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## Why should cities change from DOT to TOD?

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**Transportation systems and cities that are connected by development-oriented transit (DOT) should be reconnected under the newer concept of transit-oriented development (TOD). This paper examines the reasons why cities should progressively change from DOT to TOD. The literature was reviewed to examine the urban history of DOT and TOD and the aims of TOD were identified. The relationship between sustainable development and concepts of TOD was then established to show why cities should change from DOT to TOD. It was also concluded that the concepts of TOD match sustainable development. Finally, extended strategies of TOD were established for Taipei City in the two specific perspectives of the transport system and land use.**

### 1. INTRODUCTION

In Taiwan, a number of problems have led to a reconsideration of our metropolitan landscape. People in many regions of the country are increasingly frustrated with congestion and other travel difficulties. Concern over sprawl and the loss of open space is growing and air pollution, greenhouse gas emissions and pressure on foreign and domestic oil supplies are in the public spotlight. There is anecdotal evidence that disillusionment with auto-oriented development and urban sprawl are increasing and rising housing prices in many metropolitan areas limit the residential choices and homeownership opportunities of a large part of the population, including many who are relatively affluent.<sup>1–4</sup>

One of the transit-oriented development (TOD) studies suggests that places with sprawling, auto-centric landscapes are poor economic performers. Using data from 46 international cities, Kenworthy and Laube<sup>5</sup> found gross regional product per capita was generally higher in less auto-dependent cities: car use does not necessarily increase with increasing wealth, but tends to fall in the wealthiest cities.

Therefore, in policy efforts to mitigate these problems, smart growth has emerged under sustainable development. Smart growth calls for building communities that are more hospitable, productive, and fiscally and environmentally responsible than most of the communities that have been developed in the last century. It seeks to identify a common ground where developers, environmentalists, public officials, citizens and others can all find acceptable ways to accommodate growth.<sup>6</sup>

TOD has recently become a popular planning concept to promote smart growth and sustainable development. TODs have been hailed as a model for integrating land use with transportation in the interest of smart growth.<sup>5,7–10</sup> Cervero *et al.*,<sup>2</sup> stated, 'TOD has gained currency in the United States as a means of promoting smart growth, injecting vitality into declining inner-city settings, and expanding lifestyle choices'. Dittmar and Ohland<sup>11</sup> state that TOD is an essential part of the healthy growth and development of regional economies. TODs base urban development plans on transit systems, improving efficiency of land-use and transit operations. The theory and applications of TOD have been extensively studied.<sup>12–17</sup> The strategies discussed in these studies were classified into three dimensions by Cervero and Kockelman:<sup>18</sup> enhancing development density to raise transit use; diversifying land use to improve the passenger convenience of the public transport services, and pedestrian-friendly design of walkways and other transfer methods to increase the use of transit systems. Moreover, the benefits of TOD will achieve goals of sustainable development (e.g. environmental, economic and social benefits).<sup>2,19,20</sup>

In the past, heavy investment in roads and other implicit subsidies of automobile use, combined with comparatively low levels of transit funding, have facilitated decentralised urban development patterns and inefficient use of land.<sup>21</sup> These development patterns, which we refer to as 'sprawl', have made transit service unviable or inefficient in most suburban areas and many urban areas and have reinforced automobile dependence. Sprawling developments are consuming land, congesting roads and highways, and leading to a host of other economic, environmental, and social problems. In other words, urban development in Taiwan has been going against sustainability. The purpose of this paper was to identify TOD strategies and policy actions used in sustainable development efforts and to catalogue them in order to identify the actions that are necessary to achieve the dreams of sustainable cities.

This study aimed to connect sustainable and TOD planning. In the next section there follows a discussion of the historical contexts of TOD and the reasons why it is becoming the new planning tool for achieving sustainable development in the twenty-first century. Thereafter a definite relationship between sustainable goals for urban development and TOD is established by literature reviews.

## 2. FROM DEVELOPMENT-ORIENTED TRANSIT TO TOD

A discussion of each phase of the change from development-oriented transit (DOT) to TOD is the key to understanding which phase is best in terms of improving cities and transport. To advance this discussion, we establish the historical phases from DOT to TOD, as identified by Belzer and Aulter<sup>1</sup> to make the historical changes of TOD clear.

### 2.1. Development-oriented transit

During the early twentieth century, DOT more aptly describes many towns and cities than TOD, as private developers built transit services to serve their development rather than vice-versa.<sup>1,11</sup> From the mid-1800s to the early 1900s, numerous eastern and mid-western cities developed in parallel with the invention and expansion of rail transit systems; the growth patterns of the cities' were closely integrated with the availability of transit and caused decentralisation.<sup>22–26</sup>

Since the 1920s, and increasingly since World War II, the freedom of choice with regard to location that is offered by automobiles has allowed development to spread out in patterns that are unsuited for service by rail transit. In many cities, rail transit lines have been ripped up and rail services abandoned. The steady decline of metropolitan development densities in the last half of the twentieth century has been paralleled by decreasing use of bus and rail lines.<sup>26</sup> On the other hand, urban patterns in the early twentieth century were induced by transit.

### 2.2. Auto-oriented development

In the second phase, the post-World War II period:<sup>1,11,27</sup> auto-oriented development (AOD) saw a precipitous decline in transit use and the dismantling and abandonment of many rail systems. To the extent that transit was still in operation, it relied much more heavily on buses as the primary mode in most regions. With the exception of some of the commuter suburbs around older cities, which continued to function reasonably well as transit-based communities, most transit had become a last resort rather than a reliable transportation option tied to development. As congestion worsened, a new generation of transit systems was planned and built. They were built primarily to relieve congestion, funding was provided entirely by the public sector, and little or no additional land was purchased by the transit agencies to ensure that there would be any link between current transit investments and future development patterns.<sup>1,11,27</sup>

The urban pattern change brought about by the two types of transportation, buses and automobiles, is known as AOD. The automobile has played a revolutionary role in affecting the design of neighbourhood planning in the most developed nations. Jacobs<sup>28</sup> also said in her book, *The Death and Life of Great American Cities*, 'Automobiles are often conveniently tagged as the villains responsible for the ills of city and the disappointments and futilities of city planning'. AOD leads to automobile dependence that leads to sprawl, congestion, air pollution, and the depletion of energy sources.

### 2.3. Transit-oriented development

The final phase is TOD. Since the 1970s, many research reports have stated that transit systems have the potential to provide

residents with improved quality of life and reduced household transportation expenditure, while providing a region with stable mixed-income neighbourhoods that reduce the environmental impacts of growth. Financing for transit has been focused on cities through value capture, where low density development and auto-dependency predominate.<sup>29–35</sup> Moreover, other studies<sup>36–41</sup> have started to emerge from developing countries, where denser cities and a more even modal split can be found.

Until the 1990s, transit systems were integrated with land development and urban design. Some new concepts, tools and policies of urban and transportation planning (e.g. transit-supportive development, transit-friendly design and transit villages) were advocated by Calthorpe<sup>7</sup> and Cervero *et al.*<sup>2</sup> TOD is the most widely used term, however, and is therefore used herein. TOD can help to address problems ranging from sprawl, traffic congestion and poor air quality, to the shortage of affordable housing and the need for reinvestment in urban core communities.

TOD offers an alternative that is at once viable in the marketplace and socially beneficial. TOD in the twenty-first century can be a central part of the solution to a range of social and environmental problems. TOD may seem like a remarkably prosaic and invocative term given such lofty goals. As the economic, environmental, social, commuting and urban development trends described above progress, it is likely that the types of neighbourhoods we envision will become increasingly attractive.<sup>1</sup> Defining concepts of TOD that function complementarily is a crucial first step toward advancing sustainable development. The next step is to move those goals – in concept and reality – into the mainstream of urban and transportation development.

## 3. TOD CONCEPT AND SUSTAINABLE DEVELOPMENT

Sustainable development, definitions, goals and core strategies of the TOD concept are all relative. Sustainable development is the future vision of TOD. The TOD concept is the basis of transportation and city planning. TOD strategies are implementation tools. Therefore, in the following sections we discuss relationships between the TOD concept and sustainable development in three perspectives: definitions; aims; and core strategies.

### 3.1. Definitions of TOD and sustainable development

TOD concepts include bus-TOD and rail-TOD as well as development along major highways.<sup>42</sup> Although there is no single, all encompassing definition that represents the TOD concept in its many forms, most definitions of TOD nonetheless share common traits.<sup>2</sup> The definitions of TOD concepts found in the literature are presented in Table 1.

There are many publications that talk about definitions of TOD; in these publications, many different approaches are used to prove that the implementations of TOD, which include the increasing of housing density around transit stations, which leads to economic development, providing diverse land use and affordable housing, which leads to social equality, and designing a community that is willing to walk and use public transit, which leads to environmental protection.

References	Definitions	Sustainable development		
		Ec.	En.	So.
Salvesen <sup>43</sup>	Development within a specified geographical area around a transit station with a variety of land uses and a multiplicity of landowners.	✓		✓
Bernick and Cervero <sup>13</sup>	A compact, mixed-use community, centred around a transit station that, by design, invites residents, workers, and shoppers to drive their cars less and ride mass transit more.	✓	✓	
Boarnet and Crane <sup>44</sup>	The practice of developing or intensifying residential land use near rail stations.	✓		
Boarnet and Compin <sup>45</sup>	TOD is consistent with the mixed-use, pedestrian-friendly character.	✓		
Maryland Department of Transportation <sup>46</sup>	A place of relatively higher density that includes a mixture of residential, employment, shopping and civic uses and types located within an easy walk of a bus or rail transit centre.	✓	✓	
Bae <sup>47</sup>	A means of reducing automobile dependence, promoting more compact residential development and fostering mixed land uses.	✓	✓	
Belzer and Alter <sup>27</sup>	TOD focuses on desired functional outcomes. Three main outcomes or goals of TOD: location efficiency, choice, and value capture/financial return.	✓		✓
California Department of Transportation <sup>48</sup>	Higher density development, located within an easy walk of a major transit stop, with a mix of residential, employment and shopping opportunities without excluding the automobile.	✓	✓	
Still <sup>49</sup>	A mixed-use community that encourages people to live near transit services and to decrease their dependence on driving.	✓	✓	
Cervero <i>et al.</i> <sup>2</sup>	TOD is a tool for promoting smart growth, leveraging economic development, and catering for shifting housing market demands and lifestyle preferences.	✓	✓	✓
Lund <i>et al.</i> <sup>50</sup>	The design and mixed-use features of TOD may reduce both work and non-work automobile trips.	✓	✓	
Ec., economical efficiency; En., environmental protection; So., social equality. ✓, representative for TOD definitions relative to one perspective of sustainable development.				
Table 1. Definitions of TOD concept and sustainable development				

### 3.2. Aims of TOD and sustainable development

What are the goals and objectives that have been set for the TOD concept? Many important studies and reports<sup>1,7,26,27</sup> have identified the aims of TOD. For example, increasing utilisation is the top priority of TOD. The next most important aims are financial in nature and include promoting economic development and raising revenues for transit properties. Next in importance are objectives that are more social in nature, such as enhancing the quality of life and widening housing choices for consumers.<sup>7</sup>

The present study integrated many of these aims into the following four perspectives, namely those identified by Central Government, residents, the Department of Transportation and the Department of Urban Development (Figure 1). These four perspectives of the TOD aims match the three concepts for sustainable development listed in the preceding paragraph.

- The first perspective, identified by Central Government, is concerned with improving environmental quality in urban areas, to protect cities from pollutions and maintain a good living environment.
- The second perspective, identified by the Department of Transportation, is concerned with increasing the use of public

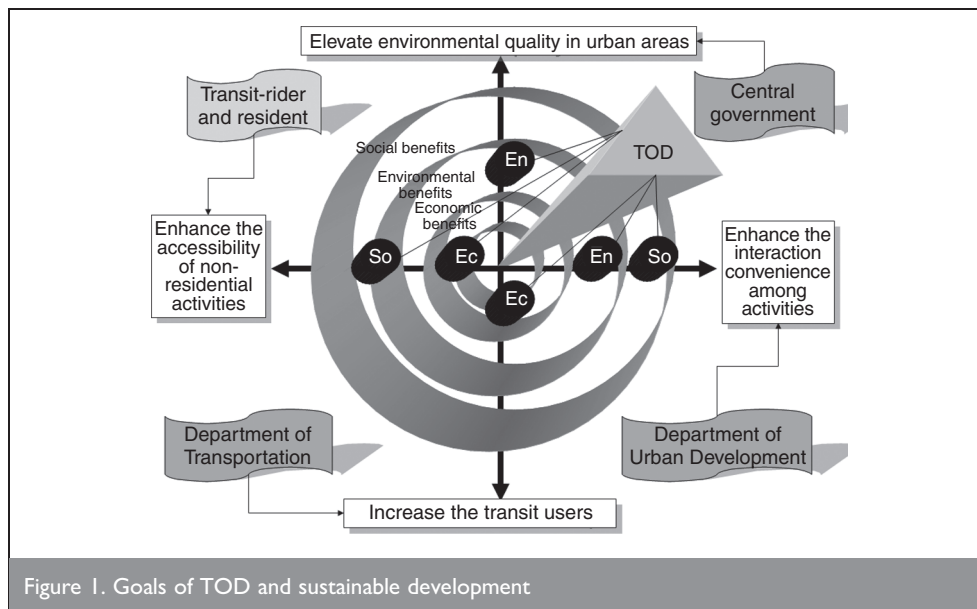
transits to create greater revenues and promote economic development.

- The third perspective identified by the Department of Urban Development is concerned with enhancing the interaction among activities to create a pedestrian-friendly community and diverse land use in the same neighbourhood to strengthen environmental justice and social equality.
- The fourth perspective, identified by transit users and residents, is concerned with enhancing the accessibility and mobility of non-residential activities to reduce their travel costs and increase transport options.

### 3.3. Core strategies of TOD and sustainable development

The main concept of TOD is to make cities and communities smart and sustainable. According to Cervero *et al.*<sup>2</sup> 'TOD has gained currency in the United States as a means of promoting smart growth, injecting vitality into declining inner-city settings, and expanding lifestyle choices'. TOD is not only the introduction of development tools but also one of strategies for smart growth. The present study concludes from the literature that there are three main items of core strategies of TOD: density, diversity and design, the so-called 3Ds.

- Density: raising housing density around transit stations within a range of 500 m.



- (b) Diversity: mixed land use, extensive choices of housing and commuting options.
- (c) Design: pedestrian and used-friendly oriented design.

The core strategies of 3Ds are intended to increase transit use, increase walking and cycling, and decrease the amount of automobile trips. The design and mixed-use features of TOD may reduce both work and non-work automobile trips. Furthermore, these potential benefits can help amortise multi-billion dollar investments in rail transit infrastructure. Urban planning history provides accounts of promising ideas that did not attain their aims on implementation. TOD strategies are based on a theory that land use near a rail transit station will produce a different travel pattern to land use in an automobile-focused area.

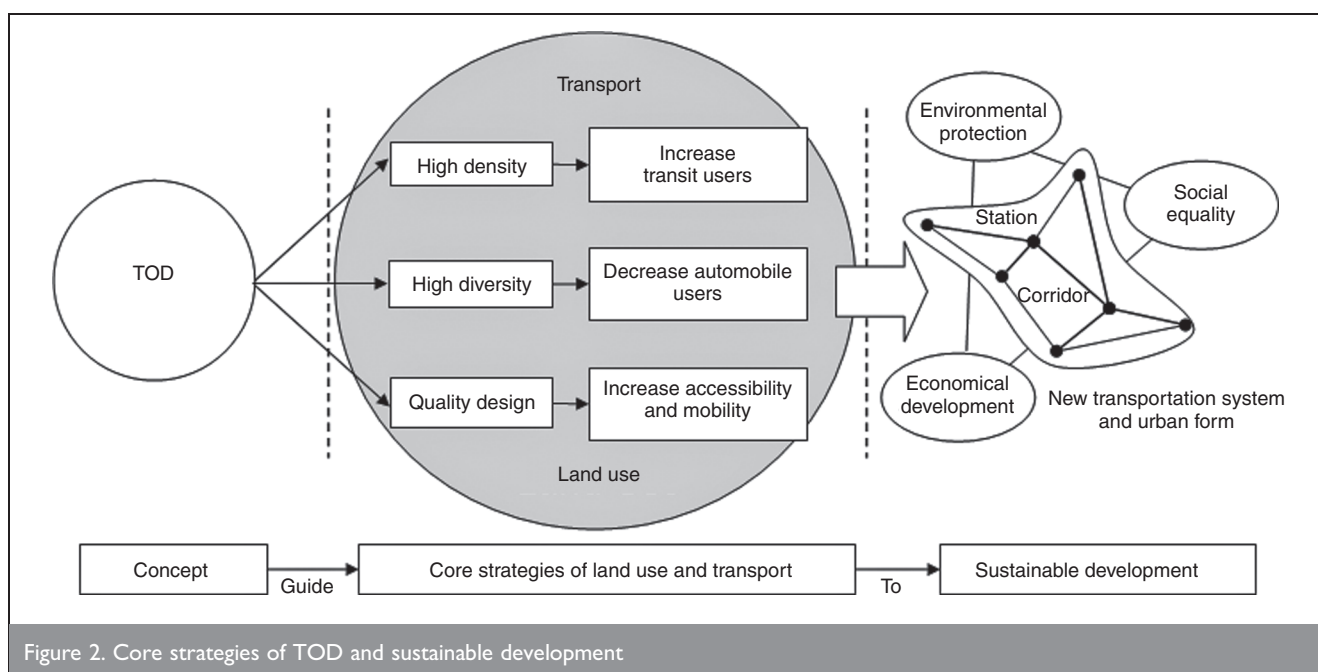
The best way to ensure that TOD can help solve urban challenges is to provide solid analytic evidence about its

effectiveness.<sup>50</sup> In other words, it is necessary to demonstrate that the numerous and various benefits of TOD contribute to economic, environmental and social effectiveness. Thus it can be seen that TOD strategies are able to achieve the aims of smart growth and sustainable development. Moreover, according to the definitions listed in Table 1 the aims of TOD are consistent with the concepts of sustainable development (e.g. economic development, environmental protection and social equality).

The core strategies of TOD provide the implementation tools to make urban development and transport systems more sustainable (Figure 2). Basically, there are three key aspects to the sustainable concepts of TOD. First, environmental protection means that TOD will restrain land development in environmentally sensitive areas and redirect it to the corridors and stations of the transit system in order to protect the ecology of the area. Second, economic efficiency means that high density and mixed development of land use around transit stations and corridors will increase transit use, promote economic development and improve location efficiency. Third, social equality means that TOD will offer affordable housing of diverse types and a greater choice of transportation modes to retain social justice. Finally, the comprehensive and ultimate goals of TOD are sustainable development.

#### 4. EXTENDED STRATEGIES OF TOD TO TAIPEI

There are millions of people living in the small metropolitan area of Taipei, Taiwan. Since the 1970s, two mutually



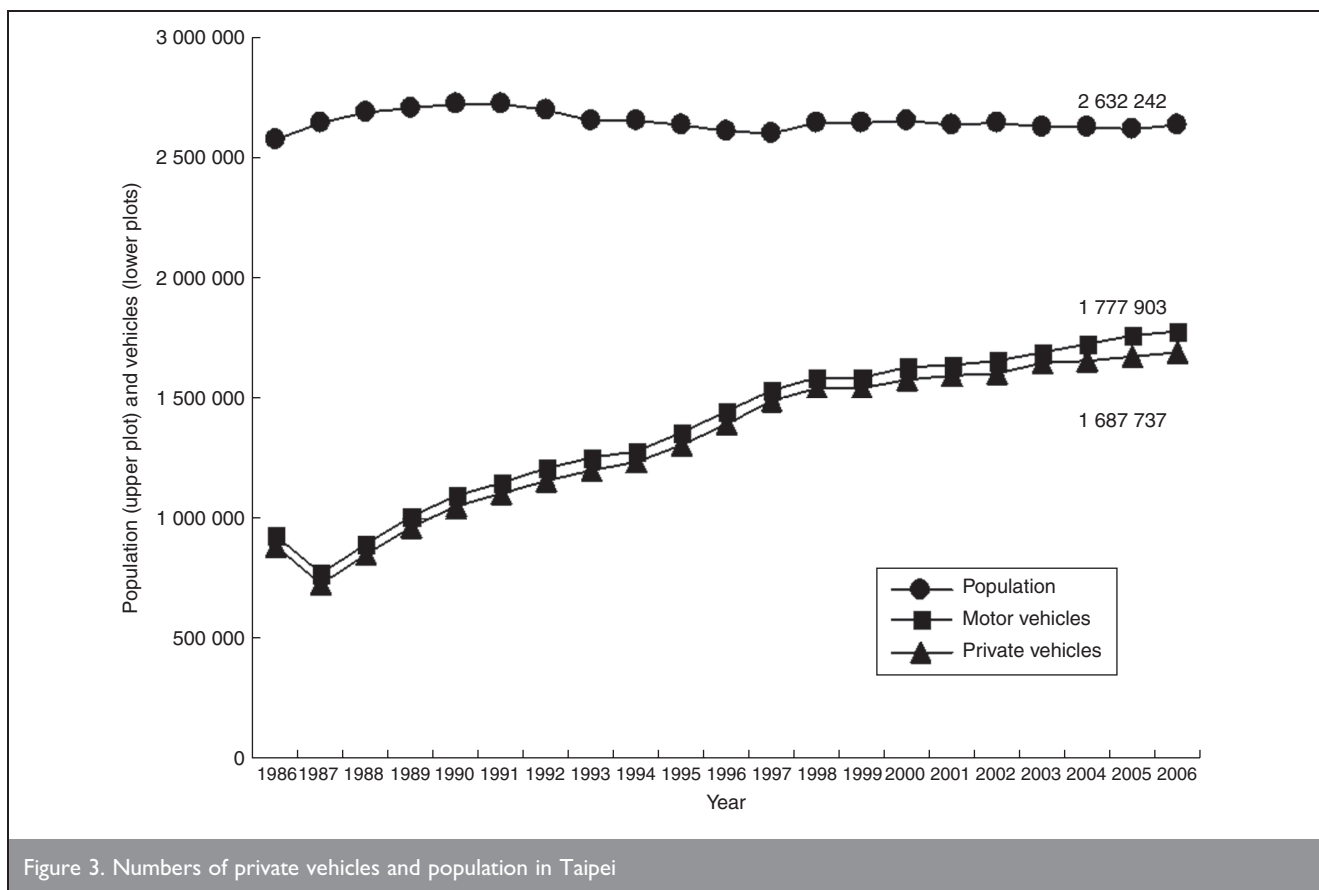


Figure 3. Numbers of private vehicles and population in Taipei

reinforcing processes have been in action, namely the decentralisation of Taipei cities and increasing reliance on the automobile. For example, the number of people in Taipei is decreasing but the number of private motor vehicles is increasing by 4.53% per year (Figure 3). There were 1.733 private motor vehicles per household in 2006. Due to the high amount of road use, the government has a large budget to build new roads and renew existing highways, which is estimated to cost 13 266 billion NT dollars in 10 years.

Moreover, urban planning without control has diminished natural resources as well as urban finances. For example, the housing vacancy rate in Taiwan was 16.7% in 2006. The number of vacant housing units amounted to 1.20 million, which has distorted demand and supply in the housing market. Despite this, local governments have permitted excessive developments that do not coordinate with the availability of infrastructure facilities. Urban development in Taipei was recognised as being in conflict with the concept of smart growth and sustainable development. It is apparent that current city and regional planning has depleted valuable resources by permitting urban sprawl and land conversion in local areas. Within this context, investigations are required to determine how to utilise the TOD concept to induce urban development patterns and build a highly attractive living environment in order to reduce urban expansion. It is necessary to enhance the economic efficiency of land use development and infrastructure delivery, and improve the functioning of the transportation system. By applying TOD concepts, urban design will improve the neighbourhoods around transit stations to create a desirable and convenient environment to encourage people and offices to move there.

As stated above, definitions, goals and core strategies of TOD can make land use and transport systems more sustainable; they are limited, however, to the development of the 3Ds strategy and simple definitions. In the present study we took Taipei City as the subject for a case study and developed extended strategies of TOD for Taipei City. TOD should develop from a regional aspect, deal with the main objectives of urban sustainability, integrate a public transportation system and then be implemented at station planning level (Figure 4). The extended strategies of TOD can also be divided into two specific perspective: transport system and land use.

#### 4.1. Transport system

- Evaluating development totality to help organise growth on a regional level to be compact and transit supportive.
- Regulating architecture design and parking space and creating a pedestrian-friendly street network that directly connects local destinations.
- Accelerating the construction of the transit system and raising development density around the transit system to increase transit use, reduce automobile use in downtown areas, release traffic congestion, and decrease air pollution.

#### 4.2. Land use

- Reserving sensitive habitat, riparian zones, and high-quality open space.
- Encouraging infill and redevelopment along transit corridors within existing neighbourhoods.
- Diversifying land use and providing a mix of housing types, densities and costs to create an attractive, convenient and self-sufficient city.



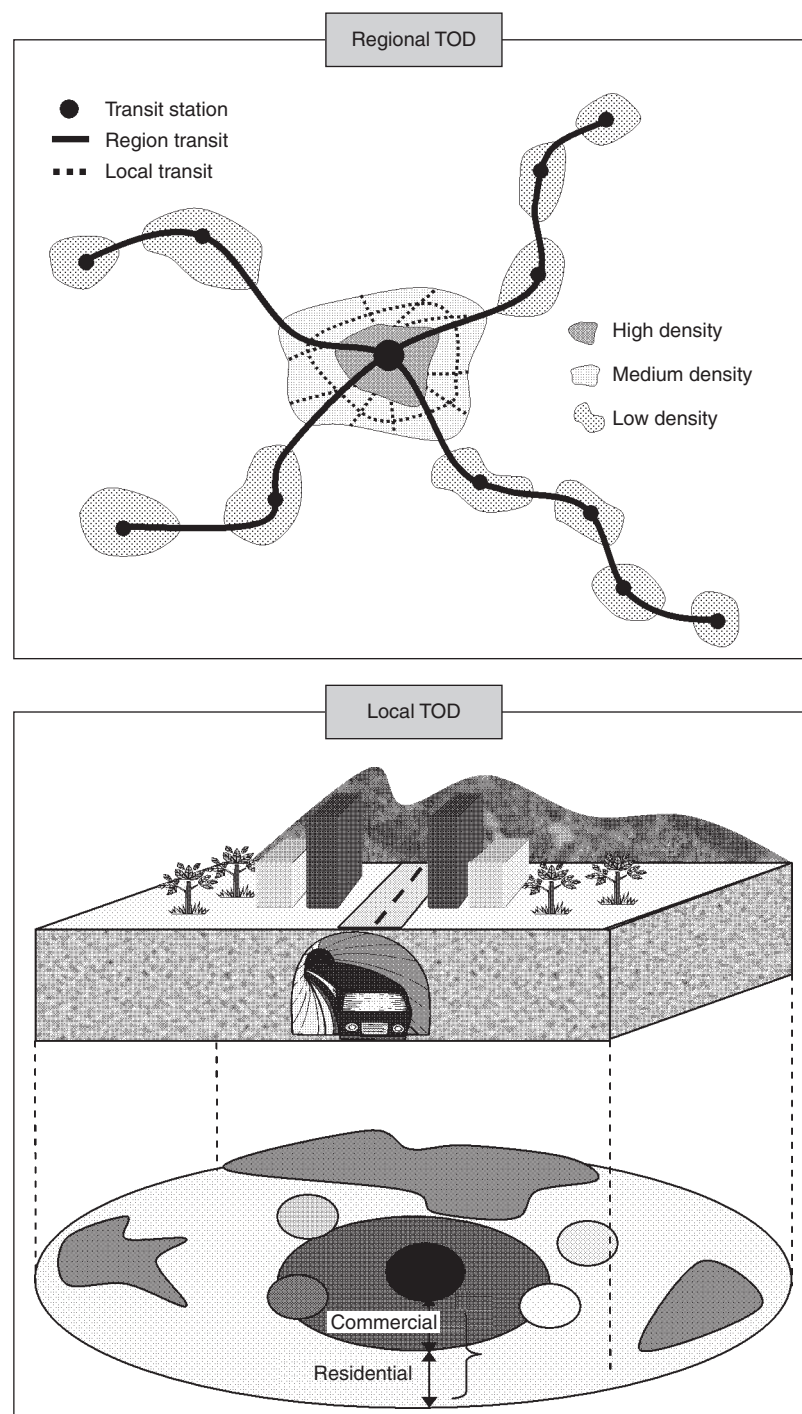


Figure 4. Extended strategies of TOD in Taipei

## 5. CONCLUSIONS

In this paper, the authors first generated the following four conclusions: first, DOT and AOD caused cities to become spread out, polluted and congested. The main cities in the world often become unsustainable in their current form and the transportation systems are congested. Second, the authors reviewed the literature to look for new ways to relieve congested and automobile-dominated cities and identified this important concept as TOD. Third, in response to the comment that TOD will make cities more sustainable, the literature review identified matches between TOD and definitions of sustainable development. Finally, the authors took Taipei City as the subject of a case study and developed extended strategies of TOD. These

strategies were divided into two specific perspectives, namely the transport system and land use to achieve goals of economic development, environmental protection and social equality.

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