The Comparison of Density and Land Use Activities near Transit Stations in Bangkok and Singapore

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ABSTRACT

This manuscript compiles the data collection of land uses around transit station in terms of density, mixed use and land use types that correspond with the Transit Oriented Development (TOD) concept. Through this end, the surrounding areas from six selective stations in Bangkok and three stations in Singapore within the radius of 500 meters from the transit station exits were investigated and analyzed for the land use indicators, including densities such as Floor Area Ratio, average number of floors, etc., mixed use percentages and the percentage of land use areas that support the TOD concept. The data show that land uses around Bangkok transit stations do not match with TOD concept comparing with Singapore ones. It was found that transit stations which have higher density, mixed-use land development and high percentages of land development areas that support TOD concept clearly have higher transit ridership. The data from this research yield important information for related organizations to issue measures and regulations for both existing and future land use development around Thailand's transit stations such that they would better support transit ridership.

Key Words: Transit Oriented Development (TOD), Transportation Planning, Land Use Planning.

1. Introduction

Transit-Oriented Development (TOD) is the design concept to encourage the use of mass transit through land use and transportation planning. Generally, the TOD consists of supporting high-density and mixed-use development near transit station, constructing walkable networks and open space to transit stations as well as facilitating feeder modes for transit riders (Cervero and Kockelman, 1997)). TOD has been implemented in several cities around the world. Notable, Hong Kong has planned new transit lines along with new town development through the use of TOD concept. The Hong Kong Railway Corporation Limited or MTR who runs Hong Kong's Mass Transit Railway and is also a major property developer and landlord in Hong Kong has reported that most company profits are obtained from real estate development by rail station property rental and housing development in the area with 500-m radius from the station exits. These developments make MTR profitable and can invest in further rail network expansion. In contrast to Thailand, the Mass Rapid Transit Authority of Thailand (MRTA) has developed mass transit lines with the main objectives to alleviate traffic congestion in Bangkok. Therefore, all lines are constructed on the dense communities with no available space for state real estate development.

This manuscript focuses on the land use aspect for TOD development, which consists of two components: 1) high-density development and 2) mixed-use development. For comparison purposes, existing land use activities around sampling Bangkok mass transit stations are compared with ones in Singapore, considered to be one of the TOD-successful cities. This analysis will yield important information for policymakers and provide evidence for academicians for understanding the impact of land use characteristics on transit ridership. The reminder of this paper is organized as follows. Section 2 summarizes related background research. The data used for this study and analysis methodology are described in Section 3. Section 4 presents results as well as their interpretations. Then, the fifth and final section contains concluding remarks and policy implication based on this study.

2. Literature Review

Originally, Cervero (1993) defined the transit coverage area as a "donut" represented in Figure 1, and determined the share of commute trips via transit among those residing in the donut found that the rail passenger those living within 0.5 mile of a rail stop were around four times as those living within a distance between 0.5 and 3 miles from the station. This study collected the data from transit stations in California and also found that 52 percent of the traveler who lived away from transit switched from drove to transit commuting upon walking distance within 0.5 mile of a rail station. Therefore, the development of land use within 0.5 mile of a rail station is very crucial to attract transit ridership and this concept has been developed in the past two decades.

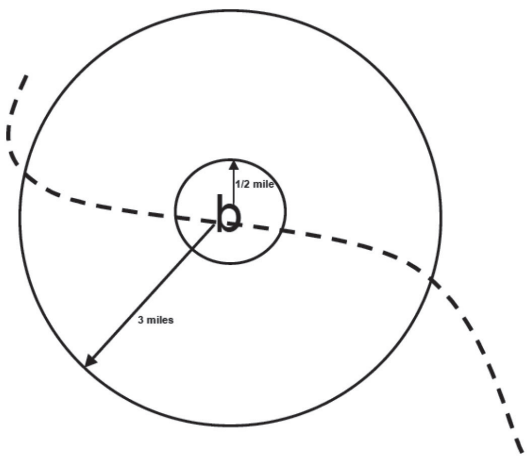

Figure 1: TOD Donuts (Cervero, 1993)

Past studies showed that the TOD concept generally focuses on the 3-D planning principles as follows: density development, diversity which is mixing land use, and design with pedestrian-friendly (Cervero and Kockelman (1997), Chakraborty and Mishra (2013), Sung and Oh (2011) and Jun, et al (2015)). High density development in the area of 500-800 meter radius from transit stations is a key component to make TOD successful since it brings values, economy, sustainability and efficiency

for land development. Higher density reduces walking distances to transit stations and can encourage pedestrian-friendly activities and business. In addition, mixed-use development is also critical for TOD success. Mixing residential and business development at a station could balance the flow of passengers alighting and boarding the mass transit and bring transit ridership during non-peak hours and weekend. However, it is not practical to have similar density and mixed-use guideline for all stations since each station serves different functions and is located in different town areas.

The Metropolitan Atlanta Rapid Transit Authority (MARTA, 2010), responsible for transportation planning in Atlanta, Georgia, U.S. issues a design guideline according to the TOD concept by categorizing all transit stations into seven groups based on their characteristics. Categories (or topologies) have been used in the past Metro Atlanta planning process and are still being used nowadays. For this specific TOD planning concept, MARTA (2010) has developed a new station typology with seven categories: urban core, town center, commuter town center, neighborhood, arterial corridor, special regional destination, and collector based on building density, transportation network and majority of land use type. These categories are intended to illustrate thematic similarities and differences, rather than pure types. Some stations might share characteristics of two or more types.

In this study, we selected only four common groups, i.e., urban core, town center/commuter town center, neighborhood, and arterial corridor for data collection and comparison. MARTA (2010) suggests appropriate density values in each group as shown in Table 1 below. Note that, the “Commuter Town Center” have the same approximate density as the “Town Center” but it serves as a captive point for commuters transferring to the mass transit system.

Table 1: Appropriate Density for Land Use Development in Different Station Types (MARTA, 2010)

Type of Station	Floor Area Ratio(FAR)	Residential Unit/Acre	No. of Floors
Urban Core	8.0-30.0	75+	8-40
Town Center/ Commuter Town Center	3.0-10.0	25-75	4-15
Neighborhood	1.5-5.0	15-50	2-8
Arterial Corridor	1.0-6.0	15-50	2-10

In addition to density control, MARTA (2010) suggested land use types that would not be located inside the TOD zone (0.5-mile from the station exits), i.e., any car-related facilities such as vehicle dealers, car repair shops, parking, and heavy plants would not be inside the TOD zone, low-density facilities such as single-family houses, large supermarkets, resorts, gas stations should not be in the TOD center and ones that require special permits if being inside the zone such as hospitals, laboratories, etc. The guideline also encourages facilities such as groceries, high-density housing, and farmer markets to be in the TOD zone.

3. Methodology

Three station types, i.e., town center, commuter town center and neighborhood, in Bangkok were selected. In each type, two stations, high and low ridership, were specifically picked for comparison purposes. In addition, three stations in Singapore were selected for data collection as well. The station names as well as average daily passengers are shown in Table 2.

The data collection is done through the use of Bangkok Metropolitan Authority's 2-D Geographical Information System (GIS) which shows the land use activity of all buildings in Bangkok. We also verified the database manually by walk to ensure its accuracy, especially on existing building uses, in the areas of 500-m radius (TOD-zone) from station exits as shown in Fig. 2.

For analysis propose, we separated the areas into two parts: 1) public space includes roadways, sidewalks, parks and other public open spaces that anybody can traverse; and 2) non-public space includes the buildings and open-space around the buildings, which are not for public use. Then for density analysis, we calculated the following indicators: 1) Percentage of each land use type; 2) Floor Area Ratio (FAR), which is the sum of total floor areas divided by total area; 3) Public Open Space Ratio (POSR), the percentage of public open space; and 4) Average number of floor, which will be divided into three levels (within 250-m, between 250-375 m, and between 375-500 m) based on the distance from station exits as shown in Fig. 3.

Note that the station types assigned to each station in this study are based on common characteristics of these stations by comparing with station types in MARTA (2010). In fact, the types could be somewhat subjective due to unplanned land use in Bangkok; however, they are comparable to the station assigned in the same category in Bangkok. For example, BTS Victory Monument and BTS Wongwienyai are assigned to be Commuter Town Center stations due to their characteristics as a major transfer point between mass transit system and bus/van transit.

Table 2: Selected Transit Stations for Data Collection

Station Name	City	Type of Station	Average Daily Passenger
MRT Huay Kwang (HK)	Bangkok	Town Center	13,445
MRT Rachadapisek (RD)	Bangkok	Town Center	6,960
BTS Victory Monument (VM)	Bangkok	Commuter Town Center	228,276
BTS Wongwienyai (WY)	Bangkok	Commuter Town Center	72,032
BTS Krung Thonburi (KT)	Bangkok	Neighborhood	52,346
BTS Taladplu (TP)	Bangkok	Neighborhood	32,519
MRT Orchard (OR)	Singapore	Town Center	Data not available
MRT Chinatown (CH)	Singapore	Commuter Town Center	Data not available
MRT Sengkang (SK)	Singapore	Neighborhood	Data not available

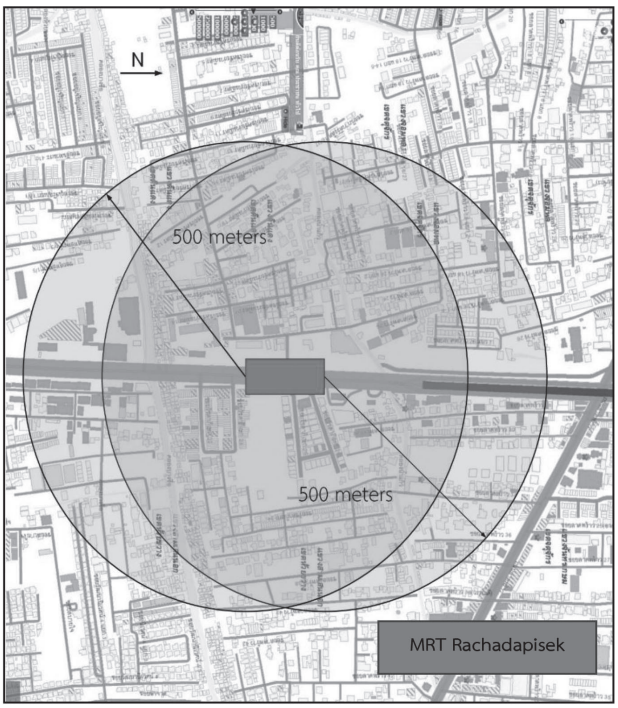

Figure 2: Scope of Data Collection

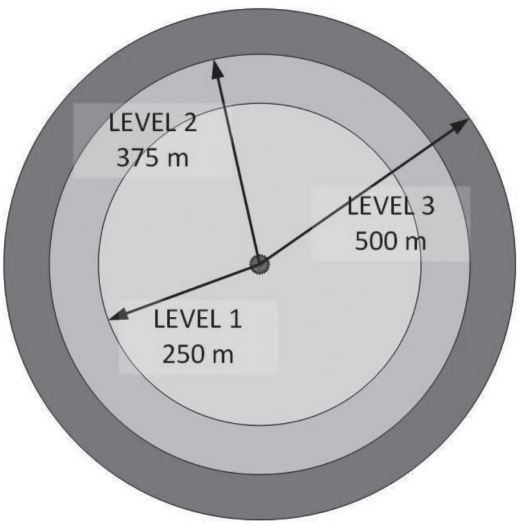

Figure 3: Three Levels based on Distances from Station Exits

For mixed use analysis, we separated the land use activities based on travel patterns into five categories: 1) resident; 2) day-time business; 3) evening-time business; 4) commercial area; and 5) miscellaneous land uses with no distinct travel pattern. We also separated the type of land use activities into three types: 1) Pro-TOD such as office, grocery stores, high-density housing, shopping malls, schools, etc; 2) Against-TOD such as vehicle showrooms, car parks, vehicle maintenance shops, gas stations, single family houses, etc; and 3) Neutral-TOD such as hotels, hospitals, laboratories, etc.

4. Findings

For density comparison, Table 3 shows density indicators such as the percentage of public and non-public spaces, FAR, POSR and average number of floors in the areas of nine transit stations. From Table 3, Bangkok stations generally have higher percentage of public areas that are not walkable (road and river) while Singapore stations has higher public open spaces. For density comparison, it is obvious that Singapore has higher density development since Singapore stations mostly have higher FAR values than ones in Bangkok even the Sengkang station is located far away from the downtown area. For the number of floors, we found that besides Chinatown station, a preserved cultural zone in Singapore, average number of building floors in Singapore are much higher than ones in Bangkok.

Table 3: Density Indicators at Nine Selected Stations

Station Name	Public Area (%)		Non-Public Area (%)		FAR	POSR (%)	Average No. of Floors			
	Road/ River	Open Space	Building	Open Space			Level 1	Level 2	Level 3	Average
HK	23.85	0.72	52.25	23.18	3.57	0.72	5.49	5.56	4.58	5.13
RD	15.18	-	31.70	53.12	1.39	-	4.17	3.67	3.35	3.73
VM	9.31	4.33	36.40	49.96	2.38	4.33	4.27	6.90	6.07	5.65
WY	17.35	-	43.94	38.71	2.26	-	6.44	3.42	3.58	4.24
KT	13.56	-	36.64	49.80	2.42	-	7.74	5.73	3.94	5.73
TP	9.44	-	31.29	59.27	1.15	-	3.77	2.57	3.61	3.33
OR	7.03	-	42.86	50.11	5.10	-	10.31	10.34	12.74	11.06
CH	11.66	10.11	36.39	41.84	3.08	10.11	8.37	4.90	5.97	6.23
SK	4.88	4.13	26.91	64.08	3.15	4.13	12.13	8.23	11.96	10.64

For land use activity analysis, Table 4 shows mixed-use and percentage of pro-TOD areas at nine selected stations in this study. For travel-pattern analysis, we found that for Chinatown and Orchard stations in Singapore, the commercial areas cover more than half of the total areas near the stations. However, the residential and day-time business areas remain significant high proportions and well balance each other. In contrary to Singapore, the proportion of residential and day-time business areas on Bangkok stations are unbalanced and bring transit line crowded on one direction while nearly vacant on the other direction. By looking closely to the land use types according to TOD concept, only 41-58 percent of total areas around Bangkok stations are considered to be pro-TOD land uses. This is sharply contrast to Singapore downtown stations (Orchard and Chinatown), which have 81 and 92 percent, respectively. The percentage of pro-TOD land use is probably a main cause that affect transit riders as evident from each Bangkok station pair (HK vs RD, VM vs WY, and KT vs TP) which has similar station types, i.e., town center, commuter town center, and neighborhood, respectively. Notably, the stations with higher pro-TOD area always have higher transit ridership.

Table 4: Mixed-Use and Pro-TOD Indicators at Nine Selected Stations

Station Name	% of Land Use based on Travel Pattern					% of Pro-TOD Land Use			
	Resident	Day-time Business	Evening-time Business	Commercial	Misc.	**Level 1**	**Level 2**	**Level 3**	**Total**
HK	69.53	5.07	5.78	15.38	4.24	59.02	57.40	52.89	56.05
RD	76.18	2.07	-	14.01	7.74	46.55	41.37	36.71	41.46
VM	36.38	32.58	-	24.80	6.24	57.75	61.20	55.96	58.10
WY	80.16	1.77	-	11.27	6.80	63.60	42.24	53.29	52.90
KT	80.98	5.20	-	8.14	5.68	61.20	61.39	52.15	58.05
TP	72.51	2.39	0.04	13.89	11.17	63.68	39.64	58.72	54.36
OR	27.24	17.20	-	50.40	5.16	78.12	74.51	95.96	82.42
CH	12.62	13.70	0.92	64.07	8.69	94.59	86.73	93.22	91.93
SK	55.16	10.06	-	1.63	33.15	73.50	41.08	63.46	56.05

5. Concluding Remarks and Policy Recommendations

In summary, by comparing among Bangkok station pairs, the stations with significant higher transit riders usually have higher-density land development around the stations. This can be observed through several density indicators such as FAR, average number of building floors. In addition, mixed-use development could bring higher transit riders as well if there has been a balance of several land use types with different travel patterns in the TOD zone. In addition, land use activities in the TOD zone have played a significant role to attract transit riders. However, due to lack of TOD land use control in Bangkok, only around half of areas around Bangkok stations are considered to be pro-TOD land use types.

For Singapore city, considered to be a successful city in implementing TOD concept, the areas around transit stations mostly have higher density and mixed-use land development. The percentages of land development areas that support TOD concept are very high as well.

For policy implication, the data presented here will be used by Bangkok Metropolitan Authority to issue a city planning guideline such as a regulation to building density control and supportive measures to create mixed-use development near transit stations. In addition, the government would specify which land use types can be located in the TOD zone especially on the newly constructed transit routes. Nevertheless, it could be difficult to implement these regulations and measures on existing Bangkok stations since most areas are occupied by private owners and buildings are already been constructed.

For future research, this research could expand by creating transit ridership forecast models based on the land uses around stations. These models will be useful for transit planning if there have been changes in land use pattern around any transit line. Also, since the TOD concept is not only about land use development around transit stations, but it relates to creating walkable pedestrian network towards the stations and linking other feeder modes to facilitate transit riders as well. The number of riders could thus depend on these accessibility factors. More studies would be done by comparing the transit stations with similar land uses but different accessibility factors. This kind of research would bring a better guideline to encourage more transit riders.

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