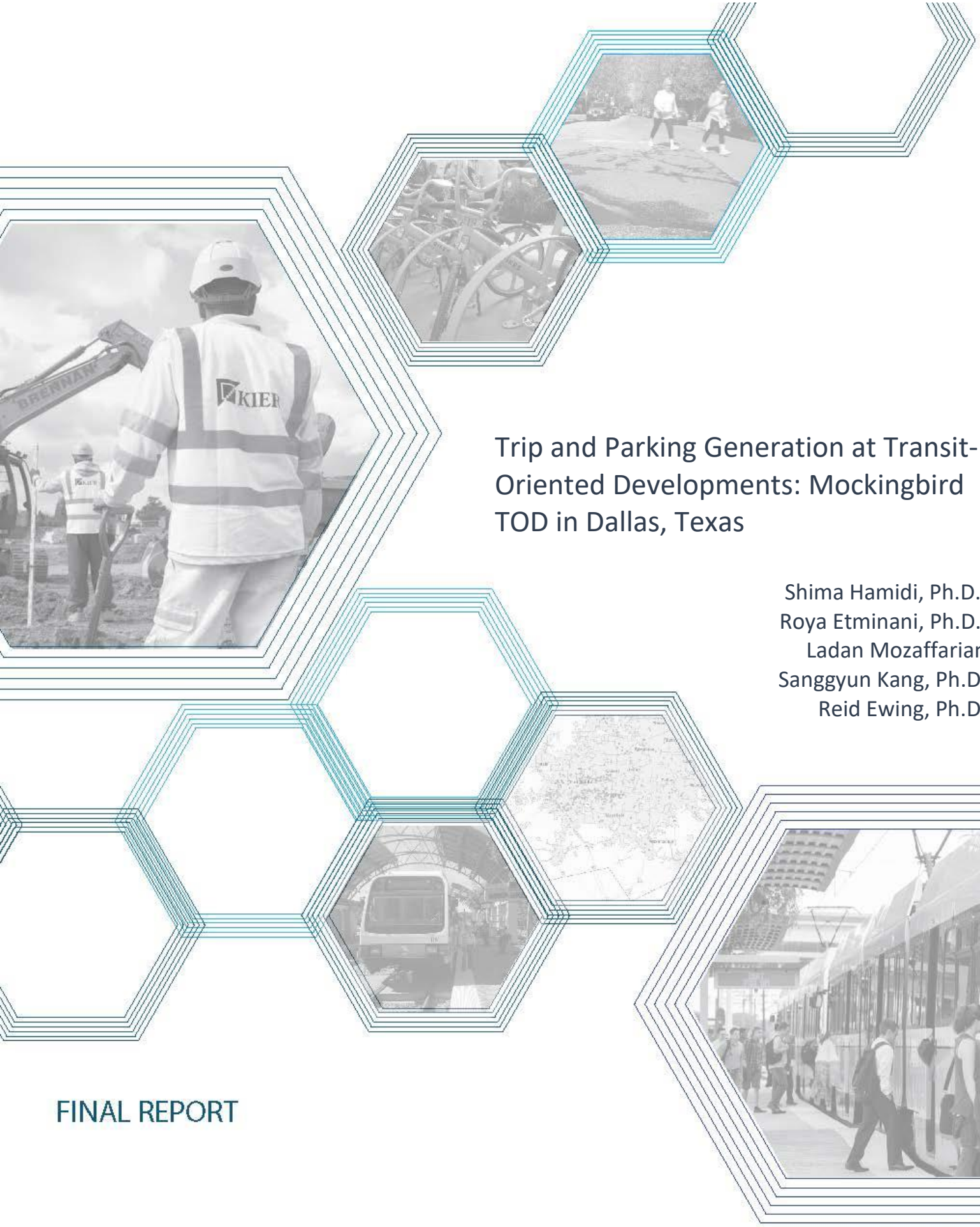

Trip and Parking Generation at Transit-Oriented Developments: Mockingbird TOD in Dallas, Texas

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FINAL REPORT

CENTER FOR TRANSPORTATION EQUITY, DECISIONS & DOLLARS

TRIP AND PARKING GENERATION AT TRANSIT-ORIENTED DEVELOPMENTS: MOCKINGBIRD TOD IN DALLAS, TEXAS

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16. Abstract

The Institute of Transportation Engineers (ITE) guidelines serve as the most widely used reference for trip and parking generation estimates of any new development in the U.S. However, recent empirical studies question the efficacy of ITE guidelines in forecasting trip and parking generation in transit-oriented developments (TODs). Following the methodology of seven national TODs across the U.S, this study focuses on Dallas (TX), as a more auto-oriented American city, to explore the trip and parking generation at Mockingbird TOD as compared to the ITE guidelines. We find that with the exception of Station Park in Salt Lake City (which is really a TAD rather than TOD), the Mockingbird TOD has the lowest walk mode share (13.6%), the lowest bike mode share (0.22%), the lowest bus transit mode share (1.09%) and by far the lowest rail transit mode share (5.9%) of all other seven TODs. Similarly, the Mockingbird TOD also ranks first in terms of the driving mode share with about 80% of all its daily trips generated by driving. This is almost twice as many driving trips as the average of the other six TODs. This is possibly as auto-oriented as a TOD could be as auto-trips account for about 80% of its trips mostly because it is located in an auto-oriented region where more than 96% of the commuting trips are done by automobile. Still, the total auto trip generation rate in Mockingbird is about 12% lower than the ITE estimates. Similarly, while the parking supply in Mockingbird TOD is less than 48% of the recommended ITE supply rate, its peak parking occupancy is only about 55% of the TOD supply.

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Abstract

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1. Introduction

The Institute of Transportation Engineers (ITE) Trip and Parking Generation Manuals are transportation planning "bibles" widely used by transportation planners, engineers and developers to estimate the impacts of proposed developments on an area's transportation system. The data utilized by the ITE manual has been collected from different types of existing developments and are used to generate average rates and statistically fitted equations to estimate trip and parking generation values.

While the ITE guidelines are the most widely used source of information for trip and parking generation estimates of new developments in the U.S, recent empirical evidence from seven national TODs question the efficiency of their forecasting rates when it comes to TOD sites. This is possibly due to the fact that TODs typically exhibit a diverse range of land use compositions such as multifamily housing, commercial and office uses with relatively higher public transit mode share and fewer auto-trips and with opportunities for trip chaining. These characteristics make the estimation of trip and parking generation more complicated as compared to the conventional suburban developments which are mostly used for ITE estimates (Ewing et al., 2017).

A series of recent trip and parking generation studies for seven national TODs consistently report significantly lower vehicle trip generation rates as compared to the ITE manual. They also conclude that the peak parking demand in these TODs could be, on average, as low as a half of ITE predicted rates. The seven TODs are Redmond in Seattle; Rhode Island Row in Washington DC.; Fruitvale Village in San Francisco; Englewood in Denver; Wilshire/Vermont in Los Angeles; Orenco Station in Portland and Station Park TAD (transit-adjacent development) in Salt Lake City (Ewing et al., 2017; Ewing et al, 2019). While these TODs are geographically distributed all around the country, they have one feature in common. They are located in the regions with successful transit systems and relatively higher transit ridership. It is still unclear whether and to what extent trip and parking generation rates of a TOD in a more auto-oriented region with a less complete transit system would follow similar patterns as these seven TODs.

This study seeks to address this gap by exploring trip and parking generation in Mockingbird Station TOD in Dallas, TX. Dallas county is recognized as one of the most car-oriented regions in the U.S with auto-trips accounting for more than 95 percent of its residents' commute mode share (4). This study asks how many fewer vehicle trips are generated at Mockingbird Station and how much less parking is demanded comparing to ITE manuals. The findings are also integrated with our previous seven station-area developments and show that TODs create significantly less demand for parking and driving than conventional suburban developments do (Ewing et al., 2017).

We limit our sample (case) of TODs in DFW to one site that meets eight criteria: 1) Dense (with multi-story buildings), 2) Mixed use (with residential, retail, entertainment, and some-time office uses in the same development), 3) Pedestrian-friendly (with streets built for pedestrians as well as autos and transit), 4) Adjacent to transit (literally abutting and hence integrally related to transit), 5) Built after a high-quality transit line was constructed or proposed (and hence with a parking

supply that reflects the availability of high quality transit), 6) Fully developed or nearly so, 7) Self-contained in terms of parking, and 8) Developed under a master development plan. The site is Mockingbird Station TOD in Dallas (opened in 2001), the best TOD in the region and one that demonstrates DART TOD guidelines.

Two types of trip and parking data has been collected in this study: (1) full counts of all persons and vehicles entering and exiting the buildings that make up the TODs, (2) parking inventory and occupancy surveys of all off-street parking accessory to the commercial and residential uses of the TODs. Data was collected between 7:30 am and 9:00 pm on a clement weekday. Parking occupancy counts were conducted even later to capture peak residential parking demand.

We developed a specific data collection plan and protocols based on our previous experiences (Ewing et al., 2017; Tian et al. 2017). The intent (of this approach) was to develop an accurate measure of total trip generation associated with the commercial and residential uses, as well as parking utilization data that provide a picture of the parking demand throughout the survey day.

2. Literature Review

Optimizing the use of lands around transit station has been receiving significant attentions in recent decades. Research shows multifamily housing, retail, commercial and office are the most efficient land uses in such places (Tian et al. 2017). In places where these compact and mixed-use developments are combined with having high-quality walking environments and are adjacent to transit, they generally are defined as TODs. Transit-oriented developments (TODs) are organized to promote transit ridership; however, they are generally assumed to generate higher demand for parking and larger park-and-ride lots. Contrary to conventional suburban developments, non-auto trips have a remarkable share of the total trip generation in suburban TODs. Since TODs are designated to be pedestrian-friendly environments providing mixed-use development, making balance between parking lots and parking demand can be complicated (Ewing et al. 2017).

The framework of this study originated from the widely studied impacts of built environment attribute on trip and parking demands. In travel studies, the effects of built environment on travel demand are addressed as D variables. Pioneer studies stated that development density, street design and land use diversity are among the most significant built environment attributes that influence travel behavior (Cervero and Kockelman 1997). Later, destination accessibility and distance to transit were included in the list of D variables (Ewing and Cervero 2001). Demand management (parking management) and demographics are other introduced D variables. (Ewing et al. 2019).

Density, diversity and design could influence travel behavior through reducing car ownership and vehicle miles travelled (VMT) (Zhou and Kockelman, 2008), and consequently results in more walking and transit riding due to shorter distance to destinations and better access to transit stations in dense developments (Ewing and Cervero, 2010; Frank et al. 2007; Cervero 2002; Ewing et al.

2009). Destination accessibility often identifies the distance to jobs and major destinations; it influences car ownership and car dependency in urban and suburban developments (Ewing and Cervero 2010). TODs are development types that meet all D variables; they feature dense and diverse land uses, greater street design connectivity, and higher destination accessibility and in proximity to transit stations. This is how TODs affect travel behavior, mode choices and vehicle trip/parking generation.

The existing literature lacks studies in terms of trip and parking generation in TODs. Previous research mainly explores vehicle trip generation (Cervero and Arrington 2008; Zamir et al. 2014) and parking demand at multifamily development near transit (Cervero et al., 2010; Rowe et al., 2011; Serafin et al. 2010).

2.1 TODs and Travel Behavior

TODs are planned to create dense, mixed-use and pedestrian friendly community developments, which are located in a walking distance from a transit station (Calthorpe, 1993). Urban planners have implemented TOD as a strategy to reduce vehicle trips, encourage walking and increase the share of environment friendly transit mode (Calthorpe and Mack 1989). Additionally, it is stated that TOD could decrease car dependency in metropolitan areas (Newman and Kenworthy 1999). At the regional scale, a successful TOD will contribute in other benefits such as reducing the greenhouse gas emission, increasing the land property values near the stations, providing jobs for households, decreasing the infrastructure costs and enhancing public health due to more available walking/biking options (Center for Transit-Oriented Development (CTOD) 2011). The principles of TOD's theory have been tested by several empirical evidences in various geographical areas.

Literature points to the impacts of built environment attributes of developments around the transit stations on individuals' travel behavior to understand to what extend TODs are successful in reducing car trips and encouraging active travel mode and public transit ridership (Cervero et al. 2004; Renne and Ewing 2013; Cervero and Arrington 2008).To recognize the effectiveness of TODs on reducing vehicle trips and shifting to sustainable trip modes, the changes in travel patterns are investigated by comparing the residents of TOD with non-TOD areas (e.g., Kamruzzaman et al. 2016; Nasri and Zhang 2014). Results from a longitudinal survey (2007-2008) in Baltimore and Washington DC indicate that people who reside in TODs are more likely to reduce their vehicle trips comparing to residents of non-TOD settings (Nasri and Zhang 2014). Hale 2014, states that the share of non-driving travel modes including public transit, walking and biking in TOD areas is more than 50 % which is considerably higher than non-TOD areas. Results from a survey study in Washington DC area by Venigalla and Faghri (2015), indicate that the trip shares by walking, biking and transit are substantially higher in TOD zones. Simultaneously, non-TOD zones have higher rates of vehicle mode. The driving mode share within non-TOD zones is observed to be 45% higher than the TOD zones.

TOD strategies have been adopted in developing countries as well as the U.S and European cities to manage transportation related issues. Accordingly, metropolitan areas in developing countries seem to follow similar trends in terms of individuals' travel behavior in TODs. In a study in Shanghai city, China, Chen et al. (2017) examined the reduction of personal vehicle kilometer travelled (VKT) in TOD and non-TOD neighborhoods. They noticed that while non-TOD residents are two times more interested in using private cars for commuting trips, rail transit and non-motorized trips of TOD residents are two times greater than non-TOD residents.

Multiple studies focused on the built environmental indicators that differentiate between travel mode shares in TODs and non-TODs. Park et al. (2018) investigated the relationship between various travel outcomes and the environmental factors of eight TODs in the U.S. metropolitan areas. Findings show that job accessibility, land use diversity and street design network in rail station areas dramatically reduce vehicle trips. In a study by Olaru and Curtis (2015), the effects of transit accessibility are examined to understand how TODs led residents to decrease their vehicle trips in Perth, Western Australia. They find that proximity to transit facilities is the most important determinant for walking, biking and transit ridership in TOD precincts.

Other studies aimed to focus on TOD typologies in order to enhance the efficiency of supporting policies. Utilizing from built environment criteria (density, design, diversity and transit access) in different sets of TODs in Brisbane, Australia, Kamruzzaman et al. (2014) identifies four TOD clusters including residential TODs, activity center TODs, potential TODs and TODs non-suitability. They state that while residents of residential TODs and activity center TODs are more likely to use public transit and active transport, non-TOD clusters are more interested in driving private vehicles.

2.2 Trip and Parking Generation at TODs

Few studies explored the difference between actual vehicle trip generation in TODs and what is forecasted by official manuals. The study of 17 TODs in five U.S. metropolitan areas (Cervero and Arrington 2008) indicated that the rate of vehicle trips per dwelling units are 44 % fewer than what has been estimated by the ITE manual. The ITE Trip Generation Manual, which is considered as a standard guidebook for local traffic impacts, is basically determined by data extracted from suburban areas with large parking lots, low density and sprawling land uses. Hence, the ITE Manual suffers from the "suburb bias" (Walters, Bochner, and Ewing 2013). In a recent study, Clifton et al., (2015) aimed to adjust the vehicle trip rates derived from the ITE's Trip Generation Handbook in Portland, Oregon. Results show that vehicle trip rates suggested by the ITE are greater than actual observed trips.

Similarly, empirical studies sought to quantify parking generation in TOD areas. Research suggests that vehicle ownership could be lower in compact areas near transit stations (Boarnet, 2011), which consequently affects the parking demand (Ding and Cao, 2019; Zamir et al. 2014, Cervero and Arrington 2008). Although the relationship between parking availability and vehicle

ownership in residential areas is widely studied (Chatman 2013; Guo 2013), there is little evidence on the actual parking demand in TODs. Results from a study by Cervero et al., (2010), confirm that the parking generation in multi-family housing complexes near rail stations is 25-30% lower than the actual supply and ITE suggested rates. The ITE Parking Generation Manual calculates the parking supply based on the data from the suburban sites, and assumes the same rate for transit-served and non-transit-served areas (Institute of Transportation Engineers (ITE), 2010).

Scant literature also pays attention to the parking generation rates in TODs, and particularly in comparison to the ITE guideline. A series of recent studies by Ewing and his colleagues focused on trip and parking generation on TODs in seven American cities. They found that, in almost all of the TOD case studies, trip and parking generation is roughly half or less of what has been recommended by ITE (Ewing et al. 2017; Tian et al. 2017; Ewing et al. 2019). These studies compared actual vehicle trip and parking demand records to the two ITE Manuals. The results from the cited studies reveal that in almost all TOD case studies, trip and parking generation is roughly half or less of what has been recommended by ITE. The next section provides more detailed information on the methodology and findings of these six studies since they serve as the foundation for our research on trip and parking generation in Mockingbird TOD, Dallas, TX.

2.3 Six Previous TOD Trip and Generation Studies

A series of recent studies by Ewing and his colleagues focused on trip and parking generation on TODs in seven American cities including: 1) Redmond TOD at Seattle Region, 2) Rhode Island Row TOD at Washington, D.C. Region, 3) Fruitvale Village TOD at San Francisco Region, 4) Englewood TOD at Denver Region 5) Wilshire/Vermont TOD, Los Angeles Region and 6) Orenco TOD at Portland and 7) Station Park TAD. The following statements summarize their findings specifically for each TOD:

- Trip generation at Redmond TOD is only about 37 percent of the vehicle trips estimated by the ITE Trip Generation Manual. The demand for residential parking supply is only 59.5 percent of the ITE manual while, the commercial parking demand is about 27 percent of ITE's suggestions.

- In Rhode Island Row TOD, the vehicle trips are 34.7 percent of the ITE's Trip Generation estimation, and the peak of residential parking demand is about 54.3 percent of the TOD supply.

- Vehicle trip generation at Fruitvale TOD is over half of the ITE suggestion which indicated a higher rate of trip generation compared to the other case studies. However, the aggregate peak parking demand at Fruitvale TOD is only 19 percent of the ITE manual.

- Vehicle trip generation at Englewood TOD is about 69.8 percent of the ITE rates and the overall parking demand in peak hours is about 45.8 percent of the ITE guideline.

- The Wilshire/Vermont TOD trip generation is about 43 percent of ITE suggested rates. The peak of parking demand for residential was about 55 percent of ITE manual and the aggregate peak parking was 33 percent of ITEs manual.

- In Orenco Station TOD, trip generation rate is more than half of the ITE trip rates (57.2 percent) while the aggregated peak parking demand is about 41.8 percent of the ITE parking guideline.

- Station Park is the only non-TOD case study and is included as a TAD (transit adjacent development) in this series of studies. The trip generation rate at this TAD was about 74.5 percent of the ITE trip generation manual which is the highest of all other case studies. The TAD peak parking demand for residential units is about 82.9 percent of the supply (the highest rate of residential peak parking demand) and the aggregate peak parking demand is about 35.5 percent of the ITE guideline.

Utilizing the theoretical framework of these case studies as some of the best examples of TOD's norm across the U.S, this study seeks to explore the parking and trip generation in Mockingbird TOD in Dallas, Texas. It is important to note that these seven TODs are located in regions with successful transit systems and relatively higher transit ridership. A high-quality transit system could be one of the possible reasons behind the substantially lower trip generation rates and parking demands in these TODs. There is still little to no empirical evidence on whether, and to what extent, the trip and parking generation in more auto-oriented regions follow similar trends. The main contribution of this study is to address this gap by focusing on Dallas as a more car-oriented region. Mockingbird Station in Dallas is one of the pioneering TOD projects in the U.S and unlike previous case studies in places like Portland and Washington, D.C., the Dallas region is substantially more auto-dependent. If TOD works in Dallas, it should work everywhere.

3. Methodology

This study seeks to measure trip and parking generation at Mockingbird TOD in Dallas, Texas. More specifically, this study aims to determine how many fewer vehicle trips are generated and how much less parking is required at the Mockingbird TOD, than the ITE guideline would suggest. We also provide a comparison of our findings to the previous findings from seven other TODs trip and parking generation studies across the nation (Ewing et al., 2017).

According to ITE (Institute of Transportation Engineers (ITE), 2004, pp. 5-7), TODs are defined as mixed-use and compact developments located near transit station and designed as

walkable environments. The previous seven studies on TOD trip and parking generation used the following criteria for the case study selection (Ewing et al. 2017)

(1) Moderately dense (multi-story development)

(2) Mixed use (residential, retail, entertainment, and office uses in the same development)

(3) Walking-friendly (streets and routes designed for pedestrians as well as vehicles and transit)

(4) Adjacent to transit (abutting and hence integrally connected to the transit station)

(5) Developed after a high-quality transit line was built or proposed in the master plan

(6) Fully (or nearly) developed

(7) With dedicated parking lots and spaces

(8) Developed based on a master plan

Since, we intended to measure parking demand, the parking lots or garages must be dedicated to the TOD site. There may be better examples of TOD in downtown areas around the country, but they share public parking lots and garages with uses outside TODs so we cannot obtain precise parking generation estimates for these TODs.

In the process of the case study selection, we listed several cases of the self-contained TODs in Dallas–Fort Worth–Arlington (Texas) metropolitan area. We used a multi-step approach to identify the best case studies in the region. First, we listed the TODs in the area based on the aforementioned eight criteria. Second, our team reviewed the TODs in the list using the Google Earth imagery to check the boundaries and to ensure they meet all criteria (dense, mixed use, pedestrian-friendly, dedicated parking). Third, we discussed our candidate sites with other transportation planners in North Central Texas Council of Governments (NCTCOG) to recognize the strengths and limitations and challenges of each site particularly in terms of the data collection. Finally, we visited through and around the development sites to check whether the case study meets all criteria. Our team made a record of photos of the development, counted all parking spaces and stalls and estimated the occupancy rate of parking lots in different hours of a weekday.

One of the most significant concerns was to get approval from property managers to conduct this study, particularly because we needed to count occupying parking every two hours in the commercial parking garage and late evening in the residential parking. Therefore, we attended several meetings with the property managers to engage them in the study. Table 3.1. shows the descriptive statistics for our selected TOD comparing to those original seven TODs. The net residential area in our case study is at the lowest rate comparing to previous TODs; however, the

gross commercial floor area ratio (FAR) is 0.83 and that means Mockingbird TOD is mostly developed based on commercial spaces including offices, retails, shopping and recreational destinations.

The Mockingbird Station TOD in Dallas (opened in 2001), is the best and only TOD in the Dallas-Fort Worth (DFW) region that meets all of the aforementioned criteria and was finalized as the case study for this project.

Table 3.1 Net and Gross Residential Density, and Floor Area Ratio for Commercial and Residential Uses at Mockingbird TOD

TOD	Region	Gross Area (acres)	Gross Residential Density (units per gross acre)	Net Residential Area (acres)	Net Residential Density (units per net acre)	Gross Commercial FAR (for retail and office uses)
Redmond TOD	Seattle	2.5	129	2.5	129	0.11
Rhode Island Row	Washington, D.C.	6	46	6	46	0.27
Fruitvale Village	San Francisco	3.4	14	3.4	14	0.94
Englewood	Denver	30	15	10.7	41	0.25
Wilshire/Vermont	Los Angeles	3.2	140	3.2	140	0.27
Orenco Station	Portland	60	32.4	60	32.4	0.10
Station Park	Salt Lake City	115	4.1	20	23.3	0.23
Mockingbird TOD	Dallas	8.7	24.25	1.3	162	0.83

3.1 Mockingbird TOD

Mockingbird station is recognized as one of the first TODs in Texas, began to develop by UC Urban in 1997 in a seven-acre property which used to be the Western Electric warehouse on Mockingbird Lane. Later in 1998, an extra three acres of land (Guaranty Federal Bank building and parking structure, an office tower next to the Western Electric building) was added to the development.

North of downtown Dallas, the Mockingbird Station is capitalized by private developer initiatives while it benefits from its location and an abundance of adjacent regional attractions. The CBRE Global Investors which is one of the highest profile owners of North Texas commercial properties with multiple properties, purchased the Mockingbird Station; DTZ manages the property and Madison Marquette manages leasing initiatives. Mockingbird Station offers retail,

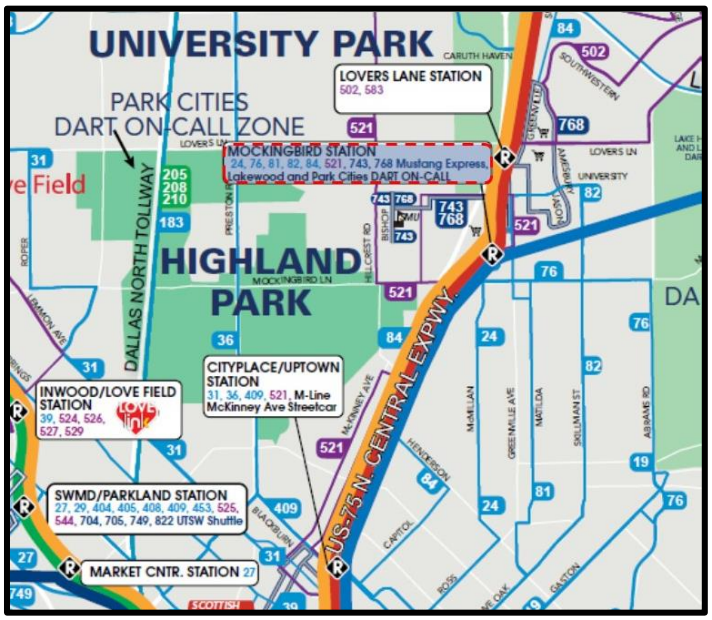
restaurants, services, and entertainment options for travelers, along with loft apartments and an office building.

At the ground floor of the office tower and adjacent to the parking structure, there are retailers including shopping stores, restaurants, and cafés. The grand staircase connects movie center to shops and residential lofts. The loft apartment, which is renovated from the Western Electronic warehouse includes 200,000 square feet area and the ground level of lofts apartment encompasses 45,000 square feet of retail space. Mockingbird Station has received several real estate industry awards for its mixed-use of shops, restaurants, apartments and office space which all located next to a commuter rail station since its operation in 2001. The outdoor mall which surrounds the station, is one of the key attributes of the station due to the vitality and liveliness that it causes and because it encourages more development around the station.

Mockingbird station is located 6.4 kilometers north of Dallas Central Business District (CBD), and is connected to the 32-kilometer light-rail system operated by Dallas Area Rapid Transit (DART). It is served by the North Central segment of the DART Rail Red and Blue lines. Mockingbird station is also a major bus transfer center served by served by bus lines including: 24, 76, 81/82, 84, 521, SMU Express (768) (M-S in session), GoLink Lakewood (M-F), GoLink Park Cities (M-F), and Bush Center/Meadows Museum Shuttle (743).

The station includes drop-off and pickup areas, bicycle racks, free commuter parking spaces, passenger shelters and seating areas. Other facilities such as customer information, ticket vending machines, telephones, elevator and escalators are available in this station. Moreover, Mockingbird Station has three leased parking spots for car-sharing services such as Zipcar. Riders planning to travel to destinations that are not accessible by other modes of transport could rent a SUV/truck as a cost-effective and reliable option of transit. The station has been developed in a customer-friendly manner.

(a) Regional DART Rail System Map (source: https://www.dart.org/maps/printrailmap.asp)



(b) Mockingbird Station in DART System (source: https://www.dart.org/maps/printrailmap.asp)

Figure 3.1. Transit Service at Mockingbird Station

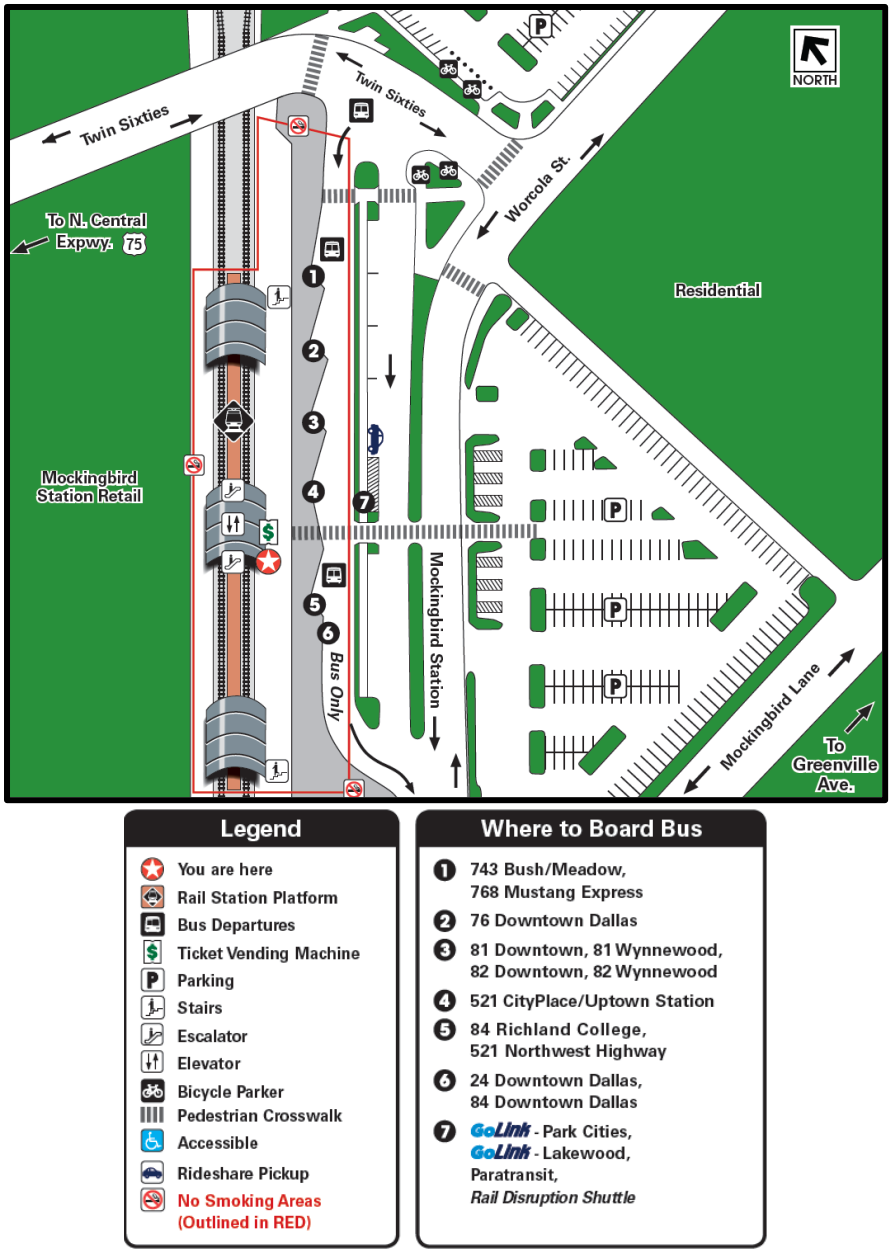


Figure 3.2. Facility Map of Mockingbird Station
(source: https://www.dart.org/maps/facilityoverviewmaps/mockingbirdstation.asp)

Mockingbird station is also connected to campus of the Southern Methodist University (SMU) by shuttle service. Mockingbird station is adjacent to other attractive amenities such as new Meadows Art Museum and the Gerald J. Ford Stadium, and it is close to regional recreational destinations including the Katy Trail (hike and bike) and White Rock Lake. Moreover, the Highland Park, one of Dallas's most affluent neighborhoods, is directly accessible from Mockingbird TOD.

Mockingbird development is a single-block TOD in Dallas (Walters et al., 2013). It is an urban mixed-use village linked to the Dallas Area Rapid Transit (DART) light-rail station via a welcoming pedestrian bridge. This station is the first mixed-use project in Texas specifically designed and built for a light-rail train station; it includes 211 upscale loft residences, approximately 140,000 square feet of total office space, and nearly 236,000 square feet of total spaces for retail, theaters, and restaurants. It provides both underground and above-ground structured parking as well (CBRE, 2019).

The residential Lofts at Mockingbird station are located in a multifamily mixed- use building consists of 211 units. This residential facility provides various options from studio to two-bedroom and penthouse units. The first three floors of the Lofts building are the old warehouse and the retail shops are available at the ground floor.

The office uses in Mockingbird TOD are located in a 10-story building with a total of 138,157 square feet building area. It was built in 1979 in a 1.14 acre of land. The average floor plans vary from 11,500 rental square feet (floors 5-10) to 4,500 rental square feet (floors 2-4). The office tower includes tenant parking garage with a direct elevator access to tenant suites and it also has convenient visiting parking spaces. It has direct access to the retail units and to the light-rail at Mockingbird Station. Mockingbird TOD provides multiple retail and shopping destinations. The retail stores are in the ground floor of Lofts residential building, and the ground floor of the office tower building. The total building area of retails in Mockingbird is about 235,984 square feet.

Mockingbird development supplies parking garages and on-street parking stalls (see Figure 4.4). The total number of parking spaces for this development is 1,463 spaces. The garage parking includes the office parking, retailing parking and Lofts residential parking. The office parking has a separate entrance from North Central Expy. The retail parking which is a 6-story parking garage provides parking spaces for visitors, retail customers and residents. The residential parking of Lofts has been constructed underground. While the on-street parking lots contain 208 stalls, the garage parking of office includes 335 spaces, the Lofts residential garage has 242 parking spots and the retailing parking has 678 spaces. Table 3.4 presents the summary of all units and land uses in Mockingbird TOD development.

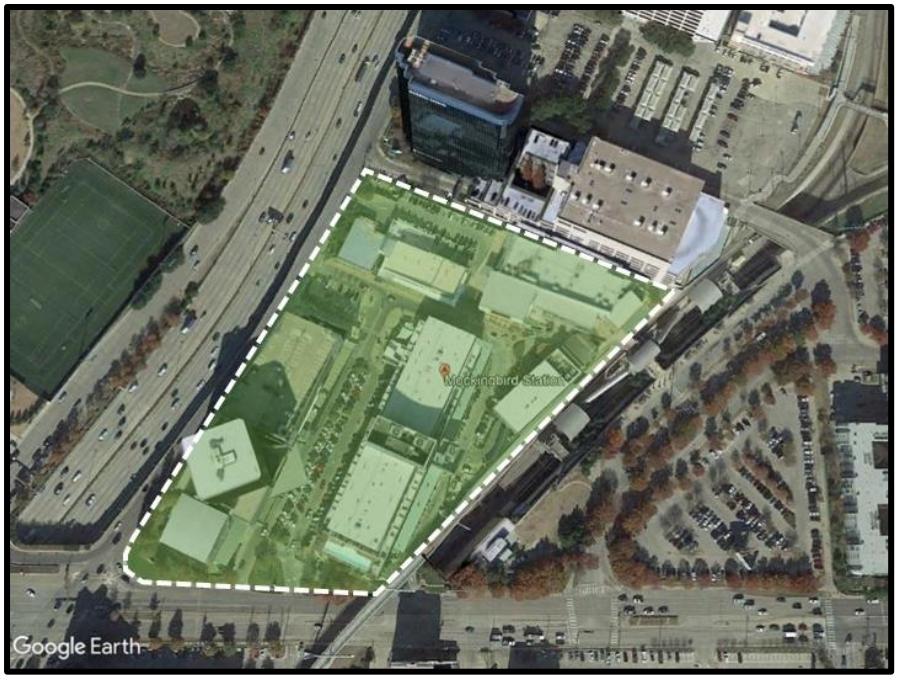


Figure 3.3. Mockingbird Station

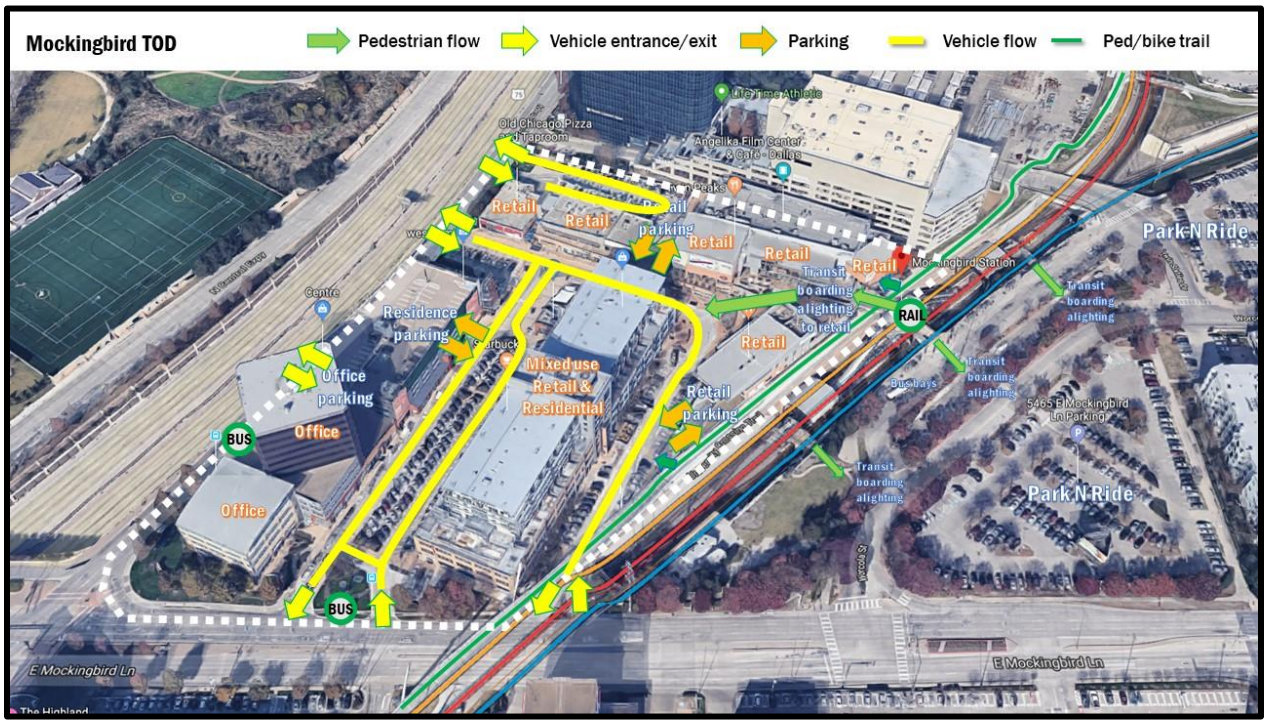
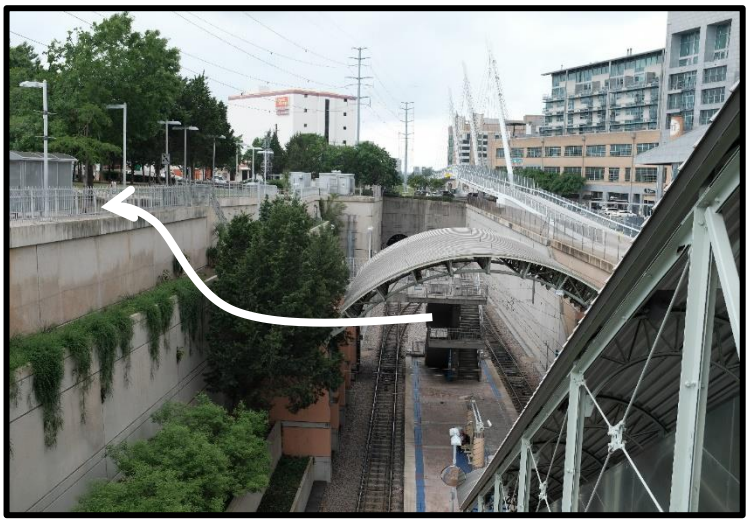


Figure 3.4. Mockingbird TOD Spatial Structure

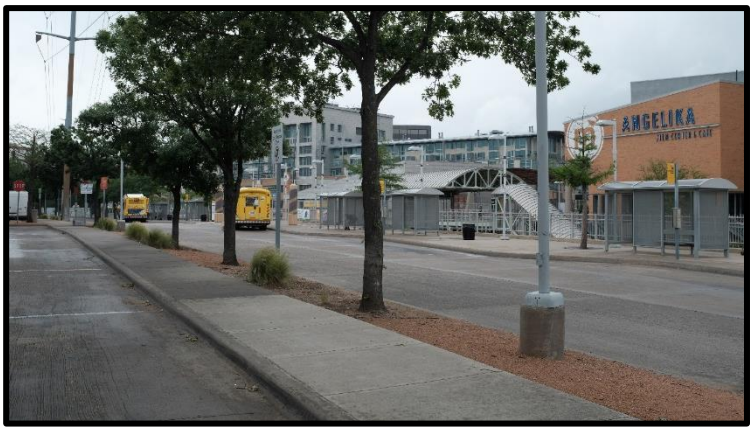
(a) Leveled platform of transit station

(b) Looking toward the station from TOD

(c) North-side exit to ground transportation

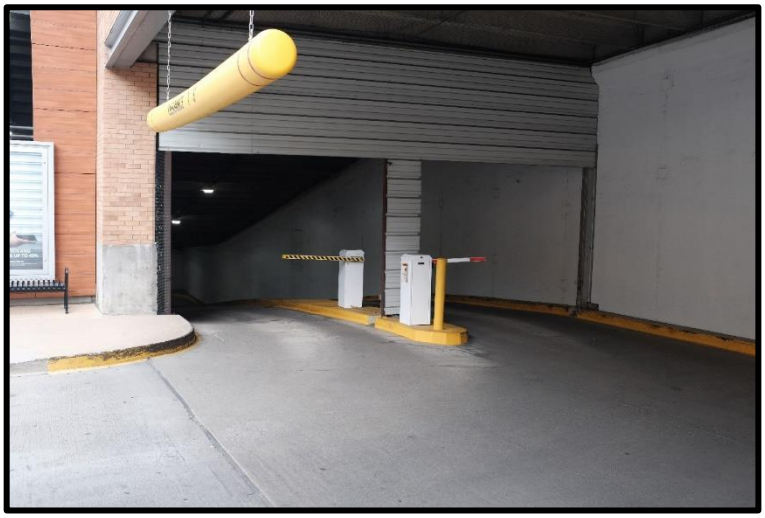


(d) South-side exit to ground transportation

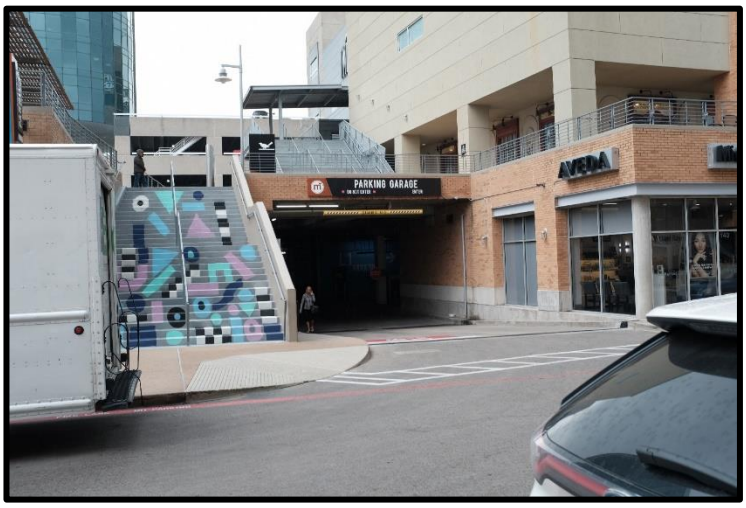


(e) Bus bays

(f) Access to residential parking



(g) Residential parking (gated)



(h) Retail parking

(i) There is no loading zone for delivery

(j) Secured bike covers in Park N Ride, (Source: credited by CTEDD)

Figure 3.5. Mockingbird TOD

Table 3.3. Land Use Summery of Mockingbird Station (8.7 acres)

Land uses	***Description***	***Unit***	***Occupancy***
Commercial			
Retail strip	Ground floor	51,333	100.00
Retail strip	Ground floor	40,557	85.80
Retail strip	2 stories	24,023	91.02
Shopping center	2 stories	74,634	92.32
Office building	10 stories	124,341	83.48
Residential			
Lofts	8 stories	211	96.68%
Parking	***Description***	***Unit***	***Peak Occupancy***
Mixed-use parking	On-street parking	208 stalls	76.92%
Retail parking	Parking garage (six stories)	678 stalls	65.19%
Office parking	Parking garage (one story)	335 stalls	71.04%
Residential parking	Underground parking	242 stalls	61.57%

Source: http://dallascad.org/AcctDetailCom

Table 3.4. Commercial uses[1] at Mockingbird development (leased retail spaces)

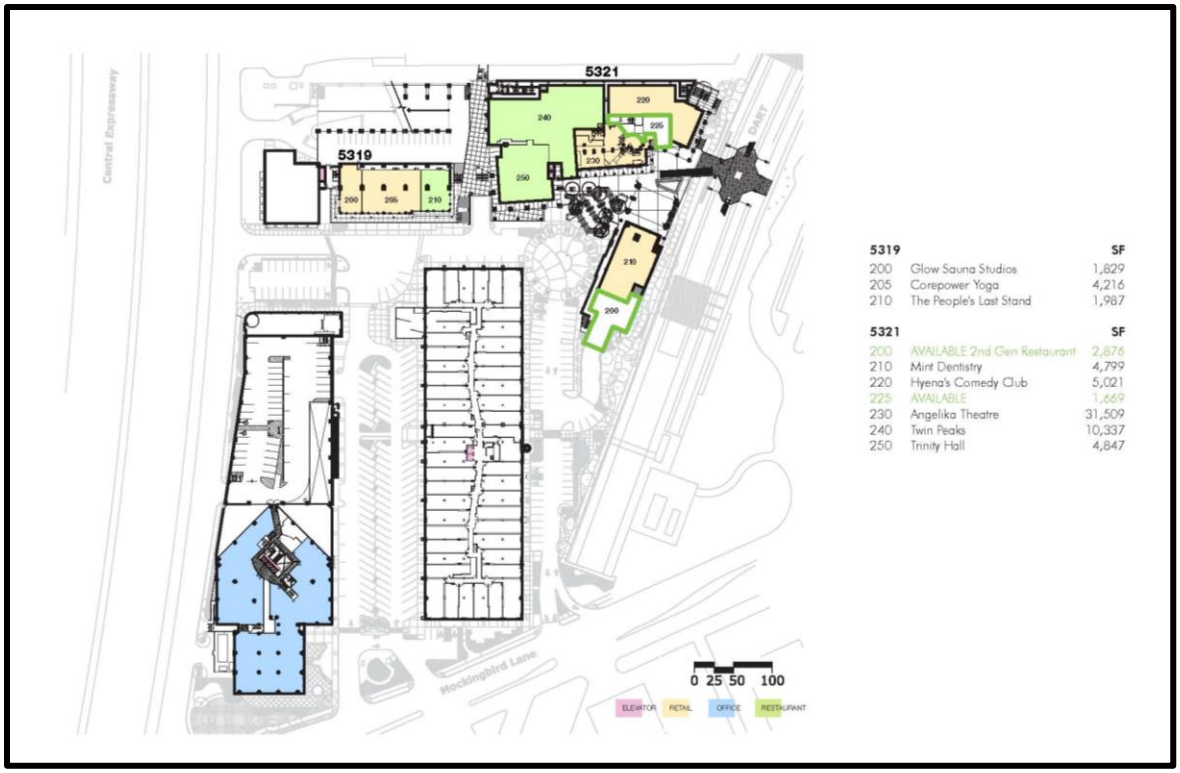
Lot ID	*Building ID*	*lessee*	*Unit (sq. ft.)*	*Land use*
5307	100	West Elm	25,000	Retail
5307	105	Francesca's collection	1,033	Retail
5307	107	Buda Juice	728	Retail
5307	130	Ann Taylor LOFT	6,294	Retail
5307	140	Center	1,742	Retail
5319	100	Old Chicago Pizza & Taproom	5,810	Restaurant
5319	120	Dallas Grilled Cheese Co.	2,400	Restaurant
5319	130	The Pretty Kitty	1,176	Retail
5319	150	Castle Nail Spa	4,448	Retail
5321	105	Urban Taco	2,265	Restaurant
5321	110	Brined	5,375	Restaurant
5321	130	Poke-O	1,500	Restaurant
5321	135	Pure Milk & Honey	1,357	Retail
5321	140	Michael Raymond Salon	1,894	Retail
5331	100	Gap	10,016	Retail
5331	105	9 Round Fitness	1,175	Retail
5331	110	Wink Beauty Bar	1,423	Retail
5331	120	Victoria's Secret	5,180	Retail
5331	125	Agu Ramen	1,769	Restaurant
5331	130	Bath & Body	2,395	Retail
5331	140	Rush Bowls	1,036	Restaurant
5331	150	Starbucks	1,328	Restaurant
5331	160	Edith's	4,211	Restaurants
5331	170	Accents	1,438	Retail
5331	175	Stroll Snap	4,492	Retail
5331	180	Verizon	3,137	Retail
5331	190	Urban Outfits	13,733	Retail
5319	200	Glow Sauna Studios	1,829	Retail
5319	205	Core power Yoga	4,216	Retail
5319	210	The People's Last Stand	1,987	Restaurant
5321	210	Mint Dentistry	4,799	Retail
5321	220	Hyena's Comedy Club	5,021	Retail
5321	230	Angelika Theater	31,509	Retail
5321	240	Twin Peaks	10,337	Restaurant
5321	250	Trinity Hall	4,847	Restaurant

Source: www. CBRE.com/TXretail

[1] This table shows the commercial uses in the first and second floors of the retail strips and shopping center without considering the office uses

Figure 3.6. Parking Spaces at Mockingbird TOD

(a) Commercial uses at first floor plan



(b) Commercial uses at second floor plan (Source: www. CBRE.com/TXretail)

Figure 3.7. Commercial Land Uses at Mockingbird TOD

3.2 Data collection

Our data collection covers four types of travel data: (1) a full count of all persons entering and exiting the retail, office and residential buildings in the TOD development, (2) a full count of all vehicle trips entering and exiting the TOD development (3) parking inventory and occupancy counts of all off-street parking accessible to the commercial, office and residential uses of all buildings (4) parking inventory and occupancy counts of all on-street parking stalls in the TOD development. Our ultimate goal is to measure the exact number of total trip and parking generation related to the commercial, office and residential uses in the TOD site.

We collected the trip generation data between 7: 30 am and 9:00 pm on Thursday, June 20, 2019. We also surveyed the parking occupancy rate for parking garages and on-street parking stalls every two hours during this period. We conducted an additional "overnight" counting of residential parking occupancy at 10 p.m. on the survey day.

A total of 15 trained students from UT Arlington assisted with the data collection in to separate teams. 1) A team of ten full-day and five half day surveyors (to account for the substantially higher rates at the peak hours) counted all vehicle and person trips in 10 entering/exiting stations (see Fig

3.8). Their counts cover all individuals who entered/exited the site by various travel modes including driving, walking, riding a bike, bus and light rail. 2) A team of four full-day researchers counted the number of occupied parking slots every two hours. One additional team member served as the reserve to switch with other members for their scheduled break times. Unlike the previous TOD trip and parking generation studies, we were able to account for the difference in residential and office trip generations by counting them separately.

Since Mockingbird TOD is a highly mixed- use and relatively dense development, we expected to have a higher travel flow in the evening. Therefore, we hired five additional half-time surveyors for the evening. The surveyors recorded whether the subject was “entering” or “exiting” to/from the site and the type and the location of entrance/exit; they also recorded the time by checking one of the 15-minute period-per-hour boxes in the data collection form. Surveyors counted 100% of the individuals who entered or exited the site by transportation mode including driving a private vehicle, walking, riding a bike and transit (bus and light rail). Figure 3.6 indicate the exact positions of the eight surveyors, the exiting/entering by different mode of transport and the locations which had a peak time. A surveyor positioned in front of the residential parking garage gate, counted vehicle and person trips entering/exiting the parking garage. Thus, we were able to calculate the occupied parking spaces for residential building every two hours and residential person and vehicle trip generation separately.

We recruited the graduate and undergraduate students from the University of Texas at Arlington through a job announcement for the data collection. Most of the surveyors were masters and PhD students and they all attended an orientation session and received training by the research staff.

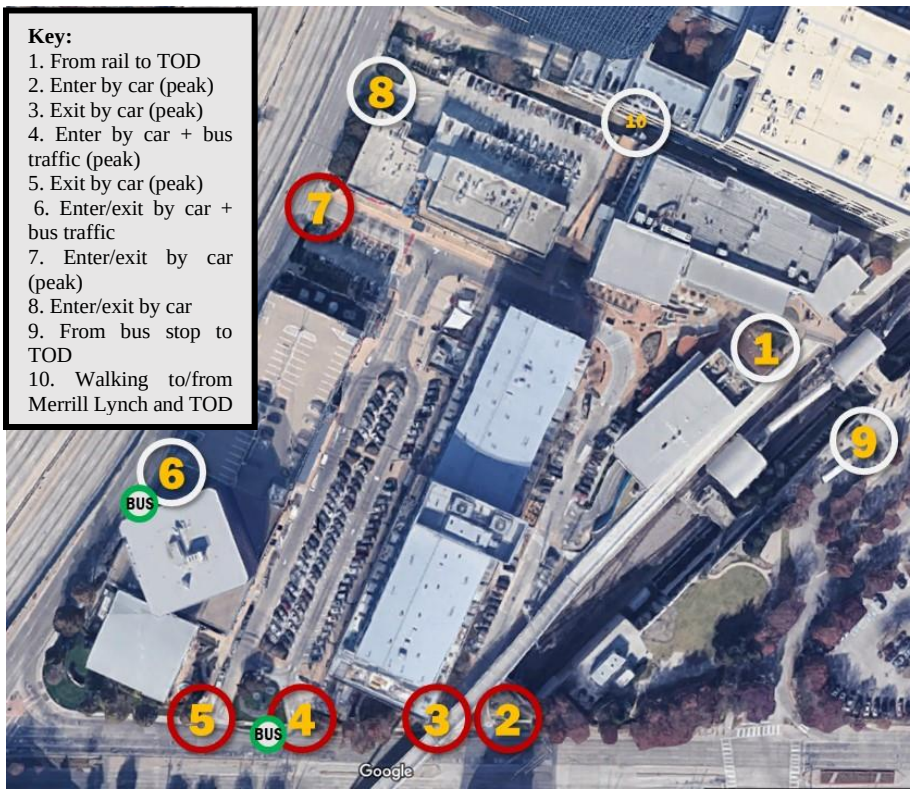


Figure 3.8. Positions of The Surveyors for Vehicle Trip Counting in 10 stations

4. Results

4.1. Mode Share

Tables 4.1 and 4.2 present the overall mode share as well as the mode share statistics by the count location. The total number of recorded person trips is 11,633 which includes trips by the single occupancy vehicle, high occupancy vehicle with two persons, high occupancy vehicle with three and more persons, walking, biking, light-rail and bus trips.

Table 4.1. Overall Mode Shares in Mockingbird TOD

Mockingbird TOD	*Person trip generation counts*				
Trip mode	***Walk***	***Bike***	***Bus***	***Rail***	***Auto***
Counts	1585	26	127	685	9209
Share (%)	13.63	0.22	1.09	5.89	79.16

The overall trip mode share in the TOD development is as following: 79.16 percent vehicle trips, 13.63 percent walking trips, 0.22 percent bike trips, 5.89 percent light-rail transit trips and 1.09 percent bus trips. These findings are differ significantly from the census-tract level commute mode shares for Mockingbird development from ACS five-year estimates (2013-2017) which

reports the modal split rates as about 90.66 percent driving, 7.3 percent transit mode, 0.44 percent bike and 1.61 percent of walk modes (American Community Survey, 2017). Across the U.S., the work trip is the most auto and transit oriented of the trip purposes due to their relative length. Walk trips are more common for non-work trips, due to their relatively short length.

Table 4.2. Mode Shares in Different Survey Entrances and Final Mode Shares in Mockingbird TOD

Entrance	*Counts*	*Mode shares (%)*				
		Walk	*Bike*	*Bus*	*Rail*	*Auto*
Location 1	731	5.34	0.96	N/A	93.71	N/A
Location 2	1,042	9.12	0.10	N/A	N/A	90.79
Location 3	921	7.38	0.22	N/A	N/A	92.40
Location 4	1,335	0.45	0.15	0.15	N/A	99.25
Location 5	1,412	5.88	0.07	N/A	N/A	94.05
Location 6	631	0.32	0.00	0	N/A	99.68
Location 7	3,445	11.12	0.06	N/A	N/A	88.82
Location 8	1,089	1.65	0.09	N/A	N/A	98.26
Location 9	532	74.62	1.88	23.50	N/A	N/A
Location 10	495	100	N/A	N/A	N/A	N/A
Final Counts	11,663	13.63	0.22	1.09	5.89	79.16

While the driving mode share of the Mockingbird TOD is higher than seven previously studied TODs, it still is lower than the regional average for the DFW metropolitan area (95.37 percent). The walk and the total transit (bus and rail) mode shares for the Mockingbird TOD are also higher than the regional average that are respectively 0.75 percent, 2.85 percent of the total trip mode share (American Community Survey, 2017).

4.2. Trip Generation

Our team recorded a total of 11,633 person trips and 7,556 vehicle trips generated by 204 residential units (211 units at 0.966 occupancy rate), 280,704 square feet of leased area for commercial uses including 103,804 square feet of office space and 176,900 square feet of shopping, recreation and retail space.

The 10th Edition of ITE Trip Generation Guideline (28) determines vehicle trip rates based on the studies from three different development categories: 1) Center City Core, 2) Dense Multi-Use Urban and 3) General Urban/Suburban locations. The “Center City Core” typically represents downtown areas in metropolitan regions with relatively higher transit coverage and frequency. “Dense Multi-Use Urban” is defined as fully developed areas, with diverse and interacting complementary land uses, high pedestrian connectivity, and convenient and frequent transit. This area can be located outside a major metropolitan downtown, with mixed land use typically

including residential, office, retails and recreation, having on-street and off-street parking facilities. The complementary land uses provide the opportunity for short trips and non-driving travel modes such as walking, biking, or transit mode choices. The "General Urban/Suburban" areas are typically referred to homogenous auto-oriented developments and can be fully developed (or nearly so) at low to medium density with a mix of residential and commercial uses. Generally, in this type of development offers relatively lower pedestrian, biking, and transit facilities.

The Mockingbird TOD fits best the characteristics of "General Urban/Suburban" and "Dense Multi-Use Urban" categories, and therefore, we used the trip generation rates from both categories in our analysis. For the residential, retail and office uses at the Mockingbird TOD, we utilized the ITE trip generate rates for "221 Multifamily Housing (Mid-Rise)", "820 Shopping Center" and "710 General Office Building" land uses respectively.

Based on the ITE guideline, the Mockingbird TOD (8.7 acres study area) is expected to generate 8,539 and 11,658 vehicle trips in a general weekday based on the "General Urban/Suburban" and "Dense Multi-Use Urban" categories, respectively. According to our observation, the actual vehicle trip generation at this TOD for all residential and commercial (retail and office) uses is 7,556 trips which is about 88.49 percent of the ITE recommended rate for "General Urban/Suburban" and about 64.81 percent of the ITE recommended rate for the "Dense Multi-Use Urban" categories.

Table 4.3. The Overall Daily Vehicle Trip Generation at Mockingbird TOD based on the ITE Recommended Rates

General Urban/Suburban	***Trip generation rate***	***Total units***	***Total daily trips***
ITE Guideline			**8539**
221 Multifamily Housing (Mid-Rise)	6.35	204	1295
820 Shopping Center	37.75	176,900	6,678
710 General Office Building	5.45	103,804	566
Dense Multi-Use Urban	***Trip generation rate***	***Total units***	***Total daily trips***
ITE Guideline (Dense Multi-Use Urban)			**11,658**
221 Multifamily Housing (Mid-Rise)	3.83	204	781
820 Shopping Center	58.25	176,900	10,304
710 General Office Building	5.51	103,804	572

We also recorded about 458 vehicle trips for occupied residential units and 569 vehicle trips for leased office spaces at the Mockingbird TOD. When subtracted from the total number of vehicle trips (7,556), this leaves us with about 6,529 vehicle trips per occupied leased retail spaces at Mockingbird TOD.

Table 4.4. The Actual Trip Generation Rates at Mockingbird TOD by Building Use (Office, Retail and Residential Uses)

Mockingbird TOD	*# of vehicle trips*	*% of ITE trip rates based on General Urban/Suburban*	*% ITE trips rates based on Dense Multi-Use Urban*
Residential building	458	35.37 %	58.64 %
Retail and shopping center	6,529	97.77 %	63.36 %
Office building	569	100.53 %	99.48 %
Total vehicle trips	**7,556**	88.49	64.81

Tables 4.4 presents the total daily trips for three different building uses at the Mockingbird TOD. As shown in Table 4.3 and 4.4, the actual trips generated by the office units are close to the ITE trip generation rates for both "General Urban/Suburban" and "Dense Multi-Use Urban" regions while the actual trip generation for residential units is about 35.37 percent and 58.64 percent of the ITE guideline in "General Urban/Suburban" "Dense Multi-Use Urban" categories, respectively. Finally, the trip generation for retail and shopping spaces is about 97.77 percent of the ITE rates for the "General Urban/Suburban" and 63.36 percent of the ITE rates for the "Dense Multi-Use Urban" categories.

4.3. Parking Generation

Table 4.5 compares the parking supply and demand for the Mockingbird TOD and the ITE guideline. According to the ITE guideline, the total parking supply for residential, occupied commercial and occupied office uses at the Mockingbird TOD would be 1,704 stalls while the actual parking supply is 1,463 spaces, which is 86 percent of the ITE recommended rate. Since the peak hour for residential and commercial uses is different, we used a single hour when parking occupancy for both residential and commercial uses was highest which was found to be 8 pm (811 occupied parking spaces). Accordingly, the actual peak parking demand for Mockingbird TOD is 47.59 percent of the ITE recommended rate and 55.43 percent of the Mockingbird actual supply (see Table 4.5).

Table 4.5. The Comparison of Parking Supply and Demand between Mockingbird TOD Residential, Commercial and ITE Guideline

	Supply		Peak period demand	
	Parking per unit for residential and per 1,000 sqft for commercial and office uses	Total # of parking	Vehicle per unit for residential and per 1,000 sqft for commercial and office uses	Total # of parked vehicles
Residential				
ITE "222 High-Rise Apartment"	2	422	1.37	289
Mockingbird TOD	1.15	242	0.71	149
Commercial (occupied space only)				
ITE "820 Shopping Center"	4.9	867	2.55	451
Mockingbird TOD	_	886	_	602
Office (occupied space only)				
ITE "701 Office Building"	4	415	2.47	256
Mockingbird TOD	_	335	_	238
Total				
ITE Guideline	1704		NA	
Mockingbird TOD	1463		811	

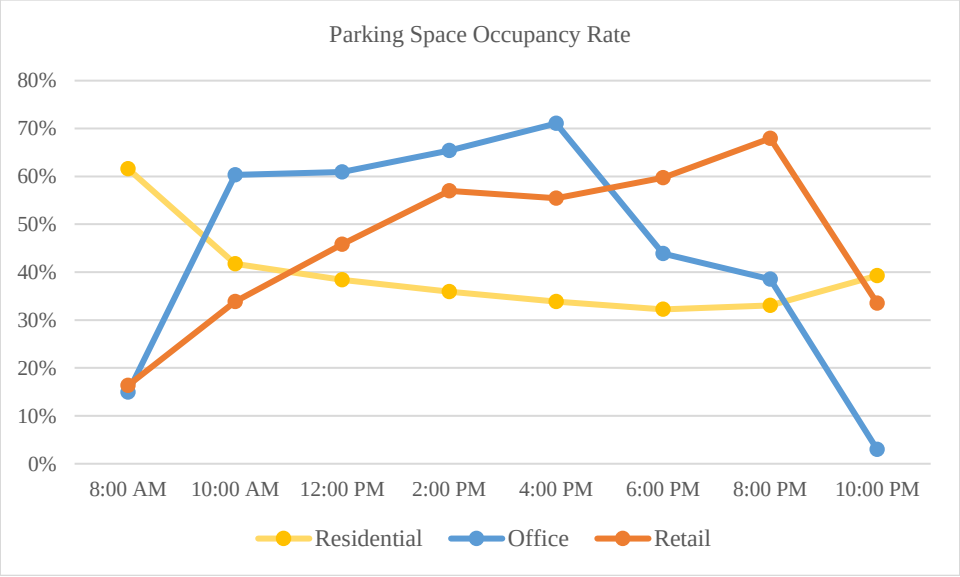


Figure 4.1 Parking Space Occupancy Rate for Different Uses at Mockingbird, TOD

Figure 4.1 shows the parking demand for different uses at the Mockingbird TOD. The parking occupancy for the residential building follows a declining trend during the day with the lowest occupancy rate reported at 6 pm. It turns to an increasing trend after 8 pm when the residential trip attraction is at the highest level.

To explore the commercial parking demand, we considered both retail and office occupied parking spaces for every two-hour count from 7 am to 10 pm. As shown in Figure 4.1, the retail and office demand are at the lowest level at 8 am with an increasing trend during the day. Demand for office and retail parking eventually peaks at 4 and 8 pm and declines to less than a half after 8 pm.

5. Case Study Comparisons

As shown in Table 5.1, Mockingbird TOD has the lowest share of light rail mode when comparing with previous TODs. The Mockingbird has the lowest mode share of bus transit as well. In addition, , the walking mode share at Mockingbird TOD is less than the average of all TOD's walking trips while its walking mode share is greater than the bus and rail mode shares. As expected, the auto mode share in this TOD is higher than other transport modes (79.16 %). After Station Park as a TAD, Mockingbird TOD has the highest rate of car trips compared to the other TODs.

Table 5.1. Average Mode Shares for Studied TODs

TOD	*Count*	*% mode share*					
		Walk	*Bike*	*Bus*	*Rail*	*Auto*	*Other*
Redmond (Seattle)	1,981	18.9	1.7	13.0	NA	64.9	1.5
Rhode Island Row (Washington DC)	8,451	16.6	0.3	9.3	27.2	42.5	4.0
Fruitvale (San Francisco)	16,558	28.3	4.3	15.2	26.1	23.0	3.1
Englewood (Denver)	14,073	19.2	3.8	3.3	13.6	59.7	0.2
Wilshire/Vermont (Los Angeles)	11,043	27.4	2.2	21.1	20.1	25.9	3.4
Orenco Station (Portland)	15,495	45.8	2.5	3.9	16.0	31.4	0.4
Station Park (Salt Lake City)	42,172	3.6	1.2	1.4	4.1	89.0	0.6
Mockingbird	11663	13.63	0.22	1.09	5.89	79.16	NA

Table 5.2. Average Vehicle Trip Reductions Compared to the ITE Rates

TOD	*ITE vehicle trips*	*Actual vehicle trips*	*% of ITE trips*	*% Reduction*
Redmond (Seattle)	1,767	661	37.4	62.6
Rhode Island Row (Washington DC)	5,808	2,017	34.7	65.3
Fruitvale (San Francisco)	5,899	3,056	51.8	48.2
Englewood (Denver)	13,544	9,460	69.8	30.2
Wilshire/Vermont (Los Angeles)	5,180	2,228	43.0	57.0
Orenco Station (Portland)	11,106	6,358	57.2	42.8
Station Park (Salt Lake City)	41,177	30,692	74.5	25.5
Mockingbird (Urban/Suburban)	8539	7556	88.49	11.51
Mockingbird (Dense Multi-Use)	11658	7556	64.81	35.19

Table 5.2 shows the actual and ITE predicted vehicle trip generation and compares the rates across the seven TODs. The observed vehicle trip generation at Mockingbird is 7,556 trips, which is 88.49 percent of the ITE estimated value in "General Urban/Suburban". This is the lowest vehicle trip reduction among the eight studied TOD sites (11.51 percent), which means that more than 88 percent of ITE vehicle trip prediction is fulfilled by Mockingbird TOD.

Table 5.3. Residential Parking Supplies as Percentage of ITE, and Residential Peak Parking Demand as Percentage of the Actual Supplies

TOD	*ITE supply (spaces per unit)*	*TOD supply (spaces per unit)*	*TOD peak demand (occupied spaces per unit)*	*TOD supply as % of ITE supply*	*TOD peak demand as % of TOD supply*
Redmond (Seattle)	2.0	1.19	0.86	59.5%	72.3%
Rhode Island Row (Washington DC)	1.4	0.81	0.44	57.9%	54.3%
Fruitvale (San Francisco)	1.4	NA	1.02	NA	NA
Englewood (Denver)	1.4	1.6	1.29	114.3%	80.6%
Wilshire/Vermont (Los Angeles)	2.0	1.10	0.81	55.0%	73.6%
Orenco Station (Portland)	1.6	1.08	0.63	68.0%	51.2%
Station Park (Salt Lake City)	1.4	1.13	0.97	80.7%	82.9%
Mockingbird	2	1.15	0.71	57.35%	61.57%

Table 5.4. Aggregated Parking Supplies as Percentage of ITE Supplies, and Aggregate Peak Parking Demand as Percentage of the Actual Supplies

TOD	*peak parking demand as % of the ITE guideline*	*peak parking demand as % of the actual supply*
Redmond (Seattle)	41.6%	73.5%
Rhode Island Row (Washington DC)	32.7%	63.6%
Fruitvale (San Francisco)	19.0%	84.0%
Englewood (Denver)	45.8%	58.3%
Wilshire/Vermont (Los Angeles)	33.0%	66.8%
Orenco Station (Portland)	41.8%	51.2%
Station Park (Salt Lake City)	35.5%	41.2%
Mockingbird	47.59%	55.43%

Table 5.3 compares parking supply and demand for residential use at Mockingbird to those of seven other TODs. The parking supply per dwelling units at Mockingbird TOD is higher than the previous TOD studies, except for Redmond and Englewood TODs, while the ITE estimated supply rate for residential parking is still higher than the TOD supply. Mockingbird residential peak demand parking (occupied spaces per unit) is higher than all other studied TODs, and still is lower than the predicted peak demand from ITE guideline.

Finally, Table 5.4 compares the overall parking supply and demand in Mockingbird TOD with other seven TODs. Mockingbird has the highest rate of aggregate peak parking demand as percent of ITE guideline compared to other seven TODs. It can be concluded that, Mockingbird TOD is the most over-parked of all TOD sites. However, and as expected from our previous results, the parking demand in Mockingbird TOD is still less than half of the ITE recommended supply rate.

6. Conclusions and Policy Implications

The comparison of our findings to the previous trip and parking generation studies at seven national TODs shows that, with the exception of Station Park in Salt Lake City (which is really a TAD rather than TOD), the Mockingbird TOD has the lowest walk mode share (13.6%), the lowest bike mode share (0.22%), the lowest bus transit mode share (1.09%) and by far the lowest rail transit mode share (5.9%) of all other TODs (see Table 6.1). Again, with the exception of Station Park TAD, the Mockingbird TOD also ranks first in terms of the driving mode share with about 80% of all its daily trips generated via driving. This is almost twice as many driving trips as the average of the other six TODs.

Table 6.1. Comparison of Trip and Parking Generation at Eight TODs in the U.S

TOD	*# of Trips*	% mode share					*% of ITE trip generation rate*	*Aggregate peak parking demand as % of ITE guideline*	*Aggregate peak parking demand as % of actual supply*
		Walk	*Bike*	*Bus*	*Rail*	*Auto*			
Redmond (Seattle)	1,981	18.9	1.7	13.0	NA	64.9	37.4%	41.6%	73.5%
Rhode Island Row (Washington DC)	8,451	16.6	0.3	9.3	27.2	42.5	34.7%	32.7%	63.6%
Fruitvale (San Francisco)	16,558	28.3	4.3	15.2	26.1	23.0	51.8%	19.0%	84.0%
Englewood (Denver)	14,073	19.2	3.8	3.3	13.6	59.7	69.8%	45.8%	58.3%
Wilshire/Vermont (Los Angeles)	11,043	27.4	2.2	21.1	20.1	25.9	43.0%	33.0%	66.8%
Orenco Station (Portland)	15,495	45.8	2.5	3.9	16.0	31.4	57.2%	41.8%	51.2%
Station Park (Salt Lake City)	42,172	3.6	1.2	1.4	4.1	89.0	74.5%	35.5%	41.2%
Mockingbird	11,663	13.63	0.22	1.09	5.89	79.16	88.49%	47.59%	55.43%

This is possibly as car-dependent as a well-designed TOD could be. Mockingbird has most characteristics of D variables widely known to reduce car-dependency and increase opportunities for walking, biking and transit ridership. It is dense, with diversity of land uses, and pedestrian-friendly and it is next to the LRT station which also serves as a major bus transfer center. Yet, driving accounts for about 80% of its trips mostly because it is located in an auto-oriented region where more than 96% of the commuting trips are done by driving (ACS, 2017).

Still, the total vehicle trip generation rate in Mockingbird, even though higher than other TODs, is about 12% lower than the ITE estimates for general urban-suburban and 35% lower than the ITE estimates for dense multi-use urban. Similar conclusions could be made in terms of the parking generation. While the parking supply in Mockingbird TOD is less than 47% of the recommended ITE supply rate, still its peak parking occupancy is only about 55% of the TOD supply. It is worth noting that Mockingbird is the third most over-parked of all seven sites.

This study has a number of limitations. The first limitation of this study is its sample size. Since data collection is labor intensive, our sample in Dallas area was limited to only one TOD site. There are also very limited number of TODs in the DFW region that could meet our criteria for the case study selection. We planned to consider other transit stations such as Plano Station in the region. However, we found that this station is not fully developed and the vacancy rates for different land uses are considerably high; consequently, it was not possible to explore and compare trip and parking generation rates to the ITE guideline. Another considerable limitation is external validity, which means to what extent the results of a study can be generalized to other TOD sites. In particular, Mockingbird TOD is exemplary in terms of the criteria we established at the outset. Hence, unless a planned or proposed TOD shares essential attributes with our sample, generalization should be done with cautious. The only way to increase the external validity (generalizability) of this effort is to expand the sample of studied TODs, and including larger TODs

with higher internal capture rates. Trip and parking reductions relative to ITE could be modeled in terms of D variables for the TODs themselves, their context, and their type of transit service (HRT, LRT, CRT, streetcar, and bus only). However, given the high cost of the associated data collection efforts, we doubt our collective efforts will ever produce a statistical sample. Hence, the best we can hope, is a mix of TODs that represent most of the common variations on the TOD theme. We believe it is crucial to include more LRT systems in the sample, since these systems are generating most of the TOD activities. In the same vein, we call for additional research on trip and parking generation at TODs.

We also faced difficulty getting permission from the sites' managements. According to a similar study, the majority of TOD sites in Dallas area decline to participate in such research projects and they mostly do not respond to the research team requests (North Central Texas Council of Government, 2019). Additionally, another limitation was inability to account for the internal capture of trips within the TOD site. Internal trips are trips that begin and end within the same development. Such trips obviously have much less impact on the environment and are generally subtracted from the total trip-generation rates in traffic-impact studies. Our selected TOD is relatively small and is likely to have lower internal capture rates. There are other limitations, such as the fact that our vehicle counts are typically from 7:00 am until 9:00 pm, rather than the full 24 hours as the ITE does. Another is that the seventh D variable, demographics, may vary between different TODs. Most of the developments offer some affordable (as opposed to market rate) housing, but according to our observations the Loft apartment building at Mockingbird was designed as a luxury housing option for high income people. However, we still contend that this study has important practical planning implications.

The findings from this study along with the seven previous similar studies confirm that, on average, parking is more than 50 percent over-supplied in TOD sites across the nation, regardless of the context and other socioeconomic differences. These empty spaces could be used in a much more efficient way with a substantially higher return in investments. The real estate literature widely cites proximity to transit station as a determinant of increased property values, with the lowest premium reported for single-family developments (2.3-4.2%) and the highest premium reported for commercial use, multi-family and office development with an average of 16.4 percent premiums. Our study calls for revising the current parking supply estimates to provide a more realistic picture of supply and demand in the TOD sites accounting for the proximity to a transit station, the mixed use nature of the development (where you can park once and visit several destinations), and the associated potential reductions in auto-trips and parking needs (Hamidi et al., 2016; Debrezion et al., 2007).

Our statistics and the statistics from previous similar studies could contribute to achieving this goal. Our statistics are among the very few trip and parking generation data available for TODs in auto-oriented regions that are based on the actual data as compared to the modeled regional travel model forecasts. Hence, our statistics could be used as default values, in tandem with the regional

travel model forecasts, for new planned TODs in the same or similar auto-oriented regions when better estimates are not available. TODs are widely known for their potential health, transportation and economic benefits. These benefits could be even more with the more realistic planning for their trip and particularly parking generation and the more efficient use of their "empty spaces."

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