of the transit station and/or surrounding buildings. Passenger loading zones should be located close to the stop and provide for handicapped access, but should not interfere with the transit stop operations. Secure and safe bicycle storage areas, such as bike lockers, bike racks, or monitored “bike checks,” should also be provided. The frustration caused by the wait for transit can be reduced by creating a lively, inviting, and useful environment at the station. Such activities help populate the station area, increasing safety.

The next picture shows the public space design of the central axis of Shenzhen city center in Pearl River Delta Region in China. In the city center of Shenzhen SEZ (Special Economic Zone) adjacent to Hong Kong, an open space of 3 km in length will be planned with

the new city hall. Pedestrian network is connected through pedestrian bridges, open spaces between subway station/parking and buildings on the site.

Figure 3-2. Pedestrian Network of Shenzhen City Center
Pedestrian Network



Source: New Architecture 3: Japan (1999)

3.3.4. Transit Line Location

Transit lines must help define the density, locations and quality of growth in a region. They should be located to allow maximum area for new transportation nodes, to access prime redevelopable or infill sites, and to serve existing dense residential and employment centers.

Too often transit lines are located in areas that are not transit-supportive because they have too little density, no pedestrian quality, and little opportunity for redevelopment. Lines through existing suburbs often make this mistake and become dominated by a “park-and-ride” auto access strategy. The alternative is to balance these conditions with alignments that run through New Growth Areas designed for higher densities, mixed-use, and walkability. In more urban areas, neighborhoods which have these qualities should be targeted for new transit, along with areas which could redevelop. Major employment centers, regional destinations, colleges, airports, and cultural facilities are, of course, prime focal points for any system.

A mix of station qualities is important to a successful transit line. Existing railroad or freeway rights-of-way play a large role in determining the routing of flexed-rail transit lines. In some cases this is positive, as is often the case with underutilized freight lines, which can provide sites for redevelopment and infill. Using freeway rights-of-way often precludes sites viable for mixed-use development and comfortable pedestrian access. Where necessary, these freeway alignments can form the logical location for the park-ride facilities.

3.3.5. Transit Stop Location

In general, in terms of station site choice, stations should be located where they are well connected to other aspects of urban or regional infrastructure. This means a good central location in a town, a position where bus and road access is direct in the suburbs, and where interchange is easy with other forms of public transport in a large city. It also makes good sense to choose a site with good visual links, such as how the station can be reached.²⁸

²⁸ Edwards, Brian. (1997). *The Modern Station: New Approaches to Railway Architecture*. London: E & FN Spon. p. 75.

Trunk line transit stops should, whenever possible, be centrally located and adjacent to the core commercial area. Commercial uses should be directly visible and accessible from the transit stop. Feeder bus stops may be located in Secondary Areas along connector streets and adjacent to parks and public facilities.

Accessibility is the key to successful transit ridership. A centrally located transit stop is closest to the greatest number of residents and employees. Transit stops should provide pleasant and convenient access to residential and commercial areas. In the best of all possible worlds the transit station would be in the middle of a neighborhood or a community, providing the shortest walking distances for all users.

Ideally, the transit stop should be centrally located, away from the arterial, and bus routes should loop through the community to the transit stop. The core commercial area should be located so that at least a portion of the retail is along the arterial and directly accessible from the transit stop via sidewalks and clear pedestrian connections.

3.4. Characteristics and Diagrams of Transportation Nodes

The following descriptions and figures are a result of case studies of transportation nodes with high-density and mixed-use developments in Singapore. In general main types of transportation nodes can be described in three categories: main terminal located in the center of a large city, interchange terminal and typical urban terminal.

Table 3-1. Description (Figures) 1

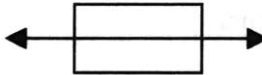

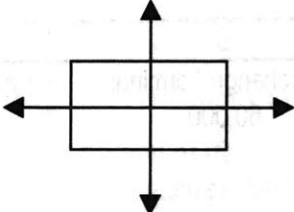
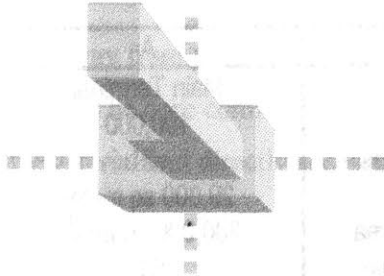
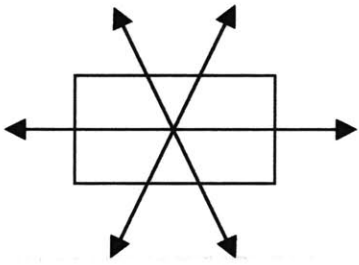
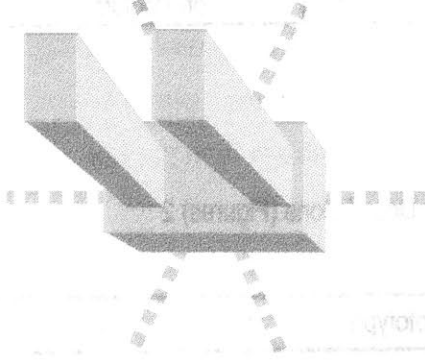
| Prototype | A | B | C |
|---------------------|------------------------------|------------------------------|-----------------------------|
| Characteristic | Main Terminal | Interchange Terminal | Typical Urban Terminal |
| Ridership | 100,000 | 60,000 | 40,000 |
| Number of Lines | 3 | 2 | 1 |
| Station Size | 29,000 sq meter | 20,000 sq meter | 13,000 sq meter |
| Gross Floor Area | 200,000 sq meter | 130,000 sq meter | 77,000 sq meter |
| Gross Plot Ratio | 6.5 | 6.0 | 5.5 |
| Site Area (approx.) | 3.2 ha | 2.2 ha | 1.4 ha |
| Massing (possible) | Detached Buildings on Podium | Attached Buildings on Podium | Single Pavilion with Podium |

Table 3-2. Descriptions (Figures) 2

| Prototype | A | B | C |
|---|---|---|--|
| Main Use | Terminal with Mix Use | Terminal with Mix Use | Terminal with Mix Use |
| Other Uses included | Commercial, Residential, Office and Parking | Commercial, Residential, Office, Educational Facilities and Parking | Commercial, Residential, Office, Hotel and Parking |
| Supportive Neighborhood Plot Ratio (mean) | 4.0 | 3.0 | 2.5 |
| Gross Neighborhood Residential Density | 180 dwelling units/acre | 150 dwelling units/acre | 150 dwelling units/acre |
| Net Gross Density (persons per hectare) | Min. 600 | 500 | >300 |

1 acre=4,046.8m²

Figure 3-3. Diagrams and Possible Massing Study

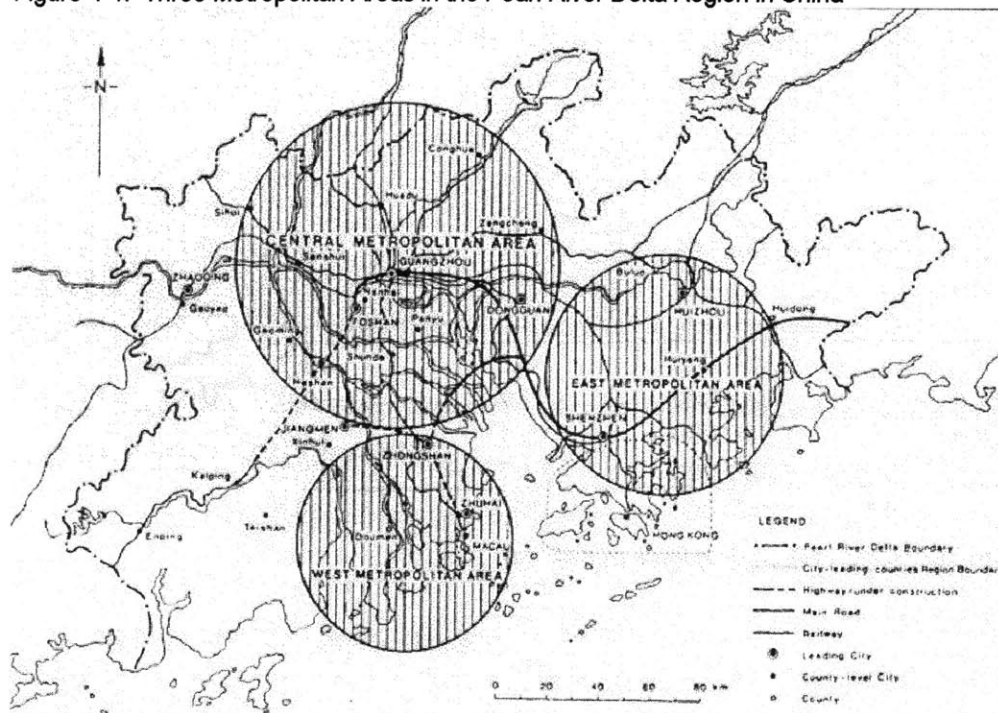
| | Diagram | Massing |
|-------------|---|--|
| Prototype C |  |  |
| Prototype B |  |  |
| Prototype A |  |  |

4. Implementation of Prototypes into Pearl River Delta Region

4.1. Conditions and Development Strategies in Pearl River Delta Region

The Hong Kong and the Pearl River Delta region, a region of 14,100km² located along the southern coast of China in Guangdong Province, has been one of the fastest growing economies of the last twenty years. However now PRD region in China has serious problems – environmental degradation, congestion, and lack of planning and intro-regional coordination.²⁹

Figure 4-1. Three Metropolitan Areas in the Pearl River Delta Region in China



Source: “The Pearl River Delta Urban System Plan” (1997)

Currently, many cities try to provide large scale or higher grade infrastructure to attract foreign investment, leading to uncoordinated urban and regional infrastructure development and waste of resources. Such a lack of coordination can be seen in the development of five new

²⁹ Lee, Tunney. “Planning Studio Introduction”. 2000.

international airports in the delta, the low density of highway and railway networks, the incompatibility of road widths between cities and an absence of consideration of high-speed transport for the whole region.³⁰

Recently a consortium has been formed to develop growth strategies and scenarios for positioning HK/PRD as a competitive city region. To develop the PRD as a major mega-urban region in Pacific Asia and to be the “dragon-head” for socio-economic development in southern China, services and industries need to be developed which will help create a healthier environment, a more productive economy, and an energetic optimistic sense of the future of the region.

Therefore, encouraging transit-oriented development in the Pearl River region has many potential benefits and possibly solve some of the current problems in this area.

Table 4-1. Distribution of City Size in the Pearl River Delta, 1993

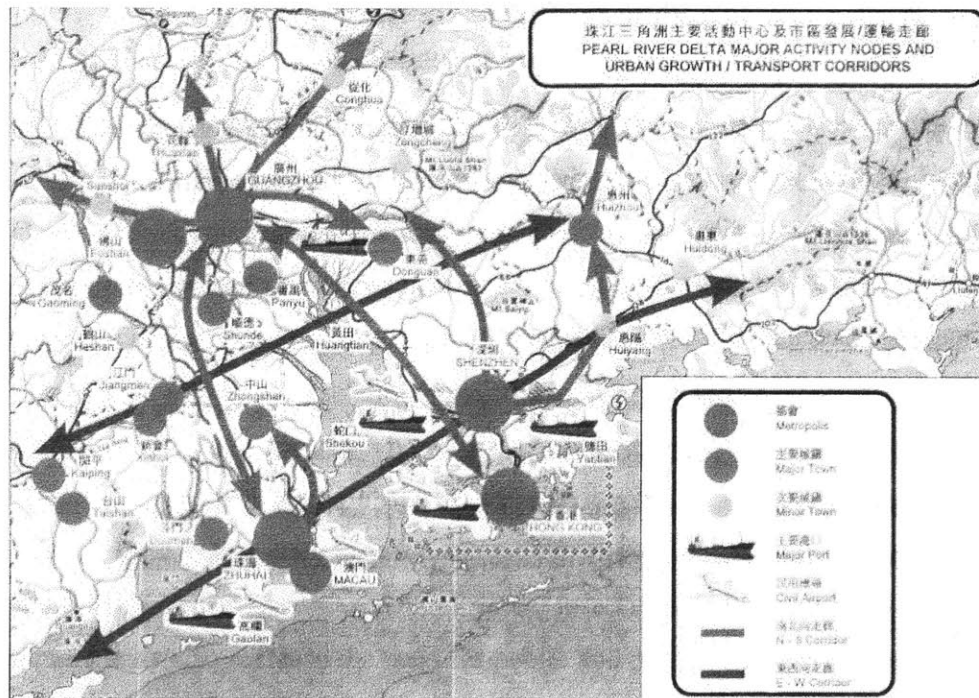
| City | Number | Population | % of number | % of Population |
|-------------------|--------|------------|-------------|-----------------|
| > 1 million | 1 | 3,037,000 | 3.8 | 40.7 |
| 0.5 - 1.0 million | 1 | 641,000 | 3.8 | 8.6 |
| 0.2 - 0.5 million | 5 | 1,336,000 | 19.2 | 17.9 |
| < 0.2 million | 19 | 2,439,000 | 73.1 | 32.7 |
| total | 26 | 7,453,000 | 100 | 100 |

Source: Construction Commission of Guangdong Province (1996:11)

³⁰ Ng, Mee Kam and Tang, Wing-shing. (1997). The Pearl River Delta Urban System Plan: An Analysis. p. 18.

4.2. Providing mass transit systems to Pearl River Delta Region

Figure 4-2. Transport Corridors in PRD Region in China



Source: Territorial Development Strategy Review, Planning, Environment and Land Bureau The Government of the Hong Kong Special Administrative Region, (1998)

4.2.1. Policy Implications

To create more productive and livable communities, and have major contribution that public transport can make in that effort, PRD should adopt a new perspective and transportation goals.

The regional surface transportation program should be restructured substantially in order to address more intelligently the mobility needs of the people and ensure progress in meeting other regional goals in PRD region. Existing regional decision-making authority over the use of regional transportation funds should be enhanced and strengthened.

4.2.1.1. Integrating Land Use, Town and Transport Planning

Transportation planners should work closely with town and land use planners to ensure that roads and other transport systems are well planned and properly integrated with urban developments.

Government and especially transport authorities should integrate urban development with transport planning. Having a proper mix of developments and the highest building densities concentrated at and around rail stations will ensure maximum accessibility for commuters to key nodes of employment housing, leisure and other social activities. Commuter facilities and building developments will be fully integrated.

Where existing rail provision exists, one can predict a revival of economic activity around the stations, both for housing and for industrial uses. Where new development is under consideration this will only be viable in the long term (20-50 years) if it has access to public transport. Urban development and public transport will increasingly be undertaken in parallel.

4.2.1.2. Control of Private Car Ownership

Many of the policies favoring mass transit systems would involve constraints on ownership and use of private automobiles. Implementation of such policies is likely to encounter considerable opposition because automobile ownership and use are common popular aspirations, not only as a means of transport to and from work, but also as a means of greater general mobility and independence and as status symbols. The control of automobile ownership and use therefore requires concerted policy actions at all levels of government that combine the use of such instruments as import tariffs, annual vehicle fees, and gasoline pricing at the national level with appropriate investment, pricing, and regulatory actions at the regional and city levels.

4.2.1.3. From Road to Rail Investment: Changing Governmental Priorities

Traditionally, policies have involved high way construction to meet the needs of the private automobile explosion, neglect of adequate mass public transit in various modes especially in low-income neighborhoods and encouragement of segregated land use, including the relocation of slum dwellers to peripheral locations.

However, in order to maximize the efficiency and potential outcome from mass transit in urban realm, such traditional investment policies need to be modified to include reduced emphasis on general-purpose arterial road construction mainly benefiting automobiles and emphasis on improved existing mass-transit facilities or providing more mass transit systems. They should also involve neighborhood street-paving programs, especially in the poorer neighborhoods and support for bicycle and pedestrian traffic. As shown in case studies in Chapter 2, new investment policies should also involve efforts to decentralize employment location close to low-income residential neighborhoods, such as ‘flatted factories’ in Singapore and Hong Kong. Decentralized employment location, although it reduces congestion in the city centers, may also increase the need for public and private transport to and from peripheral areas, which can be quite costly. Employment decentralization is therefore not a panacea for solving urban transport problems.

The regional tax code should be revised to promote private and non-regional investment in transit, and to eliminate the taxation of employer-transit subsidies and other disincentives to transit use. Moreover, regional transportation policies and programs should require closer integration of transportation investments and land use decisions in order to provide an environment that is conducive to and encourages increased provision and use of high-occupancy services.

4.3. Essential Keys to Successful High-Density Mixed-Use Development

In order to have successful high-density mixed-use developments several important principles of urban design, construction and management must be considered in advance.

These principles, which have emerged step by step over the past 30 years, may be summarized as follows.

First, there must be a firm policy context as to the principal strategic development objectives it is desired to achieve and, coupled with that, a set of agreed working assumptions as to the standards of design to be provided within limits of resource availability. Second, there must be sensible planning at strategic, sub-regional, district and site levels to ensure that interlinked aspects of land use, transport systems, infrastructure services, engineering works, three-dimensional design, conservation and landscape, economics and finance, and environmental management are all dealt with on an integrated and interactive basis. While various technical tools can be used to help achieve this, there is no simple overall system that can produce a satisfactory answer. Rather, there has to be a carefully constructed and managed system that brings a wide range of professional, political and community views together to formulate, evaluate and refine a package of options, eventually to produce a balanced end product.

Third, in the context of urban forms, there needs to be imaginative, flexible and practical, comprehensive three-dimensional designs able to cope with changing demographic profiles and high levels of pedestrian and vehicular traffic. Fourth, there must be a well-based regulatory system to ensure structurally sound, safe, durable and cost-effective standards of construction. Fifth, there must be well-structured and adequately resources systems of management and maintenance, with round-the-clock services, so as to ensure high standards of cleanliness, security and operational efficiency. And last, there needs to be an ongoing system for reviewing performance of the project concerned and for implementing improvements to keep up with new technology and standards.

4.4. Financial Framework

The vision of a world class transport system calls for a comprehensive rail network. However, such a system is very costly to build and also costly to operate.

Few urban railway schemes, whether light or heavy rail, are cost-effective in terms of the revenue generated by passengers' fares. Most are justified because of the reduction in air pollution or congestion, or because of the economic benefits that flow to the station properties and also adjoining land. These wider benefits allow government (national, regional or local) to subsidize investment in new railway projects, or to prop up existing lines. As such, railways have advantages beyond normal cost-benefit analysis, and this gives them value over and above more orthodox laws of accountancy.

Those who design and promote railway schemes are well aware that most projects are not profitable by fares alone, and seek to involve all those who will benefit in helping to fund their schemes. It is well known that railways are efficient movers of people; that air pollution is greatly reduced by persuading people to travel by train rather than by car; that railways are good for the image of a town and that property developers reap windfall profits from railway investment. For these reasons, those who promote railway schemes should look to a wide range of government subsidies and support from property developers and building owners on top of the station building and also along the line. Those with property atop of the stations benefit particularly; not only does the value of the land increase but also that of the property on it, and hence rents rise. The increase in land values often leads to redevelopment of land near to stations, thereby allowing developers to further exploit the economic benefits of railway construction.

Exploiting the commercial benefits of station building has aesthetic and urban design advantages. The trend towards joint funding of railway schemes and property development brings clear advantage to each party.

Developers can frequently subsidize railway schemes by exploiting the air rights over stations (as was common in the 1970s in the USA and more recently in Hong Kong) or by being given the option to redevelop surplus railway land (such as goods yards) alongside stations. Such land transfers to private developers from public or private railway companies may be sufficient to make an urban railway project viable. However, these partnerships tend to be undermined by different perceptions of value, cost and return on investment. Promoters of railway schemes are not usually motivated by profit but by public and environmental benefit. As such they take a long-term view of profit and loss. Commercial developers, on the other hand, seek to break even in ten years. After which they expect a regular return. Mixed-source

investment, though it is increasingly a prerequisite for successful implementation of railway schemes, carries implications for the phasing and design of railway projects. It also has consequences for the make-up of the different uses that surround railway stations. Commercial partnership leads usually to office or retail development, while partnership in a more public direction may lead to housing or the construction of community facilities.

Higher ridership would increase farebox income, thus reducing the reliance of transit agencies on outside support. Income can also be generated from land and air rights leases, station connection fees, benefit assessments, and other forms of value capture (Cervero et al., 1992). At the Ballston station in Arlington, Virginia, and the South Dadeland station in suburban Miami, Florida, regional transit agencies receive more than \$200,000 annually in air-rights lease and connection fee revenues from adjoining large-scale mixed-use projects. To the extent that benefits of being near a transit station are capitalized into higher land values and rents, local governments from communities with transit-supportive developments should also receive more property tax and value-added income.

In summary, the financial structure of a transit property can be expressed in a simple algebraic formulation that shows that subsidy plus revenue must equal costs:

$$\text{Subsidy} + \text{Revenue} = \text{Operating Costs} + \text{Capital Costs} + \text{Interest on Debt}$$

As an example, how Singapore has dealt with subway station projects in terms of financing is included in the appendix.³¹

³¹ Lim, William., *Equity and Urban Environment in the Third World: with Special Reference to Asean Countries and Singapore*, New Art Printing Co. (Pte) Ltd., Singapore, 1975, p.114.

5. Conclusion

This thesis attempts to demonstrate that responsive public transportation with transportation nodes well-designed to maximize personal interaction, and to create a center for various activities creates a more satisfying and humanistic environment. The conclusion can be summarized into two main points.

A. Efficient mass transit has positive impacts in the urban realm.

As the conclusion of this study, attention should be drawn to the fact that efficient mass transit systems have potential positive impacts in urban realm; economic growth, better environment quality, more comfortable living conditions of people, reduced energy consumption, resource conservation and so on.

In theory, as the car loses its cultural and social superiority, there begins to emerge a new urban order based upon public and individual non-car transportation. The three scales of rail provision (heavy rail, light rail and underground), buses, cycles and walking will constitute the main means of journeying within and between towns in the future. The environmental, health and community benefits will lead to restraint upon car and lorry usage. The importance of design, safety and security with public transport should not be underestimated. Design has sold cars throughout much of the twentieth century; design needs to do the same for the railway system and its stations.

As Edwards Brian has noted in his book, The Modern Station, there are “a few simple principles help to smooth the transition from private to public means of transport within urban areas”.³²

- Intensification of land-uses at higher density and levels of activity around existing stations;
- Development along public transport corridors;
- Integration of land uses to discourage the need for car-based journeys;

³² Edwards, Brian. (1997). The Modern Station: New Approaches to Railway Architecture. London: E & FN Spon. p. 10.

- Incentives to encourage movement of goods by rail rather than road through pricing and fiscal policy

B. Stations (Transportation Nodes) should have high-density mixed-use developments on top.

Stations are more efficient if they have high-density mixed-use developments on top because of three simple reasons. First of all, if the stations have additional uses (office, commercial, and residential) other than terminal use, stations would attract more people to the station and provide higher ridership which would increase fare box income. As examined earlier, in order to have efficient mass transit systems to work a certain level of ridership has to be supported. Secondly stations with working places and commercial stores are more convenient and eventually attract more customers into this area. Finally as a rail system is very costly to build and also costly to operate and besides, few urban railway schemes are cost-effective in terms of the revenue generated by only passengers' fares, stations with developments on top would create revenue generated from land and air rights leases and also other forms of economic benefits that flow to the station properties. Hence, these wider benefits would allow government to subsidize investment in new railway projects, or to prop up existing lines.

APPENDIX 1

Computations made are based on the following assumptions:

i. Number of Stations

4 MRT stations in the central area

8 MRT stations in the population/transportation centers.

ii. In The Central Area

- (a) Land immediately adjacent to the station ($500' \times 500'$) = 250,000 sq. ft. to be called Type A land Increase in plot ratio from 3 – 8
- (b) Land surrounding the station ($1,000' \times 1,000'$) excluding Type A land = $(1,000,000 - 250,000$ sq. ft.) = 750,000 sq. ft. to be called Type B land Increase in plot ratio from 3 – 6
- (c) Usage should be mainly commercial and a surcharge tax will be levied at \$ 20 per sq. ft. of the increase in permissible net rentable floor area.
- (d) Less car parks will be needed.

APPENDIX 2

The computation is as follows:

i. Stations In The Central Area

For each station:

Type A land – 250,000 sq. ft. ($500' \times 500'$)
× increase in plot ratio of $5(8 - 3)$
× \$ 20 per sq. ft. surcharge tax = \$ 25,000,000

Type B land – 750,000 sq. ft. ($1,000' \times 1,000' - 250,000$ sq. ft.)
× increase in plot ratio of $3(6 - 3)$
× \$ 20 per sq. ft. surcharge tax = \$ 45,000,000

Collectable surcharge tax
 $(\$ 25,000,000 + \$ 45,000,000) = \$ 70,000,000$

For 4 stations:
Collectable surcharge tax = \$ 280,000,000
 $(\$ 70,000,000 \times 4)$

For each station:

The rentable commercial floor area will be:
Type A = 250,000 sq. ft. × 8 = 2,000,000 sq. ft.
Type B = 750,000 sq. ft. × 6 = 4,500,000 sq. ft.

Total rentable floor area = 6,500,000 sq. ft.

For 4 stations:

The total rentable commercial floor area of both
Type A and B land $(6,500,000 \times 4) = 26,000,000$ sq. ft.

It is conceivable that the projected development in the next two decades will be able to absorb this amount of commercial floor space, provided no increase in plot ratio will be granted outside these strategic locations. This is also necessary from the comprehensive planning point of view, to preserve the environment of the central area.

ii. Stations In The Population / Transportation Centers

A modified exercise can also be worked out for the stations in the population centers and the transportation centers. In this instance, the usages are likely to be a combination of commercial/industrial/residential development. Again, a higher plot ratio/density can be permitted for properties immediately adjacent to these stations. It can be envisaged that the State can recoup an estimated \$ 15,000,000 per station from the surcharge tax. Assuming 8 stations, the surcharge tax will amount to \$ 120,000,000 ($\$ 15,000,000 \times 8$)

iii. Total Surcharge Tax

| | |
|---|----------------|
| 4 stations in the central area | \$ 280,000,000 |
| 8 stations in the population / transportation centers | \$ 120,000,000 |
| Total | \$ 400,000,000 |

APPENDIX 3

Alternative Short-Term Measures

(a) Road Improvements

Road improvements will still have to be continued. Emphasis, however, should be placed on the environmental road network within the central area rather than the construction of a major road network. An east/west freeway – north of and away from the central area – should be constructed for through traffic.

(b) Road Transport

Legislation will have to be introduced to restrict private vehicles from the central area. Special licenses should be introduced with much higher license fees as an initial deterrent. If this action is still ineffective, more stringent measures will have to be taken. The central area will need to be served much more comprehensively by buses and taxis.

(c) Parking Facilities

Major car parking facilities should be provided outside the central area, immediately adjacent to bus termini and future MRT stations. Car parking provision in the central area should be minimized, and car parking charges in this area should be substantially increased. Off-street parking is to be avoided whenever possible.

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