



Application of the concept Transit-Oriented development in linear urban spatial structures: (Fereidunkenar as the case study)

Maedeh Hedayatifard, Master Student of Urban and Regional Planning, Faculty of Urbanism and Architecture, Shahid Beheshti University, Tehran, Iran. Md.hedayati@gmail.com

Mojtaba Hosseinian, Master Student of Transportation Planning, Azad Islamic University, Tehran, Iran M.hosseinian64@gmail.com

Paper code: 6-21-1-2589

Presenter name: Maede Hedayatifard

1-Abstract

Sprawl is a common label for the low-density, auto-oriented spread of metropolitan regions pervasive throughout the United States. Sprawling urban settlement patterns have resulted in increasing social costs such as traffic congestion and environmental degradation and pollution, as well as impedance of social and spatial integration. The urban spatial form is related to the transportation networks in cities. this structure that have the collaborative conjunction between its elements including streets, main centers of human activities and the land uses, effects the reduction of urban environmental pollutions. TOD is a planning technique that aims to reduce automobile use and promote the use of public transit and human-powered transportation modes through high density, mixed use, environmentally-friendly development within areas of walking distance from transit centers. Fereidunkenar is a city in the North of Iran near the Mazandaran Sea. The problem is that, by increasing the population and the potential for attracting tourism because of the landscapes and recreational spaces in the North of Fereidunkenar, the depth of his city would increase. So it is necessary to prepare the suitable transportation system that is responsible to the access of all citizens to the basic activities. This article explains the theoretical framework for use of transit oriented development especially in cities with linear spatial structure and evaluate the spatial structure in Fereidunkenar to determine the application of the concept TOD in this city.

Keywords: Transit oriented development, linear urban spatial structure, urban environmental pollutions, urban sustainability

2- Transit Oriented Development

Transit-oriented development (TOD), first proposed by an American architect and planner by the name of Calthrope (1993), has recently gained attention. The TOD-based planning movement is commonly identified with the US and European nations. TOD is a planning technique that aims to reduce automobile use and promote the use of public transit and human-powered transportation modes through high density, mixed use, environmentally-friendly development within areas of walking distance from transit centers.

2-1- Major elements of Transit-Oriented Development

Transit-oriented development projects should, at the very least, encourage the use of public transit by locating residential, commercial, or office uses, or a combination of all three, close to a transit node. However, successful TOD involves more than simply placing a transit stop in a residential neighborhood or a business park, or building a mixed-use TOD development next to a transit hub. Transit-oriented development should not only provide transportation options but also improve the “livability” of communities and neighborhoods. According to Bernick and Cervero Table 1 shows elements of TOD. (Cervero, 1993)

<i>Element</i>	<i>Description</i>
Enhanced mobility and environment	The major element of TOD is a congregation of housing, jobs, shops and other activities around transit. Also the physical environment is enhanced for example TOD is expected to improve air quality, trips are converted to walk or bike and ride trips.
Pedestrian-Friendliness	TOD involves the development of land use that encourage walking, such as narrow streets with trees, wide sidewalks, an absence of surface parking lots. Typical structures are street-oriented, mixed-use buildings that include a blend of residential, retail, and commercial uses
Alternative suburban living	TOD enables people to live in the suburbs without being entirely dependent on the automobile to access the variety of activities and services associated with cities. The pedestrian-friendly scale and design features of transit-oriented development promote social interaction
Neighborhood Revitalization	TOD can stimulate economic growth in blighted or declining areas served by rail or other transit. Redevelopment agencies can promote transit-oriented development and improve the social and physical infrastructure of neighborhoods, providing needed housing and services to households from a mix of incomes.
Public Safety	TOD places a mix of residents, workers, and shopkeepers within a compact area, promoting a continual security presence by the constant activity
Public Celebration	TOD should include some public open space, such as a park or plaza, that is a gathering place for events such as parades, performances, concerts, or a farmers' market.

Table 1- the major elements of TOD (Bussard, 2002)

2-2- Features of Transit-Oriented Development

1-2-1- Design Features

Transit-oriented development should promote walking and transit riding and discourage automobile use. A common theme of TODs is to create places that have design features such as landscaped sidewalks, parking in the rear, and retail street walls that make walking and transit riding more enjoyable. Some commonly accepted TOD design features, as set forth by Bernick and Cervero, are as follows: (Bussard, 2002)

- Continuous and direct physical linkages between major activity centers; siting of buildings and complementary uses to minimize distances to transit stops.
- Streetwalls of ground-floor retail, and varied building heights, textures, and facades, that enhance the walking experience; siting commercial buildings near the edge of sidewalks.
- Integration of major commercial centers with the transit facility.
- Gridlike street patterns that allow many origins and destinations to be connected by foot; avoiding cul-de-sacs, serpentine streets, and other curvilinear arrangements that create circuitous walks and force buses to meander or retrace their paths; direct sight lines to transit stops.
- Providing such pedestrian amenities as attractive landscaping, continuous and paved sidewalks, street furniture, urban art, screening of parking, building overhangs and weather protection, and safe street crossings.
- Convenient siting of transit shelters, benches, and route information.
Creating public open spaces and pedestrian plazas that are convenient to transit.

2-2-1- Density Features

High density is another key element of transit-oriented development. If origins and destinations are spread throughout a region, those with access to a car will likely drive rather than take transit. On the other hand, dense, compact TOD places a critical mass of people in a single location, providing the ridership numbers necessary to make transit feasible and efficient. High density offers three benefits to improved transit service: Routes to a relatively large number of points can be offered; the cost per ride of operating transit is reduced when ridership increases; and increased density allows transit service to be provided more frequently. (Morris, 1996)

2-2-2- Proximity to stations

Most transit trips involve some walking to access stops or stations; therefore, proximity of residences to stations is another important feature of transit-oriented development. According to Bernick and Cervero, “a central premise of transit villages is to concentrate development within one-quarter-mile walking distance of rail stations.”(Bernick and Cervero, 1997) This element is directly related to density; clearly, TOD must place a sufficient number of people within a reasonable walking distance of transit for an increase in ridership to occur.

2-3- The principles of Transit-Oriented Development

The following principles serve as a guide and provide an understanding of the essential elements and characteristics of a TOD. They will serve as the foundation for the station area planning in TOD districts.

- Create a compact development within an easy walk of public transit and with sufficient density to support ridership.
- Make the pedestrian the focus of the development strategy without excluding the auto.
- Create active places and livable communities that service daily needs and where people feel a sense of belonging and ownership.
- Include engaging, high quality civic spaces (e.g. small parks or plazas) as organizing features and gathering places for the neighborhood.
- Encourage a variety of housing types near transit facilities available to a wide range of ages and incomes.
- Incorporate retail into the development if it is a viable use at the location without the transit component, ideally drawing customers both from both the TOD and a major street.
- Ensure compatibility and connectivity with surrounding neighborhoods.
- Introduce creative parking strategies that integrate, rather than divide the site and reduce the sense of auto domination.
- Create TOD plans that are flexible so they can respond to changing conditions. Strive to make TODs realistic yet economically viable and valuable from a diversity of perspectives (city, transit agency, developer, resident, and employer).
- Recognize that all TODs are not the same; each development is located within its own unique context and serves a specific purpose in the larger context.(city of Austin, 2006)

3- Linear Spatial Structure and Transportation

The systematic design of spatial structure is the basic step for spatial sustainability. City is a complex system that has a lot of inner relations. Creating rational relation between social, economical and physical activities would lead to spatial sustainability. All these human activities are in the form of the strategic elements, including urban zones, corridors and nodes in urban spatial organization. It is important to consider these main elements to create sustainable composition of urban zones (as residential, commercial and green spaces), urban corridors (as transportation systems) and urban nodes (as city and neighborhood centers). The nodes of urban activities must have disciplinary hierarchy. The transportation system should relate these nodes well to reduce the inner city travels, so pattern of traffic organization is highly related to the form of the city. Ewing and Cervero (2001) conducted a literature review and synthesis of 50 recent empirical studies on how the built environment affects travel demand and found that transit mode choice was among those components most extensively studied. They conclude that of all travel variables, mode choice is most affected by local land use patterns. (Hendricks, 2005)

4- Linear Urban Spatial Structure and environment

The term urban structure refers to the pattern or arrangement of development blocks, streets, buildings, open space and landscape which make up urban areas. It is the interrelationship between all these elements, rather than their particular characteristics that bond together to make a place. The urban structure provides the foundations for detailed design of the constituent elements. It creates a coherent framework, which forms the basis of the design of individual developments - quite possibly by different actors - in order to achieve integration,

functional efficiency and environmental harmony.(English housing corporations, 2000) Although the adjustment of industrial structure, healthy life style and technological innovation are helpful to cut down the environmental pollution and energy use in production and living, however, these measures can hardly change traffic volume and relative energy consumption and emission determined by urban spatial structure. Urban spatial planning determines the spatial structure and finally determines the environmental pollution of city (LuJia, 2009). As it is mentioned above, the spatial form of the city affects the transportation and the environmental pollution in highly related to the pattern of traffic organization.

Economic	Social	Environmental
Traffic congestion Mobility barriers Crash damages Transportation facility costs Consumer transportation costs Depletion of non-renewable resources	Inequity of impacts Mobility disadvantaged Community cohesion Community Livability Aesthetics	Air pollution Climate change Habit loss Hydrologic impacts Noise Pollution

Table2: Negative Impacts of Inefficient transportation systems on sustainability objectives. (Litmann, 2002)

The city with linear structure has the distribution of its services along the main street. So, the accessibility is low for the sites in the distance from the main corridor. This causes the increase in the inner city travels and the more environmental pollution production. the NO_x emission in different spatial structures is different and the linear has more emission in the same condition.

The maximum of emission (kg /km-2)	Compact model	Linear model	Sprawl model
NO _x	60.1	220	42.7
Average of emission (g/ capita -1)	Compact model	Linear model	Sprawl model
NO _x	4.32	8.61	7.40

Table 3- NO_x emission in different urban patterns

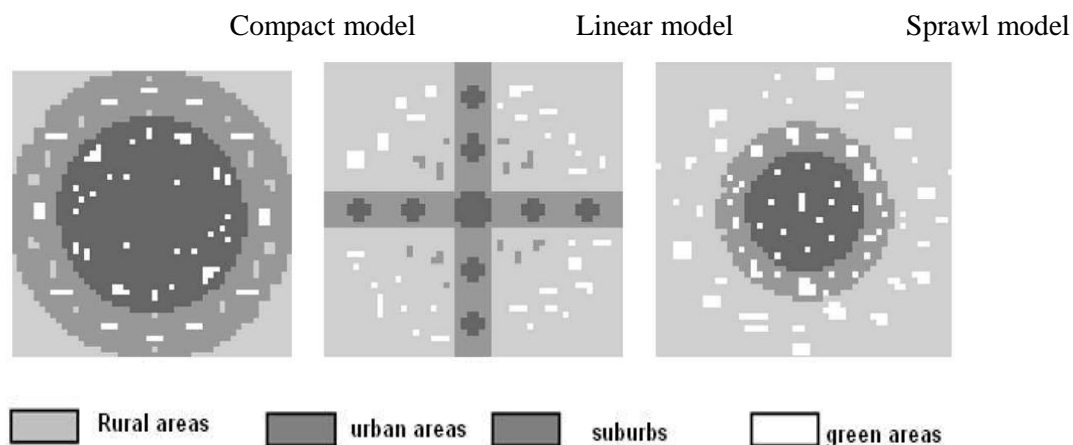


Figure1- Different urban Patterns

5- How does the linear Structure in Fereidunkenar effects on transportation

In 2010 the population of Fereidunkenar was estimated in 34452, covering an area of 830 hectare, and a density of 41 inhabitants per hectare. The residential and green space per capita is about 72 m² and 1.48 m². Structure of the city is the result of different socio-economical forces that shape the physical spaces. These are productive, consumer and transmitter spaces. In Fereidunkenar, the productive space which involves the commercial activities is along the main street. As the spatial structure is in linear form, along the Caspian Cost, this street plays the key role in the distribution of other elements like urban activity centers. The consumer space, involves the residential and public services spaces that feed the production space and prepare the labor forces. In Fereidunkenar, this space is covered by productive spaces. The transmitter space relates the productive and consumer space by the streets and functional corridors. The main street in Fereidunkenar involves the main activities such as banks, local commercial nodes, recreation spaces and etc. so the maximum of density occurs in this lane.

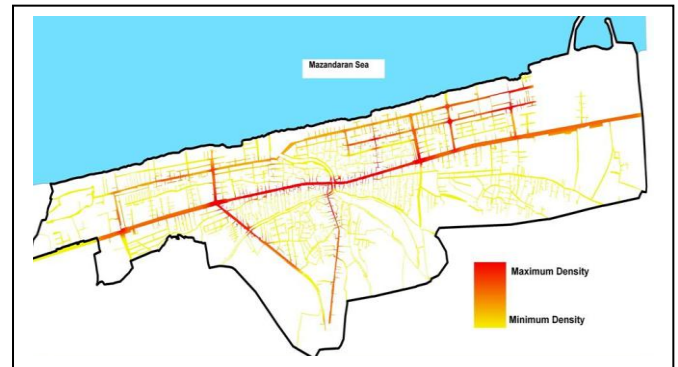
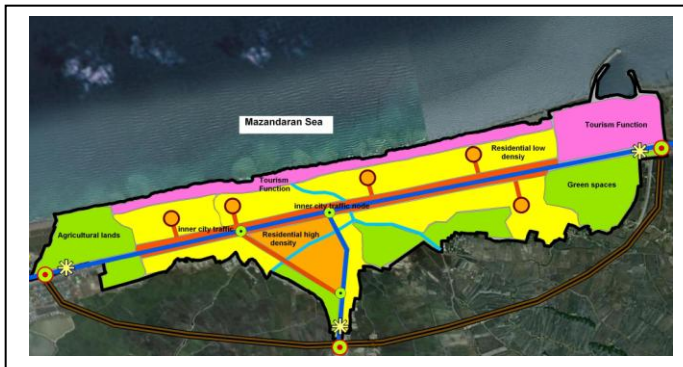


Figure 2- current urban spatial in Fereidunkenar figure 3- corridor's traffic congestion

The problem is that, with the increase of population and the potential for attracting tourism because of the landscapes and recreational spaces in the North of Fereidunkenar, the depth of his city would increase. So it is necessary to prepare the suitable transportation system that is responsible to the access of all citizens to the basic activities. On the other hand in should create attractive open spaces to encourage walking and bike instead of the auto mobile.

6- Evaluation the performance of linear spatial structure in Fereidunkenar

For evaluation of the spatial performance in Fereidunkenar, some criteria are defined. These measures are related to the effectiveness of transportation system and environment quality. The context of this evaluation is in two dimensions, first Environmental sustainability and second is Livability. Table 3 shows the comparison of the TOD elements with the characteristics of the linear structure in Fereidunkenar. It shows the potential and necessity of

applying the concept TOD in Fereidunkenar as a way to the urban sustainability that ensure livability, economic growth and environmental sustainability.

context		Elements of TOD	Performance of linear structure in Fereidunkenar
Environmental sustainability	Population density	Public safety	The population distributes equally in the city, and there is no concentration of population.
	Land use density		The compactness of land uses along the main corridor occurs. The periphery spaces have low density in comparison to the main lane.
Livability	Environmental pollution (air pollution, noise and etc.)	Enhance environment	As the city is not deep, because of the trends of development in the corridor, it seems that the neighborhoods are safe from the environmental pollution. On the other hand because of the dense in the main corridor, the congestion of air and noise pollution occurs in this area and the spaces in the distance from the main corridor are not dynamic and have insecure spaces.
	Access to the open and green spaces	Enhance mobility	Because of the limited depth in linear form, the access to the open and green spaces is prepared. It has the feasibility of walking or biking to the recreational and natural places. Fereidunkenar has the potential for attracting tourism, and have the beautiful landscapes.
		Pedestrian friendliness	
Public celebration			

Table 3- evaluation of the performance of linear structure of Fereidunkenar for application of the concept TOD, Source: Writers, 2012

7- Conclusion

The urban spatial form is related to the transportation networks in cities. this structure that have the collaborative conjunction between its elements including streets, main centers of human activities and the land uses, effects the reduction of urban environmental pollutions. Among planning methods, transit-oriented development (TOD), first proposed by an American architect and planner by the name of Calthrope (1993), has recently gained attention. TOD is a planning technique that aims to reduce automobile use and promote the use of public transit and human-powered transportation modes through high density, mixed use, environmentally-friendly development within areas of walking distance from transit centers. Fereidunkenar is a city in the North of Iran near the Mazandaran Sea. by increasing the population and the potential for attracting tourism because of the landscapes and recreational spaces in the North of Fereidunkenar, the depth of his city would increase. So it is necessary to prepare the suitable transportation system that is responsible to the access of all citizens to the basic activities. On the other hand in should create attractive open spaces to encourage walking and bike instead of the auto mobile. In this article the performance of linear spatial structure in Fereidunkenar is evaluated to determine its potential and necessity for application of the TOD method.

8- References

Bussard, Earl . G, (2002), Envisioning Neighborhoods with Transit-Oriented Development Potential, *International Institute for Surface Transportation Policy Studies*

Bernick, Michael, and Robert Cervero (1997), Transit Villages in the 21 Century *New York: McGraw Hill*,.

Cervero, Robert. (1993), Transit-Supportive Development in the U.S. Washington, D.C.: *Federal Transit Administration*,

City of Austin Neighborhood Planning and Zoning Dept(2006), Transit Oriented Development (TOD) Districts *April*

English partnerships the housing corporations, (2000), *urban design compendium Creating the urban structure*, London.

Hendricks, Sara J.(2005), Impact of Transit Oriented Development on Public Transportation Ridership, *National Center for Transit Research Center for Urban Transportation Research University of South Florida*

Litman, T. (2002). "Transportation Cost and Benefit Analysis: Applications in Developed and Developing Countries", in K. Puttaswamaiah (Ed.), Cost-Benefit Analysis: *Environmental and Ecological Perspectives* (pp. 115-138). Transaction Publishers.

LuJia, (2009), *Spatial Planning in Shenzhen to Built a Low Carbon City*, 45th ISOCARP Congress

Morris (1996) , Creating Transit-Supportive Land Use Regulations. Chicago: *American Planning Association, 1996, p. 41*