RESEARCH ARTICLE

European Journal of Architecture and Urban Planning
www.ej-arch.org

The Criteria and Indicators for Applying Transit-oriented Development (TOD) in Metropolitan Cities Based on Lessons Learned from the International Experiences

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ABSTRACT

Most countries in developed countries have been implementing the TOD approach in their urban planning. TOD design in urban planning is not a new theory and has existed for almost three decades since the 1990s, and then it has been applied to a lot of various model designs suited to a country's purposes. The aim of using TOD depends on urban form, the physical aspects, socio-economic, cultural sides, and political views (policy) connected highly to each other. This paper depicts a literature review and critical review of the successful TOD from international practice gathered by researchers in recent decades. The authors realize that many documents on TOD focus on analysing the existing TOD and evaluating TOD, and the paper presenting the TOD guideline, especially the new-modern design of TOD, is limited. Therefore, the authors review the criteria and indicators and find that there are two objectives of TOD design, macro, and micro levels. At the macro level, the TOD focuses on determining the nodes of all public transport and creating a well-integrated system between the city structure (urban center, urban, and suburban) and its element. The micro level focused on urban design, like pedestrian ways, bicycle paths, station affordability, road design, parking lots, building structure and design, and others. The authors formulate the criteria and indicators in the TOD planning guideline, and it will be rules of TOD for the country in developing countries, which have not to apply for TOD or to improve their TOD effectively based on the successful TOD in any models.

Keywords: international practice of TOD, macro and micro level, planning guideline, transit-oriented development.

Published Online: May 06, 2023

ISSN: 2796-1168

DOI: 10.24018/ejarch.2023.2.2.25

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I. Introduction

Model Transit-Oriented Development (TOD) is a popular theory in urban planning to achieve sustainable urban development involving all aspects of urban features (AlKhereibi *et al*., 2022; Renne & Listokin, 2021). The TOD is part of the model new urbanism theory of urban planning founded in America in the 1990s (Pojani & Stead, 2018), and first implemented TOD is prominent by urban design principle (Quinn, 2006), then currently, the range of TOD theory and strategy has widely grown with the contemporary design modified from its original concept and the part planners, researchers called this theory with the evolution of urban design theory (Niu *et al*., 2021). Moreover, the base concept of transit-oriented development is focused on integrating public transport into people (density), land use (mixed-use), environment, urban design, urban corridor, and the main urban features between the urban centre and suburban centre (Rahman *et al*., 2022). In this decade, all metropolitan cities require a TOD system as an indicator of sustainable development (Thomas *et al*., 2018; Wang *et al*., 2022). Hence, the TOD is an assessment method of knowing the integrated public transport with land use, people, and urban design. Some works of literature mention that TOD systems integrate the neighbourhood, commercial, work, and entertainment with nodes-development of public transport (AlKhereibi *et al*., 2022). Hence, one of TOD's aims is to reduce the air pollution of private cars and increase walkability (Ibraeva *et al*., 2022). In addition, the TOD system influences socio-economic aspects like social ties. The implementation of TOD for each country in Europe, the United States, and Asia has a different method and purpose, and it depends on what they need for the city. In its country of origin, the United States, TOD is concentrated on relocating construction near transit stops in order to address the suburban sprawl crisis (Song *et al*., 2021). Recently, in California, TOD refers to household travel by TOD, and transit stop of TOD tends to closely with living housing to enhance and create more travel preferences (Chatman, 2014). In Europe, the emphasis appears to be shifting more toward station refurbishment, for example, the public transportation system of Amsterdam is comprised of metro,

tram, bus, and bicycle (Song *et al*., 202; Pojani & Stead, 2018). Papa and Bertolini (2015) in their research found that in Europe, greater accessibility to trains is seen in urban areas where people live, and work more closely together than it is in urban regions with greater levels of network connection. In Asia, TOD focuses on how to integrate public transport into the areas having high development function, such as in China, the central commercial area, business area, open area, green space, and residential area focused to integrate TOD (Blust, 2022).

In this paper, we write about the criteria and indicators of the successful implementation of TOD based on international practice in some countries. Many metropolitan cities are still having problems with its public transport, which is not effective yet, like the rich countries in the gulf countries and African countries not having yet TOD systems (Kuwait, Muscat, Riyadh (Youssef *et al*., 2021), Jeddah (Aljoufie, 2014; Halawani & Rehimi, 2021), Ethiopia (Teklemariam & Shen, 2020) and Asian & African countries with ineffective applications for TOD (India (Khare *et al*., 2021), Dhaka (Rahman *et al*., 2022), Hanoi (Iida *et al*., 2022), and Bangkok (Nyunt & Wongchavalidkul, 2020)). As a metropolitan city, they have significantly emerged city problems which are the high private car ownership, difficult access to public transport, limited optional choice of public transportation, and less access to pedestrian ways (Z. Li *et al*., 2019). Therefore, in the future, if we do not do planning that involves sustainable development, it will be a severe problem, traffic congestion, an unfriendly city, air pollution, crowded city, etc. Based on the theory and strategy of TODs, these problems can be managed by implementing the indicators and criteria of TOD. Many conveniences can be obtained from TOD, such as enhancing the economy (income), diversity (social ties), pedestrian-friendly, and the well-integrated primary function of the city (commercial, residential, industrial, etc.).

Applying TOD is one of the solutions to reduce the problem regarding public transport management and to create a liveable city (Z. Li *et al*., 2019). Teklemariam and Shen (2020) state that TOD advantages include enhanced accessibility. Public transportation leads to more opportunities, walkable environments, higher transit ridership, low air pollution and greenhouse gas emissions, enhanced employment access, and healthy lives. There are direct and indirect benefits to TOD. The principal advantages are those benefits might accrue to the transit agency, including higher ridership and revenue, local redevelopment, and economic gain through cooperative development, and transit agency. Indirect advantages of TOD include congestion reduction, land conservation, lower road expenses, and enhanced safety for pedestrians and cyclists (Teklemariam & Shen, 2020).

A. Research Problem

Metropolitan city has been growing continuously, and it will face the real city problems mentioned above (Wu & Li, 2022). Each city aims to create its town as walkable, liveable, comfortable, accessible, and public transport is one of the keys to these purposes. Currently, in the authors' view, most metropolitan cities as fast as grow significantly and overlook integrated public transport and some countries are not optimal in using the TOD system as a solution because they ignore some main criteria and indicators. Therefore, the authors state that the problem statement of this paper is "Many countries (developed and developing countries) do not yet implement of TOD strategy for their integrated public transport, and then some countries are not optimal in TOD application". Hence, the appropriate strategy we can use for these aims is TOD planning which will be reviewed in this paper.

B. Research Question

In this paper, the authors will resume the indicators and criteria for implementing TOD concluded in a planning guideline and formulate the research question for writing as follows.

1) What is the international practice of applying the TOD system in the city?
2) How does the TOD system work by lessons learned from international experiences?
3) What are the criteria and indicators for selecting and applying the ideal TOD and its ideal criteria for TOD position?
4) What are the planning guidelines of TOD formulated in this paper?

C. Research Objective

This paper focuses on the indicator and criteria of TOD gathered from international practices as one solution for public transport in a crowded city. The discussed topic relates to the integration of public transportation, transit stop, and the structure of main city activities, which consist of suburban, urban, and urban centre.

Authors identify the main objective, which is to find out the criteria and indicators of TOD strategy from successful global practice. Therefore, the end of this paper will give the guideline frame of TOD to manage the city's problems concerning transportation, environment (air pollution), accessibility, walkability, and urban sprawl.

The specific objectives consist of:

1) To describe the successful international practice for TOD strategy.

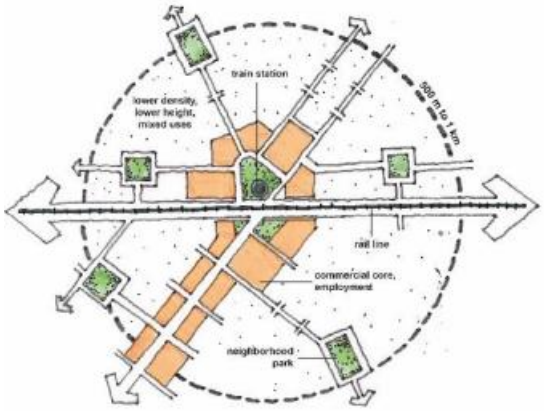
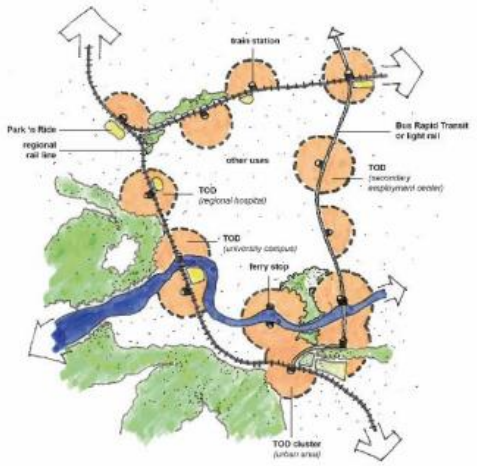
2) To find out the working of TOD system.
3) To gain the criteria and indicators of TOD based on the successful implementation.
4) To determine and conclude the planning guidelines of TOD strategy.

D. Research Method

This paper tends to a literature review and critical review of how essential the TOD is and what are the indicators and criteria of TOD based on international practice. Then, the similar characteristic of the city that has successfully implemented the TOD from international practice to be a benchmark for a case study for metropolitan cities which have not yet designed TOD and are not optimal in applying TOD. It can be a planning guideline to create a potential area for using TOD in policy, position (macro level), and urban design (micro level). The organization of the written paper consists of the introduction (explaining the theory, problems, how important the issues are, and what are the effects of the problem), the research problem, the research question, the objective of the research, the method, the literature review, thereafter the finding, and discussion, then the final is a conclusion.

Pojani and Stead (2018) present (Table I) the summary of the criteria, primary TOD types, traits, and designs based on the TOD theory.

TABLE I: TYPES OF TOD SYSTEM (POJANI & STEAD, 2018)

TOD Design	TOD types	Key Traits
	One-Node TOD System	➢ A solitary community built on major rail stations ➢ Circular construction around a train station ➢ City or suburban setting ➢ 0.5 km is the ideal radius (walking distance to the station).
	TOD multiple-Nodes	➢ Nodes in a regional network centered on heavy rail stations ➢ City or suburban setting ➢ Nodes with circles or semicircles ➢ Common "beads-in-a-string" pattern Complementary nodes as opposed to competitors ➢ Workplace specialization at nodes (such as in higher education or the health care sector, for example)
	Urban Corridor TOD	➢ Centered on stops for bus rapid transit or light rail transit ➢ Urban setting ➢ Development pattern that is linear or ribbon-like along a transit line (s) ➢ Applicable to planned or current urban extensions (along fingers or lobes) or existing urban areas

Today, The design model of TOD enlarges in any model, green TOD is one of the current model adhering green environmental and ecological concepts that have been successfully implemented in Singapore with five basic concepts (density, diversity, design, destination, and distance) (Niu *et al*., 2021). The several aspects of TOD impact different phases of planning, design, implementation, assessment, and evaluation in urban environments (Patnala *et al*., 2020; Thomas & Bertolini, 2017). Nesmachnow and Hipogrosso (2022) describe that in the technological era, smart transportation is a key and can be added as a criteria of TOD strategy to reduce air pollution and enhance efficiency. Besides, TOD is part of political aspects that cannot be separated from policies (J. Renne, 2008). Jamme *et al*. (2019) interpreted that there are three concepts of TOD design by their literature review analysis, 1. TOD may be defined as a style of urbanism (a way of life) focusing on communal life, 2. a planned station area, 3. or a self-contained housing complex.

II. Results and Discussion (International Practice)

The literatures review the study of the successful practice of TOD gained as the references of this paper are from TODs in California (Dong, 2021; Lund *et al*., 2004), China (Blust, 2022; Song *et al*., 2021), Qatar (AlKhereibi *et al*., 2022; Furlan *et al*., 2019) and Jakarta, Indonesia (Hasibuan *et al*., 2014; Taki *et al*., 2017). The references will be described to depict the implemented TOD for each country and to gain the ideal implementation of TOD. The authors chose the TOD sample for this paper for the following reasons.

TABLE II: Reasons Taken by Authors from International Practice Samples (the Authors)

International Practice	Conveniences	References
California	One of the early cities implementing TOD in the United States	(Quinn, 2006)
	The successful TOD in the beginning era of TOD	(Parker & Arrington, 2002)
	Having a popular TOD neighbourhood	(Lund *et al*., 2004)
European Countries	Specifically, it emphasizes the integration of land use and transportation, expanding the local to a regional approach framework in a case study Netherlands and Italy.	(Staricco & Vitale Brovarone, 2018)
	Interrelated TOD in European countries, case study Austria, Netherlands, and Sweden	(Pojani & Stead, 2018)
	The successful implementation of TOD in urban design and urban corridors.	(Pojani & Stead, 2015)
China	China has the longest urban rail transit across the capital cities, and the greatest number of transit stop.	(Xu *et al*., 2017)
	Successful applying smart technology for urban transport/ public transport.	(L. Li & Tang, 2009)
	Well-achievement of increasing people by walking and using public transport	(Blust, 2022)
Qatar	Creating smart development and environmentally sustainable urban living are promoted by stressing TOD concepts that make a pedestrian-oriented area.	(Nafi *et al*., 2021)
	The new transportation system could lead successfully to less automobile congestion	(Furlan *et al*., 2019)
Singapore	Smart technology for urban transport/ public transport	(Debnath *et al*., 2011)
	A new model of TOD strategy (Green TOD) supporting sustainable development goals	(Niu *et al*., 2021)
Indonesia	Successfully connecting the agglomerated region in Jakarta, Bogor, Depok, Tangerang, and Bekasi.	(Taki *et al*., 2017)

The table above explains clearly why the authors choose the samples of international practice by the benefits succeeding.

A. TOD Characteristic in California

The TOD system in California refers to the transit village development/ resident TOD that focuses on connecting households to the rail transit stations in California's four largest metropolitan areas, which contain nearly all of the state's rail transit stations (Dong, 2021). Residents of TOD areas often utilize public transportation. In comparison to similar regions, cities, or nearby places, the rates are greater. Nearby

commuters use public transportation around five times more often than the typical resident worker in the same city (Lund *et al*., 2004). The four regions are the San Francisco Bay area (which includes the cities of San Francisco, San Jose, and Santa Rosa), the greater Los Angeles region (which includes the cities of Los Angeles, Riverside, and Oxnard), the San Diego metropolitan area, and the Sacramento metropolitan area (Dong, 2021). The main purposes of living in TOD are to increase people using integrated public transport and it will decrease vehicle ownership and air pollution. Lund *et al*. (2004) describe that a recent study by the California Department of Transportation (Caltrans) defines transit-oriented development (TOD) as "moderate to higher-density development, located within an easy walk of a major transit stop, generally with a mix of residential, employment, and shopping options (Fig. 1). It is "planned for pedestrians while not excluding automobiles" and can be accomplished through "new construction or rehabilitation of one or more buildings whose design and orientation support transit use".

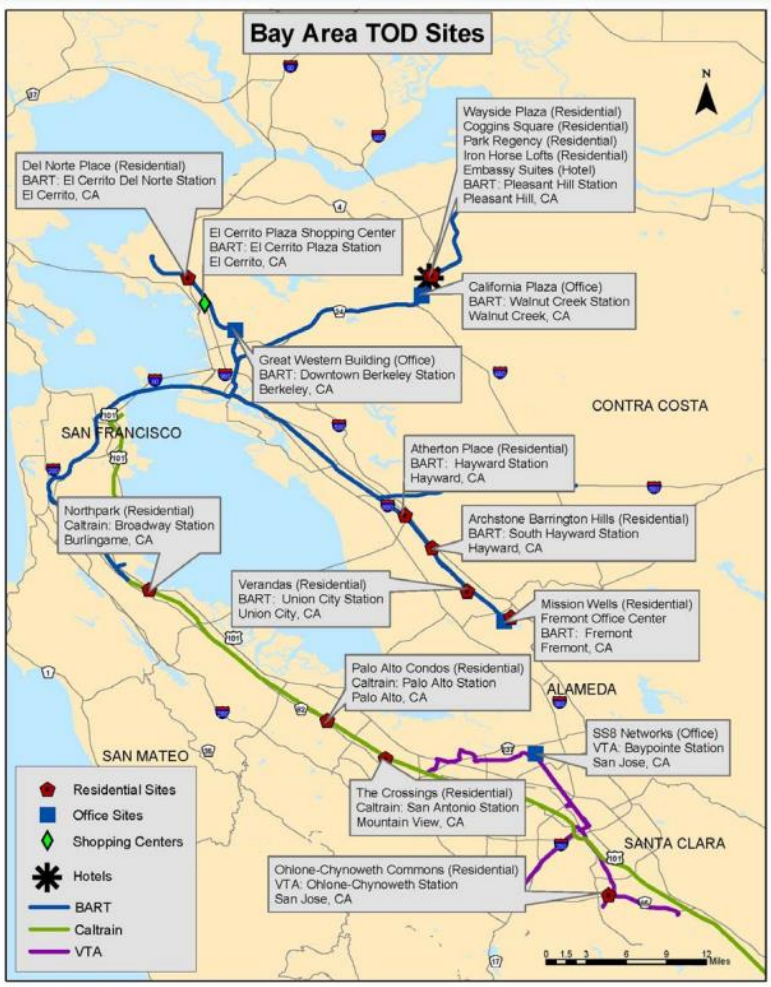


Fig. 1. TOD Design in California (Bay Area) (Lund *et al*., 2004).

The elements of criteria and indicators of physical design, in California, are prominent in station area diversity, diversity land use, pedestrian accessibility, and station area parking (Lund *et al*., 2004). Some elements of a transit overlay are included in California's Transit Village Development Planning Act, such as accelerated permits and financial support for creating a Transit Village with specific features, such as increased density. The Transit Priority Projects Program, which exempts projects within a half-mile of transit that satisfies minimum density requirements from some environmental permits, is another component of California's effort to reduce greenhouse gases through altering transportation options.

B. TOD Characteristic in China

The main criteria of TOD design in China are to create well-integrated land use based on the density and its function. Blust (2022) in his literature review of (Yuchen Z *et al*., 2022) Research and Reflection on Transit Oriented Development: A case study of Shijiazhuang City, Hebei Province, China, shows that as illustrated in Fig. 2, certain Chinese towns with rail transit have implemented TOD in practice. Shijiazhuang City, for instance, is the provincial capital of Hebei, and "Xinbai Plaza" is a transfer station at the junction of lines 1 and 3 of the metro. The downtown area where this region is located has a high population density and heavy traffic, and there was formerly a lot of congestion on the roads. Road congestion in the area was significantly reduced because of TOD. It means that the capital city is to be a central station of TOD for all

nodes of the station, and it is essential to placing the TOD in the crowded area and busiest area facing transportation problem.

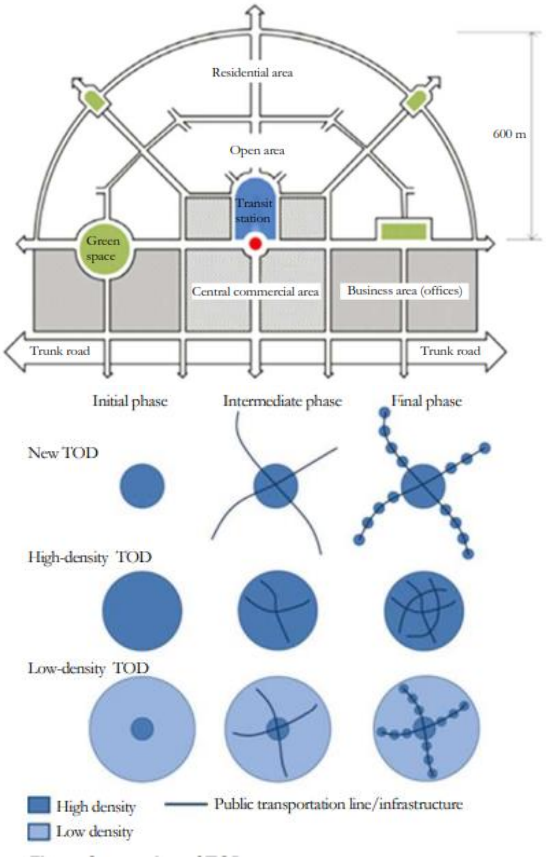


Fig. 2. TOD Design in Shijiazhuang City, China (Blust, 2022).

The illustration given above is a TOD structure in one of the cities applying the TOD, for example, in the surrounding TOD system, in Shijiazhuang, this area's land use is relatively dense and diverse, and different functional sectors may be reached in approximately 10 minutes by walking. Multiple bus routes and shared bicycles also serve this neighbourhood, allowing for a seamless link of various modes of public transit with the metro. Furthermore, the subway entrances and exits near the two commercial squares are well-designed. People can choose to approach the heart of the commercial square directly from the subway station or to reach the neighbouring ground by another exit, which reduces the walking distance to the commercial core while having no effect on the travel choices of others.

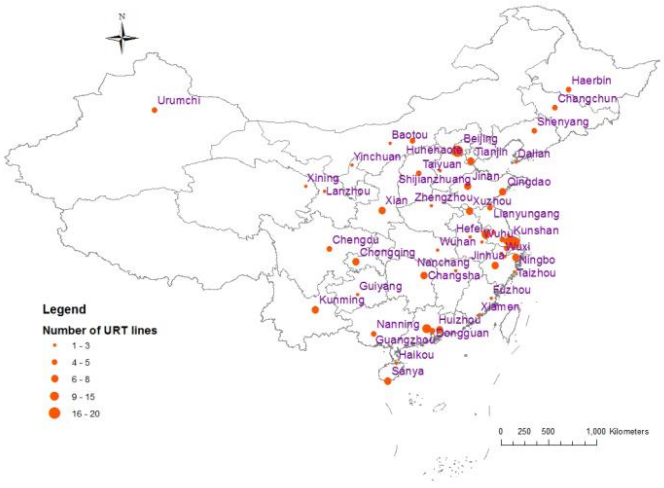


Fig. 3. Routes of urban rail transit across cities in mainland, China (Xu *et al*., 2017).

As shown in Fig. 3., in 2020, China provided urban rail transits throughout the country that is divided into three models based on the population, 1. Cities have more than 10 million, 2. They are having 5-10 million population and 3. less than <5 million people (Xu *et al*., 2017). In general, TOD in this area has

been successful; significantly, traffic conditions have improved, and inhabitants can meet their daily needs primarily by walking or taking public transportation.

C. TOD Characteristics in Qatar

In Qatar, the TOD approach used to create sustainable development is focused on enhancing public transport to all areas in the city. As shown in Fig.3, they claim that the solution to the major problem of unpredictable city growth is improving public transport. Furlan *et al*. (2019) argue that TODs promote sustainable urbanism by improving livability through greater integration of transportation and land-use policies in urban form. In addition, TOD concepts are actively supported in Qatar by QNV 2030, which was developed to ensure sustainable growth and land-use planning efficiency, as well as to reduce uncontrolled sprawl and traffic congestion (AlKhereibi *et al*., 2022).

In Fig. 4, the development of new significant urban public transit networks, such as the Doha Metro, Lusail light rail transit (LRT), and bus rapid transit, is currently receiving significant financial investment from the State of Qatar (BRT). Before the FIFA World Cup in 2022, it is anticipated that the new transportation systems will be up and running. Additionally, in order to accommodate the growth of the urban fabric of the city, transportation systems were upgraded and expanded. In order to better integrate Qatar's economic, sustainability, environmental, and sociocultural facets, the government plans to invest $100 billion over the next five years in new infrastructure projects as well as improvements to the country's current transportation systems (Furlan *et al*., 2019).

Fig. 4. Public Transport of Metro line, Doha (AlKhereibi *et al*., 2022).

The indicators used for applying TOD in Qatar are 3-D (Diversity, Density, and Design) that are strongly related to transportation demand, mode of transportation choice, and degree of peak-hour congestion (AlKhereibi *et al*., 2022).

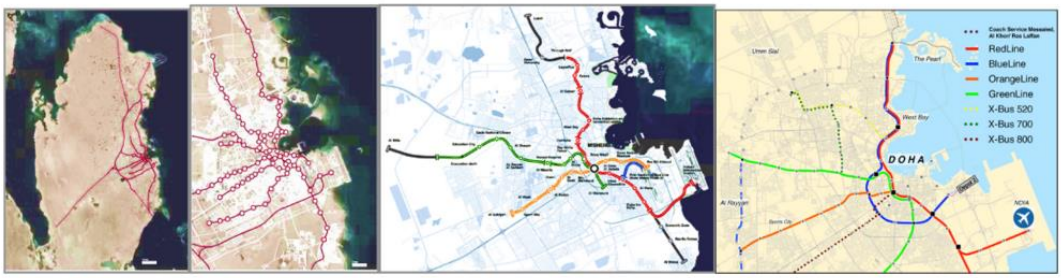


Fig. 5. Imagery Satellite view of Metro line, Doha (Furlan *et al*., 2019).

The West Bay area, Airport City, and the government district in the city center are considered the core areas of Metro Doha in the QNDF-2032 Spatial Strategy, while other dense, transit-oriented metropolitan and town centers are connected by orbital, transit corridors. Then, to ensure food security, the capital region's urban growth is restrained by an agricultural "belt," and the integration of land use and transportation planning is seen as crucial for easing congestion and increasing employment opportunities (Fig. 4).

D. TOD Characteristics in Jakarta and Bodetabek (Agglomeration city and abbreviation of Bogor, Depok, Tangerang, and Bekasi), Indonesia

The Metropolitan city of Jakarta is always related to its neighbourhood cities consisting of Bogor, Depok, Tangerang, and Bekasi, and then it is officially called Jabodetabek. Jakarta and its neighbouring cities have a population of around 28 million people and the biggest economic circulation in Indonesia. The TOD system provided by the government is the integrated public transport of commuter railways transportation, bus station, and local public transportation (jaklingko). The urban growth pattern of Jakarta is divided into three concentric zones, such as the first ring, the inner circle, and the center of CBD, Jakarta, the center of economic, public services, and governance activities. The second ring, the peri-urban, is located on the outskirts of Jakarta and serves primarily as dormitory towns with a service-based economy. The third ring is the distant suburbs, which are still semi-rural areas with a growing manufacturing industry (Hasibuan *et al*., 2014). Taki *et al*. (2017) write the service of commuter railways transportation serves all areas of Jabodetabek including Jakarta City, Bogor City, Depok City, Tangerang City, and Bekasi City, which are all urban and suburban areas. A commuter rail system known as Jabodetabek allows residents to travel from the suburbs to the urban (city center of Jakarta) and opposite. In spatial (Fig. 6), Jakarta metropolitan regional is divided in three TOD typologies, regional, urban, and suburban (Taki *et al*., 2018).

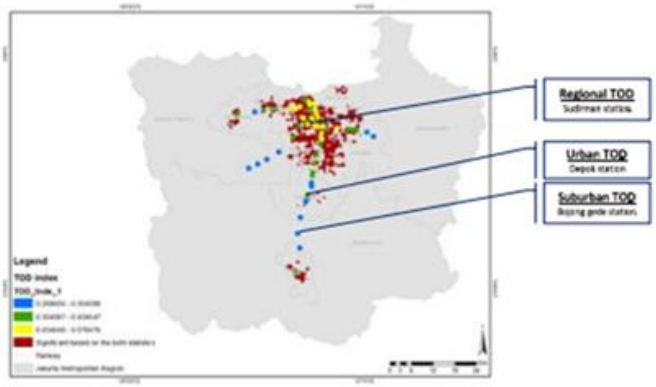


Fig. 6. Typology of TOD in Jakarta Metropolitan and its neighbourhood city (Taki *et al*., 2018).

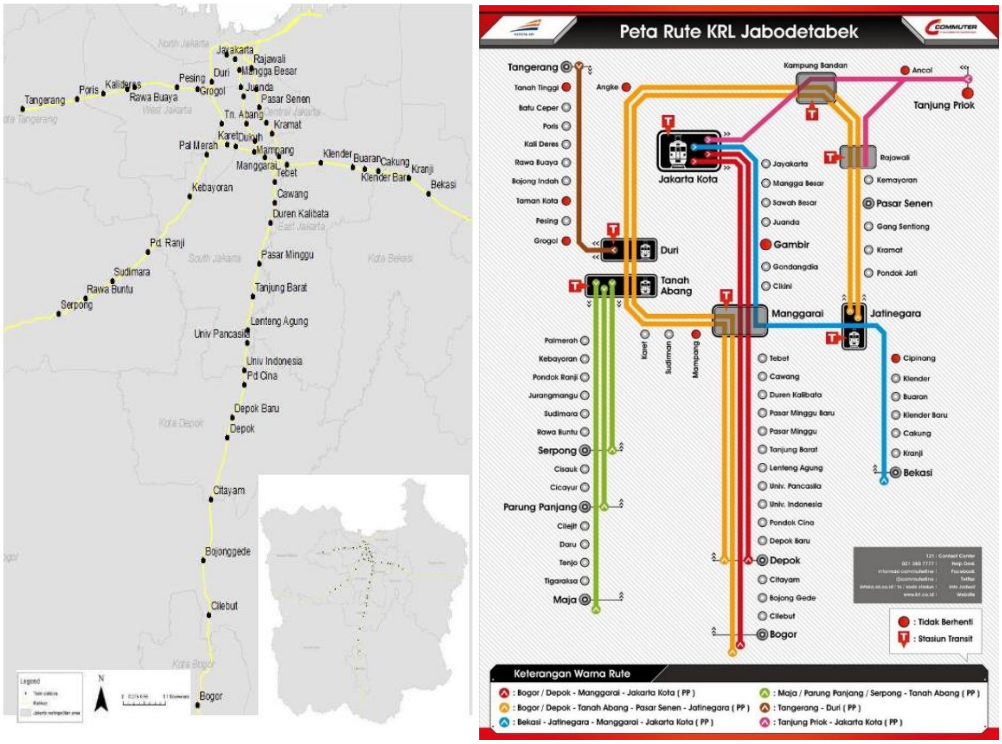


Fig. 7. The routes of Jabodetabek Commuter Railways Station (Taki *et al*., 2017; KRL routes, 2022).

In Jabodetabek, the TOD system is supported by some types of public transportation modes, such as commuter lines, busways, and local transportation designed to link all public transport stations. Hasibuan *et al*. (2014) research findings indicated that the transit stations in Jakarta have characteristics of moderate mixed-land use, which means that the proportion of homes and businesses is quite similar, ranging from 30% to 40% for each. Because Jakarta's transit areas are not particularly densely populated, it is difficult to

access homes and workplaces by walking or cycling alone, necessitating the use of a car. Due to the predominance of settlement land uses and the sprawl of spatial design, mixed land-use, and competitiveness in suburbs are low, both in the first and second rings. According to the study's analysis of the street network combined with commuter survey findings, all of Jabodetabek's transit station areas, whether in Jakarta or the suburbs, fall into the low category for pedestrian friendliness.

III. Findings and Conclusions

A. Findings

Based on the literature reviews from international practice, the authors find the criteria and indicators of TOD with suitable purposes for its implementation. The authors summarize that the applied TOD in some countries consists of two model designs, the location of TOD related to all types of public transport (Fig. 8), the urban design/ physical environment surrounding the TOD (Fig. 9).

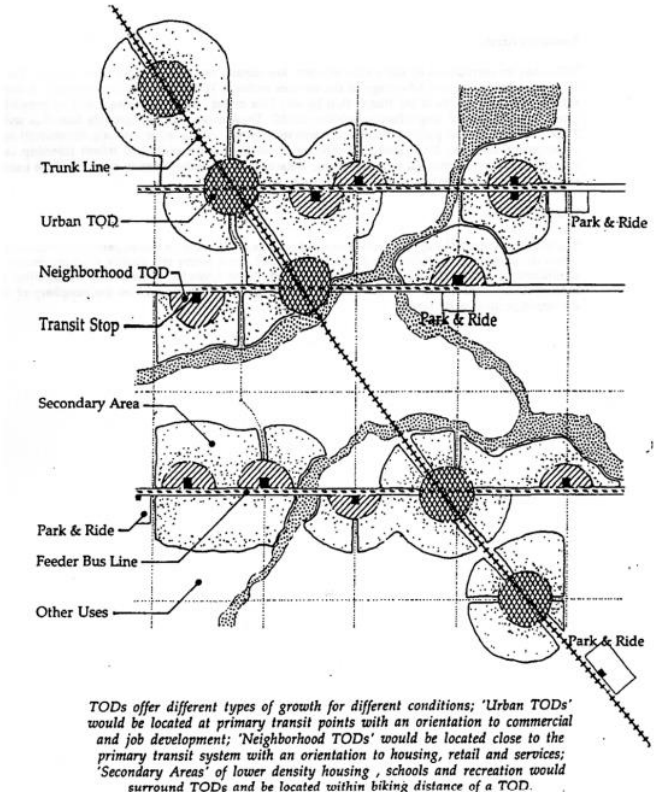


Fig. 8. TOD Locations (Calthorpe & Mintier, 2011).

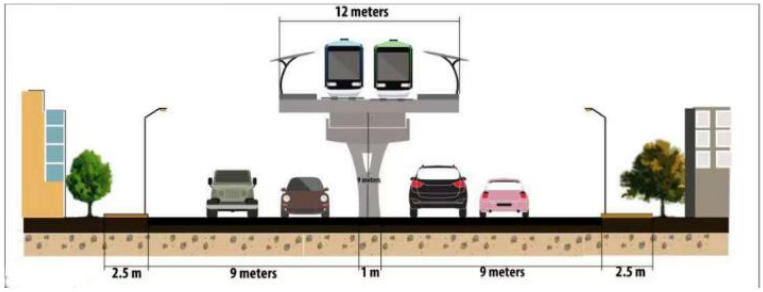


Fig. 9. An example of Urban Design for TOD (Teklemariam & Shen, 2020).

The international experiences of applying TOD for urban planning development in developed countries and developing countries have obtained the conveniences, such as economics, accessibility, urban pattern, traffic solution, and environment. All criteria and indicators shown in the table (Table III), the authors conclude that TOD in planning guideline divides into two levels, Macro level, and Micro level. At the macro level, it refers to how the TOD will be implemented as nodes for all public transport overall regions. At the micro level, it mentions that TOD creates an urban design and urban corridors, like mixed-land use, road design, pedestrian path, cycling ways, transit-transportation design, and others. The authors illustrate the planning guideline of TOD in the diagrams (Fig. 10).

TABLE III: REVIEWS OF CRITERIA AND INDICATORS (THE AUTHORS)

References	Study Area	Focus	Criteria	Indicator	Result
Dong (2021)	California	Household TOD	➢ Income ➢ Neighbourhood density ➢ Neighbourhood mixed-use	➢ Household income ➢ Persons and workers per acre ➢ The ratio between service jobs and the population ➢ Distance to CBD	➢ The analysis demonstrates how TOD households' transportation expenses differ significantly from those of typical households that don't reside in TODs. ➢ Compared to residents who don't live in TOD, their transportation costs are 40% less. ➢ According to this study, TOD can assist Californians in saving money on transportation expenses.
Lund *et al*. (2004)	California	TOD for Urban Design/ Physical Design	➢ Station Area Density ➢ Diversity of land use ➢ Pedestrian Accesibility ➢ Station Area Parking	➢ Population Density ➢ Residential Density ➢ Employment Density ➢ Land-use mix ➢ Pedestrian ways ➢ Parking supply, distance to the nearest station, and cost (spaces per unit)	➢ TOD residents are more likely to use transit if there is less of a time benefit for traveling via highways (compared to transit) if there is good pedestrian connectivity at the destination if they are allowed flexible work hours, and if they have limited vehicle availability, according to disaggregate models. ➢ Physical design elements like streetscape enhancements and neighbourhood designs have a small impact on how individual station area residents choose to use transit, but they do have some bearing on the prediction of project-level differences.
Blust (2022)	Shijiazhuang City, China	TOD nodes for Integrated Public Transport	➢ Population Density ➢ Traffic Flow ➢ Mixed-Land use ➢ Public Transport Modes	➢ Number of population in a specified area (people per m^2) ➢ Number of vehicles traversing a particular section of road (vehicle/hour). ➢ Land use diversity (Percentage and Index) ➢ Kinds of public transportation routes provided (modes and spatial routes)	➢ TOD in this area has been successful; especially, traffic conditions have improved, and residents can meet their daily needs primarily by walking or taking public transportation. ➢ However, the region does not plan more open spaces for residents, like urban parks and squares, and bus lanes and bicycle lanes are frequently used illegally.
Song *et al*. (2021)	Guangzhou and Shenzhen, China	TOD nodes for Integrated Public Transport	➢ Metro line system ➢ City structure (suburban, property development, and regional development)	➢ Projects for the development of transit station areas without special institutional arrangements ➢ Rail plus property development on depot stations The ➢ Stations for regional transportation hubs that have been integrated	➢ TOD practices in China have demonstrated that the current planning and land use regulations and urban growth mechanisms have turned into institutional obstacles to the widespread adoption of TOD practices. ➢ The authors discovered that land value capture can take the place of the current system, in which local governments rely heavily on land-leasing revenue, and also promotes better coordination between transit and land development.

TABLE III: REVIEWS OF CRITERIA AND INDICATORS (THE AUTHORS)

References	Study Area	Focus	Criteria	Indicator	Result
AlKhereibi *et al*. (2022)	Qatar	➢ TOD nodes for Integrated Public Transport ➢ TOD for Urban Design/ Physical Design	➢ Built Environment ➢ Transportation ➢ Socio-economic	➢ Land use diversity ➢ Land use density ➢ Walkability ➢ Accessibility ➢ Public transport availability ➢ Parking Supply and Lots ➢ GDP ➢ Currency Stability ➢ Political Stability	➢ Urban planning in Qatar that conforms to the principles of transit-oriented development will result in more successfully implementing sustainability at all levels of the built environment, transportation system, and economy. ➢ Land use and public transport are the necessary components to create TOD ➢ It is crucial to use designs that better support pedestrians' needs and rights. Accessibility in and around public transport access points, such as bus stops and metro stations, would be greatly improved by pedestrian-friendly urban design, making it easier for commuters.
Furlan *et al*. (2019)	Qatar	➢ TOD nodes for Integrated Public Transport ➢ TOD for Urban Design/ Physical Design	➢ Urban Design of TOD ➢ Urban Transport of TOD	➢ Connectivity and Accessibility ➢ Public Realm ➢ Pedestrian Paths ➢ Cycling Paths ➢ Human behaviour and activities ➢ Doha Metro ➢ Bus System ➢ Taxis ➢ Vehicles Ownership ➢ Bicycles	➢ An improved pedestrian environment could greatly increase connectivity. ➢ Reduced traffic congestion may result from the new transit system. ➢ Livability and/or quality of life can be improved by the public realm. ➢ Enhancing the neighbourhood's quality of life would raise the area's land value and appeal to people who use transit.
Taki *et al*. (2017)	Jabodetabek, Indonesia	➢ TOD nodes for Integrated Public Transport	➢ Density ➢ Economic ➢ Diversity	➢ Commercial city ➢ Residential mix ➢ Parking area mix ➢ School mix ➢ Open space ➢ Population density ➢ Floor Area Ratio (FAR) ➢ Building Coverage Ratio (BCR) ➢ Land use diversity	➢ Conclusion: Stations with high index values are more likely to be found in urban areas, and inversely; stations with low index values are more likely to be found in suburbs.
Hasibuan *et al*. (2014)	Jabodetabek, Indonesia	➢ TOD nodes for Integrated Public Transport	➢ Demographic and land use system ➢ Urban mobility pattern ➢ Environment	➢ Population (people) ➢ Residential area (ha) ➢ Net population density (people/ha) ➢ Mixed-land use ➢ Compactness ➢ Density ➢ Pedestrian-friendly ➢ Carbon emissions (CO_2) ➢ Transport ecological footprints (Ha)	➢ It is strongly advised that the transit-oriented development alternative be used as the most efficient strategy to address land ➢ According to the study, TOD's contribution to the construction of the sustainable Jabodetabek urban environment focuses on lowering fuel consumption and carbon emissions and maintaining the availability of green open space for the urban ecosystem.

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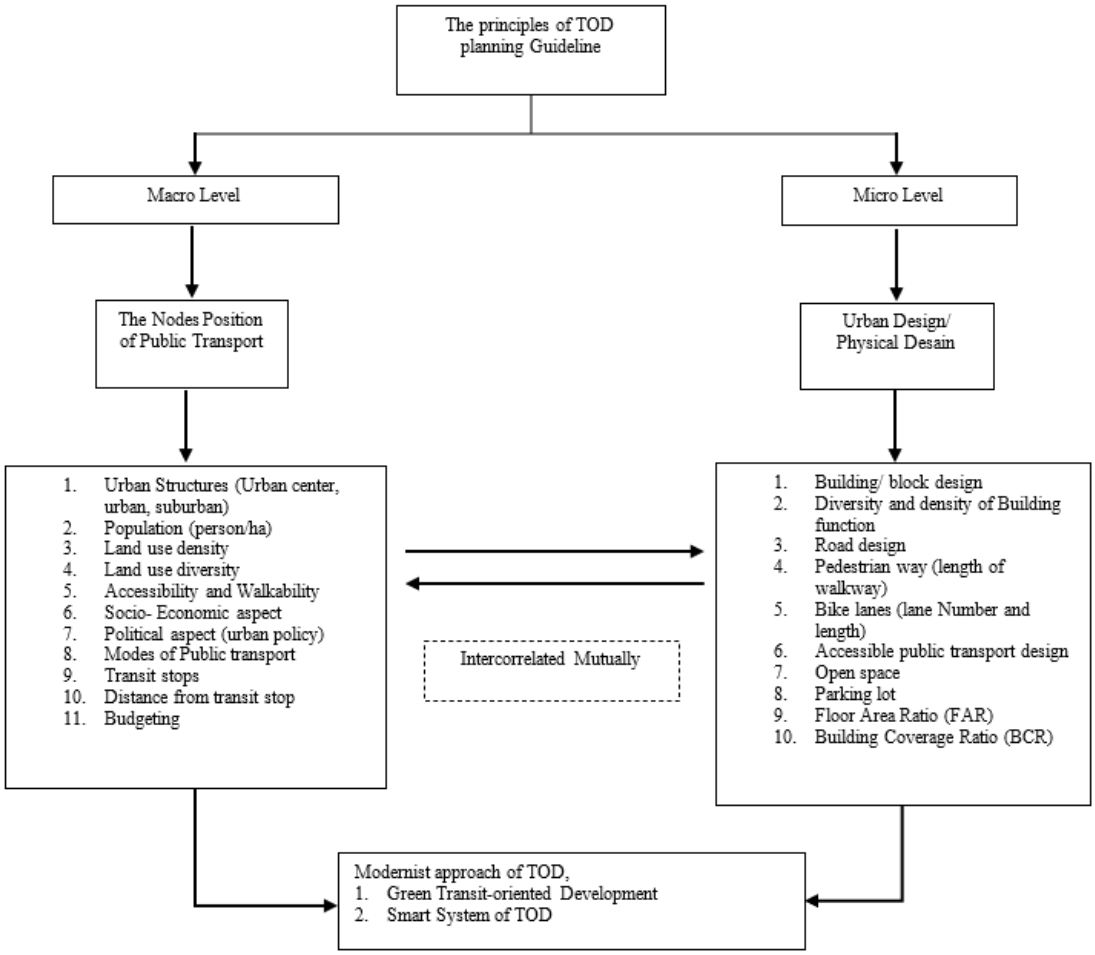

Fig. 10. The Diagram of TOD Planning Guideline (the authors).

The planning guideline could be considered by the countries which develop their TOD system or improve the TOD system based on the TOD keys from criteria and indicators. In addition, it is an answer to the question of what the criteria and indicators for are selecting and applying the ideal TOD and its ideal criteria of TOD position.

B. Conclusions

This research attempts to collect the ideal criteria and indicators applied by several prosperous countries worldwide. The international practice taken by authors is from the last decade of research done by developed and developing countries, California, China, Qatar, and Indonesia. It shows that the criteria and indicators of TOD are a requirement to determine a TOD design in a country, or it will be a concern if the implemented TOD is not effective and optimal. The difference between this research and previous research is that study the new-model design of criteria and indicators of TOD, and then it is concluded as an urban planning guideline in TOD form. Currently, authors assume that most TOD papers discussed the existing TOD using any methods and evaluated the implemented TOD through a case study. It is appropriate with the statement of other researchers, who (Nesmachnow & Hipogrosso, 2022) declare that the effectiveness of current TODs has been assessed by several studies worldwide. However, little research has been done on how future TODs will be planned.

One of the important things to note is that this paper sums up all criteria and indicators in a planning guideline containing two main points, macro (region) and micro (local) implementation. The region TOD proposes to decide TOD position, and the local TOD aims to design TOD comprehensively. In addition, the essence of this result (TOD planning guideline) is an urban planning approach for applying or evaluating the TOD carried out by urban planners.

Nevertheless, this research lacks some detail literature reviews because the authors describe a general point of criteria, and authors hope that further research regarding TOD suggests determining specific criteria and indicators for two model countries, developed and developing. Then, the planning guideline for more research must mention the real index and standard indicator value for applying TOD strategy to help quickly implement or assess the TOD.

ACKNOWLEDGMENT

The authors would like to thank for the accomplishment of final report supported by many things, that he/she cannot mention one by one. In particular, the corresponding author would like to present gratitude for Prof. Mohamed Mahmoud H. Maatouk as a supervisor and all friends at Department of Urban and Regional, Faculty of Architecture and Planning, King Abdulaziz University, Jeddah, Saudi Arabia.

CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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