



Assessing the Implementation of the Functional Principles of Transit Oriented Development in the Mirdamad Station Complex

Pooyan Shahabian^{1*}, Reyhaneh Asadi² and Mahboubeh Mohammadi³

¹Assistant Professor, Department of Urban Planning, Central Tehran Branch, Islamic Azad University, Tehran, Iran

²MSc. Student of Urban Planning, Urban Planning, Central Tehran Branch, Islamic Azad University, Tehran, Iran

³MSc. of Urban Planning, Central Tehran Branch, Islamic Azad University, Tehran, Iran.

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ABSTRACT: Today's Transportation is known as one of the most important elements of urban development structure. Public Transportation, according to its more extensive functional capacity, can play a vital role in wider scale. Transit Oriented development by focusing on the subways is one of the special approaches in this field. Recently, Tehran Public Transport Fleet has significantly improved especially in the field of subway and BRT. Although Tehran has the potential capacity it could not only benefit from the advantages of this development, but also has imposed many social and traffic problems around stationary complexes. These are because of lack of implementation principles of TOD and the proper functioning of them. Mirdamad Station Complex plays a role in the implementation of these principles to achieve an efficient station complex. TOD is included four main principles: (1) Intensive development, (2) mixed land uses, (3) pedestrian-orientation, (4) Transportation facilities. In this study, the functional principles of TOD in the Mirdamad Station Complex are assessed using librarian data and archived studies in order to do descriptive and analytical research. As a main result the Mirdamad Station Complex, with the implementation rate of two-third of the functional principles, is in desirable condition and can be used as one of the complex station in Tehran.

Keywords: Transit-Oriented Development Principles, Subway, Mirdamad Station Complex.

INTRODUCTION

The most important sub-group of transportation systems is urban public transportation systems which play an undeniable role in coping with the traffic problems in cities, and the attempt to improve the optimality of public transportation systems through devising the functional indices for them which is known to be an effective measure for exploiting them (Khaksari et al., 2011, p. 2). Public transportation system in Tehran, Iran has significantly developed in recent years, particularly in relation to subway and bus rapid transit (BRT) systems. Mirdamad Boulevard in Zone 3 of Tehran is a specific transit center as one of the most important official and

commercial centers where Mirdamad Station Complex (MSC) is located. As station complexes are constructed in accordance with some predetermined standards and principles, MSC is expected to become more efficient since it is located in a specific area and plays a critical role in local public transportation system. The present study aims at measuring the extent of realization of these principles in MSC given the functional principles of transit-oriented development (TOD).

* Corresponding author email: Shahabian@iauctb.ac.ir



THEORETICAL FRAMEWORK

Transit-Oriented Development: Principles and Concepts

The developments after the World War II were supported by the projects defined by decentralization, unstructured development of suburbs and vehicle-dependent development. Communities realized the drawbacks of this type of development in the 1980s and 1990s and smart development attempted to provide solutions for overcoming these drawbacks, one of which was TOD, a practical approach fostered by new ideas (Rezabeigi et al., 2011, p. 2).

As a new, growing approach, TOD focuses on the land-uses around transit stations and/or transit tracks. It aims at reducing the use of personal vehicles by increasing the number of trips which people make on foot or by bicycle, shared vehicles, bus or other public vehicles. To realize these ends, peoples with high travelling potential are approached to transportation facilities, rather than pushing them to suburbs, which are far from population centers and result in more dependence on roads and personal vehicles. Closeness to transit stations allows increasing life quality with no complete reliance on personal vehicles (Feri, 2004, p. 16).

When TOD was introduced into urban planning and designing, it was widely perceived as a solution for prevailing diffusiveness and an approach for smart growth. TOD is defined by Dittmar and Patika as a mixture of land-uses with various densities within a half mile of a transit station. Parker defines TOD as a moderate to higher density development, located within an easy walk of a major transit stop, generally with a mix of residential, employment and shopping opportunities designed for pedestrians without excluding the auto bus with an emphasis on pedestrian (Houshmad E. Masoumi, 2010, p. 2).

Calthrop is one of those who describes the details of this development pattern and notes that TOD is a center with a dense mixed residential, commercial, official use and public places where retail and service shops are located in, with a commercial core and easier access than the houses (about 600 m). A public transit stop is located in the core of this center and the land uses of the center are for public purposes while offices are located in upper floors. The four essential components of a TOD unit include commercial space, residential space and secondary parts as shown in Fig. 1 (Rafi'ian, 2009, p. 82).

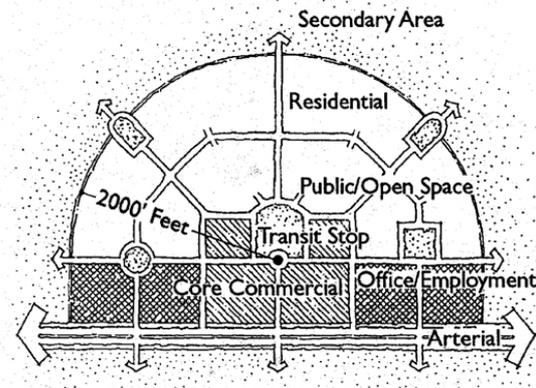


Fig. 1. Calthorpe's Idea about TOD (Calthorpe, 1993, p. 78)

In another definition, TOD is considered as to be a mixture of land uses with public transit as well as creating intensive, walkable neighborhood and mixed land uses with an easy walk from transit station. This kind of development brings together people, jobs, and services which is designed in a way that makes it efficient and safe to travel on foot or by bicycle (Canpzd, 2006, p. 5). Calthorpe characterized TOD with these features: organizing regional growth for supportive transit; mixing commercial, residential, employment, parks and services land uses with given opportunities for pedestrians to walk between trans stop spaces; creating close pedestrian networks with direct contact with local destinations; providing various types of residential spaces in terms of density and cost; conserving sensitive stations in terms of coastal areas and high-quality open spaces; creating public spaces with an emphasis on the orientation of the buildings and local activities; encouraging redevelopment inside the transit lanes in the neighborhood (Soltani et al., 2010, p. 3).

The characteristics of TOD can be summarized as following functional integration between land uses and transit:

1. Special attention to pedestrian courses within 0.4 - 0.8 km of the transit station
2. Intensive and dense development
3. Designing a space and station generating an activity core
4. Encompassing transit station with high density development in the center and its expansion to outside with lower densities
5. Mixing residential land use with retail and service land uses
6. Encouraging walking and bicycling with convenient accessible sidewalks



7. Creating comfortable, friendly and convenient sidewalks using good local malls and creating spatial persistence in streets
8. Mixing diverse views of residential, official and retail buildings and finally, creating a mixed structure
9. Building diverse houses for different classes in the community
10. Creating a green belt and park
11. Creating street signs and improving attractive entrances
12. Creating an inter-connected transit network (Transit Oriented Development Guidbook, 2005, pp. 5-7)

When looking at sustained TOD concept, in addition to physical characteristics like density, land use mixture, service levels of transit system and the connections among streets, qualitative criteria should be taken into consideration too so that TOD is a development that seeks six following qualitative objectives:

1. Locale efficiency in terms of density, convenient and pedestrian-orientation
2. A rich combination of choices for different residential options and the possibility for diverse activities for all social classes
3. Realizing social, economical and environmental values in the locale
4. Creating locale in accordance with designing principles for people
5. Coping with the tension between mixed land uses (Behzadfar et al., 2011, p. 3)
6. Enhancing livability like improving air quality, increasing transportation choices, enhancing access to retail and service centers, public spaces as well as improving social and economical health and security (Balzer, 2002, p. 12).

Advantages of TOD

The uppermost advantage of TOD is that it can help urban districts and Municipalin fulfilling sustained development principles. TOD increases the choices for public transportation and reduces the use of personal vehicles. On the other hand, it improves the useful use of the existing lands, infrastructures, services and supportive measures while maintaining social centers and neighborhoods by encouraging re-uses of the lands, land use change and internal development. TOD enhances the sense of belonging to locale by creating centers with mixed land uses where residential and commercial land uses are mingled. It can create a passion for the locale by providing security and high quality urban design and

attractive connecting paths among land uses. An essential objective of TOD is to create connections among business, recreation, shopping and living centers within walk-able distance from the transit station so that people can conveniently use public transportation system instead of personal vehicles (Rezabeigi et al., 2011, p. 16).

Benefits of Using TOD

The benefits of TOD can be divided into two groups: transportation and nontransportation benefits.

TRANSPORTATION BENEFITS

- Lower number of long trips with personal cars: TOD reduces the reliance on vehicle on one hand and the distance that should be driven for personal, educational, shopping, recreational trips on the other hand. The relevant advantages include improved air quality, reduced infrastructure costs and increased life quality via reduced trip time of personal vehicles.
- Higher residential mobility: placing residential and job opportunities in the vicinity of transit station leads people towards public transportation through which moving options are increased. This is especially important for disabled people or people who are reluctant to driving (e.g. teenagers, elderly, disabled people and low-income classes).
- Higher Access to Requests: in addition to helping the mobility, the placement of residential, job and service buildings near the transit stations in the form of mixed land-use allows people to do their daily activities with shorter and more extensive trips.

NON-TRANSPORTATION BENEFITS

- Transit-irrelevant advantages are associated with transit-oriented transportation resulted from the deployment of moderate-to-high density buildings with mixed land-use pattern near the transit stations. These advantages are partially understandable without transit component too. Some transit-irrelevant advantages of TOD are as follows:
- Increased public safety resulting from high-density, mixed-use development in a pedestrian-friendly environment, creating vibrant and lively neighborhoods
- Increased household disposable income as a result



of reduced reliance on personal automobiles and therefore decreased transportation costs

- Conservation of open space, possible by focusing development in high-density, established urban centers;
- Increased land availability for public space, as a result of compact, high-density development;
- Economic development opportunities provided by mixed-use urban centers based around transit;
- Increased tax base for local government, as a result of the TOD attracting commercial and retail activity;
- Affordable housing, made more financially feasible due to zoning for higher-density residential use; and
- Increased diversity of housing choices within a region, including apartments and condominiums in a mixed-use environment (a shto, 2006).

Subway Station Complexes

Station complexes are multi-purpose projects for creating commercial, official, cultural, recreational and residential complexes near public transportation stations (with a commercial core). These complexes increase investment on public transportation (subway and light urban train), establish access among complexes and stations by creating attractive, safe sidewalks, and finally, increase trips done by public transportation. Therefore, TOD is regarded as a method for concentrating the population around transit stations and reducing their reliance on personal vehicles. In this method, residential, commercial and official buildings are constructed in a manner that the distance is <0.5 mile from the transit station allowing residents and workingmen to travel on foot or by bicycle. In this method, it is tried to have the entrance of these complexes towards the transit stations and main streets and to place public parking spaces behind the complexes or under/over the ground (Montazeri, 2012, p. 6). A subway station is placed in the core of this district enclosed with quite dense, advance complexes with mainly commercial and official land-uses (Behtash, 2004, p. 28). Furthermore, station complexes can reduce transit per capita costs, increase trip options, and create an enjoyable atmosphere for residents by enhancing public transportation services in its realm (Sarikhani, 2004, p. 85).

Metro stations can be classified in three groups:

- Suburban neighborhoods around transit stations, metro in particular
- As gradual changes in urban districts and neighborhoods where metro lines crosses,

especially around the entrance and exit of the station

- Within the radius of 400-800 from station center which is regarded as pedestrian walking radius (Sarikhani, 2004, p. 83).

Objective of constructing metro stations

1. Improving the structure of the spaces around metro stations and correctly, stably orienting urban development and creating high-quality, attractive urban spaces
2. Using value added and facilities of constructing metro stations in lands and buildings around them for providing the resources required for metro development (the cooperation of public sector, private sector and foreign investment)
3. Reforming town structure and changing its architecture from traditional to modern form and creating attractive, mobile regions
4. Sound mixture of land-uses, reducing the volume of trips inside the city & playing a decisive role in urban development
5. Realizing land-based employment
6. Providing conditions for absorbing inside-city trips that can be done by personal vehicles
7. Leading investments by people, private sector & public sector towards the development of metro stations & routes (Behtash, 2004, p. 3)

In total, the construction of metro station is regarded a modern method for leading total urban management-oriented construction. In many crowded cities of the world (Tokyo, Seol, Beijing, Helsinki, ...) station complexes are constructed to improve the chances for planning and increasing the availability of governmental offices, shopping centers, recreational facilities, services, etc. , so that the construction of such complexes is a part of their high-priority strategies for urban development plan.

The benefits of these complexes fall into four categories

- Economical benefits including the increase in land value and benefits related to the sale and renting of units with various land-uses in stations. Other economical impacts include money-making resulting from the construction and development of denser transportation systems
- Social benefits including employment opportunities as well as improving social welfare.
- Urban development benefits including renewal of urban structures, accumulating old structures,



improving city view and creating chances for urban development with diverse land-uses.

- Transit and environmental benefits including the decrease in daily commuting length and the increase in the contribution of public transportation and its optimal role in inside-the-city daily trips which would have such results as lighter traffic in routes, lower fuel consumption, and lower air pollution (Montazeri, 2012, p. 7).

Land-uses of Metro Stations

Although the debate is mainly on the commercial core near the center of public transportation station, the sound distribution of land-uses throughout the station, too, is of a special importance. The land-uses in station play direct or indirect role in affecting and being affected by the station.

These land-uses are divided into the following groups:

- terminal (metro/taxi, metro/bus)
- Office space
- Exhibition space
- Commercial buildings
- Medical centers
- Public parking spaces for metro ridership's personal vehicles (Rahnavard, 2009, p. 4).

Types of Metro Stations

There are two types of metro stations.

Underground Commercial Complexes Inside Metro Stations

In methods in which the tunnel of metro lines dug under the ground, instead of filling the level from tunnel to street level, cement ceilings can be built to have commercial floors where commercial booths and salons are embedded. In addition, commercial complexes can be constructed next to gateways and ticket booths where passengers pass across during commuting which in itself increases the value of commercial salons.

Station Complexes Adjacent to Metro Stations

When locating the lines and stations inside the city, urban train companies can buy the spaces around the stations for defining station complexes where gateways of the metro are placed or is transferred directly from underground to the stations. The underground spaces can be dedicated to parking space, the middle floors to commercial booths and salons, and the upper floors to athletic, cultural and official salons (Montazeri, 2012, p. 8).

Functional Principles of TOD in Station Complexes

The planning and implementation of TOD projects face their own special challenges. There are no integrated regulations about the planning and implementation of TOD projects, but a reasonable framework can be set on the basis of four principles emphasized by most eminent theorists of TOD as follows.

Intensive Development

TOD Scale

In total, TOD borderline is defined by the distance from transit station. Since the main users in TOD are pedestrians, it is defined by the distance which is comfortably and safely walk-able. The common comfortably walk-able distance is regarded as to be 600 m or for 5-10 min. Furthermore, the borderline of TOD is influenced by walking people access obstacles like freeways, land topography and the train rails (Behzadfar & Zabihi, 2011, p. 4).

Block Attributes

An important aspect of urban planning projects is the differentiation of lands. The smaller the blocks are, the higher convenience and access for pedestrians would be and the more optimum conditions for higher densities would be. It means that the planning and designing is based on the principle of penetration according to which the smaller the blocks are, the more penetrative they would be. The penetration of a system of public spaces depends on the number of potential routes for going from one point to another. These potential routes should provide visual penetration, too. Both skeleton and visual aspects of penetration depend on how public space network blocks the environment. A space composed of small block has more number of access routes than a space composing of only one big block (Behzadfar & Zabihi, 2011).

Buildings Intensity and Density

The activity centralization and density in support of transit system and creating vivacity in street are key factors in improving environment quality. The high density should be where the best access to transit system is guaranteed under which it would support more number of passengers. On the other hand, since pedestrians are the main users of TOD, the density must be so adjusted that people can readily walk to their destination with face-to-face communication and without fearing the large



scales. Density brings about three advantages to transit service improvement:

- allowing the connection of many routes to different points
- reduction of fees if transportation system is used more
- reduction of the sequence of vehicles due to high density (Abbaszadegan et al., 2011, p. 48).

Land-use Mixture

One essential component of TOD and pedestrian-friendly development is the mixed land-use. It attracts pedestrians and since it makes the points of departure and destination closer, it internalizes the trips in TOD realm.

The application of mixed land-uses and the simultaneous occurrence of shopping, job and residential centers near transit stations make them destinations for trips with different objectives with just one stop (Hedayati, 2002, pp. 5-12).

Land-uses are mixed in three forms: vertical, horizontal and residential-job functional. Vertical mixture of land-uses is to locate different land-uses in different floors of a building. One common type is to place commercial land-use (like retail) in ground floor and to place residential or official land-uses in upper floors. Locating land-uses whose activity center around traffic in the ground floor next to main streets is usually forbidden. The horizontal mixture of land-uses is to locate consistent land-uses next to each other in adjacent block or one single block (Behzadfar & Zabihi, 2011, p. 5).

Land-use Type

It is necessary to have a suitable mixture of consistent land-uses to ensure the economical success and sustainability of the development. This is especially

important in TOD with a direct impact on the number of passengers who use transit system and on pedestrians' activities. The zoning of areas under TOD around a station should be checked for the land-uses potentially inconsistent with the principles for which the land-uses are divided into permitted, prohibited and conditional uses (Valley Connections, 2001, p. 5).

Pedestrian-Friendliness

Creating attractive, pedestrian-friendly environments is a crucial goal of TOD which should be sought as a key principle in constructing the sidewalks in transit stations like metro and bus stop. It can be realized by creating attractive complexes for walking people by designing, caring the orientation of the buildings and entrances, the sound connection of the streets to alley networks, and caring the width of sidewalks in accordance with climatic conditions (Behzadfar & Zabihi, 2011, p. 15).

Transportation and Handling Facilities

In TOD, the use of public transportation and sidewalks is the prevailing pattern for handling the residents and users which reduces the demand for parking. The parking spaces and all other transportation facilities must be constructed cautiously and should not have a control on the environment. They should not become obstacles for pedestrians. The demand for parking in TOD should be planned and fulfilled with a close attention to such facts as the parking spaces shared by complementary land-uses, internalization of trips inside the developing space, and the use of both sides of the streets as parking space (Behzadfar & Zabihi, 2011; Fari'ian et al., 2009).

The principles and criteria of land-uses in TOD in station complexes discussed in literature can be summarized as following.



Table 1. TOD Land-use Principles

Principles	Criterion		Index	
Intensive development DoinaOlaruet al., 2011, p. 220 K.A. Ratner et al., 2013, p. 32 Behzadfar and Zabihi, 2011, p. 41 Larimian et al., 2011, pp. 11-12	Scale CANPZD, 2006, p. 18	Distance of 600 m (5-10 min walking) Intermediate Transfer	Gateway Immediate Realm of the Station (100-150 m)	
			Intermediate Realm with Residential, Office and Retail Land-use	
			Realm with the Lowest Building Height and Density with Dominantly Residential Land-use	
	Block attribute Greenberg, 2004, p. 73 CANPZD, 2006, p. 9	Small Building Blocks with the Width of 200-400 Feet for Increasing the Access and Optimum Density		
Building Intensity and Density Valley Connection, 2001, Ch.3, pp. 11-14	Equal or More than the Highest Density in Adjacent Areas			
Mixed Land-uses Valley Connection, 2001, Ch.5, pp.7-8 DoinaOlaru et al., 2011, pp. 220 K.A. Ratner et al., 2013, p. 32 Behzadfar and Zabihi, 2011, p. 43 Rafi'ian and AsgariTafreshi, 2009, p. 89 Larimian et al., 2011, pp. 11-12 Abbaszadegan, 2011, p. 46	Land-use type Daisa, 2004, pp. 115-116	Permitted	Land-uses Supporting Public Transit with High Density (Banks, Restaurants, Pharmacies, Parks, Recreational Centers, Supermarkets)	
		Prohibited	Land-uses Interfering with Pedestrians' Safety (Carwash and Car Repair, Auto Trader, Materials Sale and Cemetery)	
		Conditional	Public Land-uses Like Gas Station, Open Parking Space and Athletic Facilities	
Pedestrian-Friendliness CANPZD, 2006, p. 10 DoinaOlaru et al., 2011, p. 220 K.A. Ratner et al., 2013, p. 32 Behzadfar et al., 2011, p. 44 Rafi'ian et al., 2009, p. 87 Larimian et al., 2011, pp. 11-12	Taking Care of Buildings Orientations and Gateways		Buildings that Should Withdraw by 3-5 m and have Gateways to Sidewalks	
	Appropriate Connection of Streets		Sound Connection of Streets and Taking Care of the Hierarchy of Access	
	Appropriate Width of Sidewalks		3.6-4.5 m in Commercial and Mixed Areas	
	Appropriate Facilities for Pedestrians		Additional 2.5 m in Parts with Service Land-use Like Restaurants for the East of Motion for Pedestrians Bicycle Parking, Lanes for Pedestrians to Cross the Street, Urban Benches for Increasing the Number of Pedestrians	



Transit Facilities DoinaOlaru et al., 2011, p. 220 K.A. Ratner et al., 2013, p. 32 Behzadfar et al., 2011, pp. 44 Rafi'ian et al., 2009, p. 87	Construction of Parking Space	Construction of Marginal and Share Parking Space for Efficient Use of the Space
	Accessibility	Coverage of Public Transit Stations Like Metro and Bus stops

METHODOIOGY

Given the objective of the research, i.e. the evaluation of the extent of the realization of TOD functional principles in station complexes, the methodology used in the present study was practical and analytical-descriptive. Analytic hierarchy process (AHP) was used for evaluating the extent of the realization of these principles in Mirdamad metro station (MMS). AHP is a flexible, vigorous and simple method that is used when a number of criteria and sub-criteria are dealt with in decision-making. AHP starts with identifying the elements and criteria of decision-making. These elements include criteria, sub-criteria or attributes. Then, experts' opinions are studied to find out the importance of these criteria and sub-criteria and to dedicate a weight and final importance to them.

Four main criteria are chosen in the present study including intensive development, mixed land-use, pedestrian-friendliness and transportation facilities. The sub-criteria of intensive development included

the scale, block attribute and building density; those related to mixed land-use included land-use type; those related to pedestrian-friendliness included caring building orientation, sound connections among street, and appropriate width of sidewalks; and those related to transportation facilities included parking spaces and convenience. A set of these criteria and sub-criteria generated a framework for applying AHP. This method allowed the evaluation of the extent of the realization of the foregoing principles. After identifying the criteria, their relative importance should be recognized too. Therefore, the relative importance of criteria and their sub-criteria was determined on the basis of the opinions stated by five experts. At the next stage, all criteria and their relevant sub-criteria should be collected in one single structure for which the importance of the criteria was multiplied to the importance of their sub-criteria. After calculating the final weight in AHP, the next step was to determine their status in MMS. The results show how much the four land-use principles are realized in MMS.

NO	Levels of Attention to Sub-Criteria Under the Present Status score	
1	Very Low	1
2	Low	2
3	Fair	3
4	High	4
5	Very High	5

AN INTRODUCTION TO CASE STUDY

Mirdamad Street is a particular commuting route in Zone 3 of Tehran which is connected to Shariati Street from east and to Vali-asr Street from west. It is known as one of the most important official and commercial centers in the region. This street as a mixed land-use therefore most of land-uses along the street have been changed from residential to commercial and official land uses

or they are used in the mixed form. Mirdamad Station Complex is one of the stations along line 1 of Tehran metro which is located around Mirdamad Boulevard. The main roads crossing with this street are Africa Highway, Modarres Highway, Naft Street and Madar Square. The area of covered space of this station is over 2422 m2 which was started to work in 2009. As stated, the standard construction of a station complex should be based on some pre-determined principles. Considering



the special position of Mirdamad station and its role in regional public transportation, it is expected to be an efficient station. Therefore, the consistency of this station with these principles is studied to find out the extent of their realization.

Comparative Study of Functional Principles in MMS

Intensive Development

The borderline and functional scales of a TOD vary in the range of 400-800 m according to the distance to the transit station with an emphasis on pedestrians' access. The given location of MSC in terms of being in realm of main commuting routes (Mirdamad Boulevard, Jordan Street and Madar Square) and the field perception, the land-use realm of MMS was considered as 600 m in the present study which was in itself divided into three realms

of gateway, intermediate and transfer. The gateway realm is where the passengers enter and exit through. In the realm under the present study, the integration of street view with public transportation and the appropriate connection of the station and surrounding buildings were considered. Intermediate sub-realm was located between two other sub-realms which had residential and official land-use – as shown in Fig. 2 – and finally, the transfer sub-realm had mainly residential land-use with the lowest building density and height.

Another principle under the present study was the block attribute in the realm of TOD. The study showed that MSC had blocks with dimensions of 600-1200 m. The dominance of buildings with five floors or over like Rose and Nader commercial complexes and Pars Shisheh office tower in the gateway realm reflected the high building density around the station and as moving away from the station, the density and height of the residential locations in the intermediate and transfer realms decreased.



Fig. 2, 3. Limited of Mirdamad Station Complex

Mixed Land-use

The application of mixed land-uses: shopping, job and residential center near transit (metro) stations changes Mirdamad station to a destination for one-stop multi-purpose trips. According to field perception and existing land-use map, the land-uses around the station are divided into three groups of permitted, prohibited and conditional. The active land-uses on the skin of Mirdamad Boulevard and supporting land-uses like banks, restaurants, open, green spaces, etc. in a vertical combination adhering to the placement of commercial land-uses in ground floor and residential and office land-uses on the upper floors shows adhering to land-use combination in this station, whereas no public green space is observed around the

station which is the drawback of this station. However, the lack of prohibited land-uses looks like materials sales, carwash, etc. which ensures the security for pedestrians, can be regarded as strength of this station. There are some conditional land-uses looks like gas station, open parking space and athletic facilities around Mirdamad station which need to be revised in future plans.

Pedestrian-Friendliness

Creating pedestrian-friendly environment is an important principle that should be taken into consideration in the realm of station complexes. Considering the hierarchy of access like slow-motion lanes, withdrawal from sidewalk level in such commercial complexes as



Rose and Nader, two pedestrian bridges in MSC and appropriate width of sidewalk we can come to conclusion that the station has been design in accordance with land-use principles. On the other hand, bicycle routes and

their supporting facilities like bicycle parking space are among the issues that should be dealt with in this station complex.



Fig. 4, 5, 6. Transit Facilities in Limited of Mirdamad Station Complex

Transit Facilities

Regarding transit facilities around MSC, the existence of public parking space in Rose commercial complex, provision of facilities for lateral parking spaces like park meter and slow-motion lanes in Mirdamad Boulevard, the

coverage of this station with two bus stops at most 200 m apart, and caring the access hierarchy in the connection network can be listed as the positive attributes of this station complex in realizing the objectives of TOD as shown in Fig. 2. Table 2 summarizes the evaluation of land-use principles of TOD in MSC.

Table 2. Evaluation of TOD Functional Principles Around Mirdamad Station Complex

Criterion	Score	Sub-Criterion	Score	Description	Current State Score	Total Weight
Intensive Development	0.08	Scale	0.63	The immediate realm of the station and gateways where the consistency of street view with public transportation should be noticed. It has been done in MSC by connecting it to a commercial body (Rose commercial complex) The presence of residential, official and retail land-use The realm with the lowest building height and density with dominantly residential land-use and land-uses in the scale required by neighborhood	8	0.4
		Block Attribute	0.1	The presence of small block with the diameters of 600-1200 m around MSC which had been so effective in increasing the accessibility.	8	0.17
		Land-use Intensity And Density	0.27	The presence of high buildings like Pars-Shisheh building and Nader tower is decreased with the distance from the station and the height and density are increased in residential parts.	8	0.17



Mixed Land-use	0.15	Land-use Type	1	<ul style="list-style-type: none"> - Banks, restaurants, pharmacies, parks and recreational centers, and green landscape are regarded as permitted land-uses. There are weaknesses in access to green landscape and parks in land-use realm in MSC. - Carwash, auto traders and materials traders are regarded as prohibited land-uses. The presence of auto traders in the realm of MSC is regarded as an example of prohibited land-use - The presence of gas station, open parking space and athletic facilities in the realm of MSC is regarded as conditional land-use which needs to be revised in future plans considering their inconsistency with land-use realm in MSC. 	5	0.75
Pedestrian-Friendliness	0.51	Noticing The Orientation of Buildings and Gateways	0.09	Withdrawal of buildings (3-5 m) like Rose commercial complex, Nader tower and Parsian Bank and connecting the gateways to sidewalks are examples of those issues which should be considered in the realm of MSC with respect to pedestrian-friendliness.	7	0.32
		Sound Connection of Streets	0.17	Attending access hierarchy and the presence of slow-motion networks which correctly connects Mirdamad Boulevard to MSC gateway are the good attributes of this station in improving the access and performance.	8	0.69
		Appropriate Sidewalk Width	0.74	The appropriate width of sidewalks is 3.6-4.5 m in commercial and mixed areas with additional facilities for disabled people like special lanes for blind people In areas with service land-use like street restaurants, additional 2.5 m is required for the ease of motion and access for pedestrians which had been taken care of in the studied station	6	2.26
Transit Facilities	0.26	Construction of Parking Spaces	0.16	Constructing marginal and share parking spaces	7	0.29
		Accessibility	0.84	The presence of bus stops around MSC 500 m apart reflects the appropriate coverage of transit stations. The lack of bicycle lanes and supporting facilities like bicycle parking reflects inattention to land-use principles around MSC.	6	1.3
Total	1					6.24

RESULTS AND CONCLUSION

According to the points mentioned about TOD, it is a new approach which is different from traditional approaches and is based on four principles of (1) intensive development, (2) mixed land-use, (3) pedestrian-friendliness and (4) transit facilities around station complexes and tries to solve the problems arisen from lack of the attention to land-use principles around these stations. Therefore, the present study aimed to

study the principles and indices of land-use which are realized around MSC and also identify their drawbacks with the objective of improving the quality of land-use in metro stations, especially MSC. To do this, the criteria and sub-criteria were identified by AHP method and they were weighed. Then, the sub-criteria were scored to find out the extent to which the criteria and four land-use principles are realized in MSC. Considering the scores of the sub-criteria, the total weight was determined by



multiplying the score of the criteria to the relevant sub-criteria. In fact, considering the present status of MSC and the scores of the sub-criteria, the score is 6.24 out of 9 resulting in total score of 69.4 implying that MSC has a suitable status despite having some drawback. Then, the scores of the sub-criteria were studied to compare them and their prioritization in improving the realization of the land-use principles, so that the higher the scores of the sub-criteria were, the more important they were. However, if an important sub-criterion had a low score in the present status, it needs to be revised and to be tried to realize it. For example, out of the studied sub-criteria, the sub-criterion of appropriate width as the most important sub-criterion among pedestrian-friendliness sub-criteria had the score of 6 and so, it is regarded as the most important sub-criterion for realizing pedestrian-friendliness principle under the present status. Considering transit facilities as the most important sub-criterion, the accessibility obtained the score of 6 because of the lack of bicycle lanes and the supporting facilities like bicycle parking. It is ranked the second priority after the appropriate width. Then, the mixed land-use sub-criterion acquired the score of 5 and was ranked as the third most important sub-criterion because of the existence of non-permitted land-uses like auto trader and conditional land-uses like athletic field and gas station. It needs to be revised in future plants for organizing the land-uses. Similarly, the extent of the realization of land-use principles in MSC can be evaluated by comparing its criteria and sub-criteria. At the next stage, given the extent of the realization of these principles, some strategies were studied for realizing TOD objectives and improving this station:

- Increasing urban spaces and public spaces around the station for improving the environmental quality and increasing the efficiency of the station
- Creating safe, consistent sidewalk network with appropriate width equipped with urban benches and light system for socially disabled people
- Planning for development public and marginal landscape given its lack in MSC
- Excluding the land-uses inconsistent with TOD nature like carwash and auto traders around MSC
- Attending the re-planning for organizing the conditional land-uses like gas station around MSC
- Creating appropriate ground for improving pedestrian-friendliness around MSC by creating suitable bicycle lanes and their supporting facilities including bicycle parking.



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