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Evaluating the Impact of Walkability and Third Places on Multifamily Property Rental Premiums and Sale Values in Texas Metropolitan Areas: A Hedonic Pricing Model Analysis

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Being a dissertation submitted to the faculty of The Built Environment as part of the requirements for the award of ***MSc International Real Estate and Planning*** at University College London:

I declare that this dissertation is entirely my own work and that ideas, data, and images, as well as direct quotations, drawn from elsewhere are identified and referenced.

Abstract

This dissertation investigates the relationship between walkability, the presence of Third Places, and on-property social amenities with the sale and rental values of multifamily properties in the car-dependent Texas Triangle region. Addressing public health concerns related to sedentary lifestyles and loneliness, this study applies a hedonic pricing model to analyze data from the metropolitan areas of Dallas-Fort Worth-Arlington, Houston-The Woodlands-Sugarland, Austin-Round Rock, and San Antonio-New Braunfels. The findings indicate that higher Walk Scores are associated with increased sales and rental values, underscoring the importance of walkability. The proximity to Third Places has a varied impact; At the same time, access to fitness centers and restaurants increases property values, while proximity to amenities like hairdressers and schools correlates with lower sales prices. On-property social amenities, such as fitness rooms and clubhouses, enhance property values, whereas features like playgrounds may detract from property appeal. These results suggest that the integration of specific Third Places and social amenities tailored to the target demographic can enhance the economic viability of multifamily developments. This study highlights the need for future research on the qualitative aspects of walkability and Third Places to better understand their impact on multi-family property sale and rental values.

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CHAPTER 1 - Introduction

Sedentary lifestyles and physical inactivity, characterized as sitting for extended periods, are causing a global public health issue and resulting in elevated all-cause mortality (Katzmarzyk and Lee, 2012; Park *et al.*, 2020). The World Health Organization estimates that the cost of treating preventable noncommunicable diseases stemming from physical inactivity will be over $300 billion from 2020 to 2030 (2022). Furthermore, sedentariness compounds as people age and gain weight, leading to more medical issues and reduced quality of life (Faghri, 2015). Loneliness, characterized as feeling a lack of connection, and social isolation, characterized by infrequent social contact and a lack of relationships, have also become a global health issue (Lim *et al.*, 2023).

A lack of walkability and the presence of Third Places in multi-family property locations leads to the public health issues of sedentary lifestyles and loneliness. This study defines walkability, as the degree to which a location promotes walking to other places and uses WalkScore as a proxy (Pivo and Fisher, 2011) Third Places are "informal public gathering spaces" between work and home that are predicated on walkability (Oldenburg, 2023). The built environment through its impact on behavior has contributed to people's sedentariness (Frank and Engelke, 2005). Similarly, the built environment, through the provision or lack of provision of social infrastructure, affects subjective well-being, quality of life, social cohesion, and social capital (Finlay *et al.*, 2019; Mouratidis and Poortinga, 2020; Zahnow, 2024).

While not a magic bullet solution, changes in the built environment, through the promotion of walkability, Third places, and social amenities, could mitigate the negative health effects of sedentariness and loneliness. Promoting walkability can reduce sedentariness (Kärmeniemi *et al.*, 2018). Likewise, the presence of Third Places can act as a remedy for loneliness but also requires one to be inclined to engage in social activities (Oldenburg, 2023).

Walkability, Third Places, and on-property social amenities have a symbiotic relationship and collectively contribute to healthier, more social communities, it therefore makes sense to estimate their added value together. In walkable areas, Third Places become natural extensions of living spaces where people can gather

spontaneously, engage in casual conversations, and form social bonds. Areas with a greater density of Third Place promote walkability by providing more destinations people want to walk to. Similarly, on-property social amenities such as gyms, swimming pools, and communal spaces could provide tenants with immediate access to social and recreational activities, further enhancing the attractiveness and livability of properties. Together walkability and Third Places add aesthetic and convenience value to neighborhoods and cities. It follows that there is then an added economic value.

The public issues of sedentariness and loneliness can only be ameliorated if there is willingness to pay from apartment tenants or investors for properties with greater walkability, increased proximity to Third Places, and social amenities. The economic viability of incorporating these elements into multi-family property developments, especially in car-dependent areas, is thus a critical area of study, as it can provide the necessary incentive for developers and investors, who need evidence of added value or economic profitability, to prioritize these features in future projects (Pineo and Moore, 2022).

1.1 Research Objective

This study aims to analyze the sale and rental value premia of walkability, access to Third Places within walking distance, and apartment complex social amenities in multi-family properties in car-dependent areas. From the critical problem of lack of walkability and loneliness as public health issues that can be alleviated with built environment interventions comes the main research objective:

Is there a financial incentive for developers and investors to prioritize walkability and proximity to Third Places in multifamily developments in car-dependent areas?

From this main objective comes a series of follow-up sub-objectives:

1. To what extent does the Walk Score® increase sale and rental premia in areas with lower Walk Scores?
2. To what extent does the presence of a Third Place within a short walking distance of an apartment affect its sale and rental values?
3. To what extent do on-property social amenities affect sale and rental values?

1.2 Hypothesis

This paper hypothesizes that the higher walkability, through the proxy of Walk Scores, the presence of a Third Place within walking distance, and on-property social amenities do increase sale and rental premia.

1.3 Dissertation Structure

The remainder of this dissertation is structured as follows:

Chapter 2 - Context: Overview of the Texas Triangle's major metropolitan statistical areas (MSA).

Chapter 3 - Literature Review: Review of walkability, Third Places, and social amenities.

Chapter 4 - Data and Methodology: Data sources, robustness checks, and the hedonic equation.

Chapter 5 - Findings and Analysis: Descriptive statistics of variables and findings from the regression models.

Chapter 6 - Conclusion: A summary of key findings, a discussion of the study's limitations, and recommendations for stakeholders.

Chapter 2 - Overview of Texas Triangle Major Metro Areas

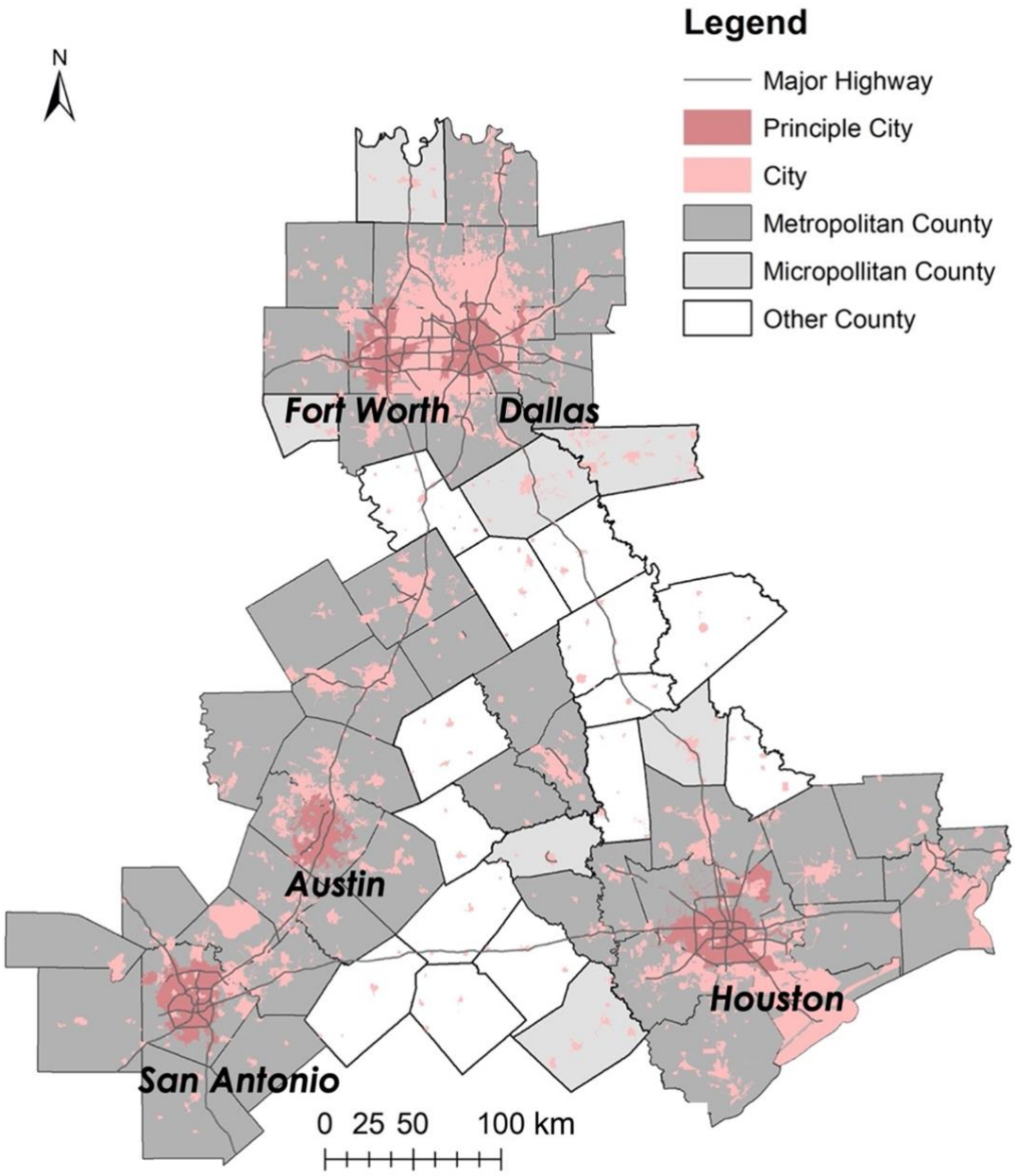

Figure 1. Map of Texas Triangle (Guo and Zhang, 2021).

The focus of this study is the geographical area of the Texas Triangle Megaregion, see Figure 1, which includes the MSAs of Austin–Round Rock–San Marcos, Dallas–Fort Worth–Arlington, Houston–The Woodlands-Sugar Land, and San Antonio–New Braunfels. This region has been chosen because it encompasses almost 20,800,000 people and accounts for 10.71% of the USA national multi-family unit inventory of 20,009,725, see Table 1 below (*About CoStar*, 2024). This already highly

populous region is growing faster than the other eleven U.S. megaregions and is projected to reach a population of 27,600,000 million by the year 2030. (Clark, 2021b; Triolet, 2023). From 2010 to 2023, 3,900,000 people moved to the region (Triolet, 2023). From 2010 to 2020, of the top fastest-growing 20 U.S. counties with populations over 50,000, 9 were suburban counties in the Texas triangle (Clark, 2021a).

MSA	Estimated 2023 Population	5 Year Population Growth	Walk Score	Total Inventory of Multi-Family Units
Austin	2,473,275	17.3%	41.7	308,422
Dallas	8,100,037	11.4%	40.5	891,657
Houston	7,510,253	8.1%	47.5	718,757
San Antonio	2,703,999	10.5	36.9	223,398

Note: Walk Scores are city-wide. Dallas and Fort Worth Walk Scores were averaged.

Table 1. Texas MSA Walk Score, Population, and Multi-Family Inventory. Adapted from (U.S. Census Bureau, 2023; CoStar Group, 2024a; Walk Score, 2024a).

These MSAs have Walk Scores® greater than 25, but below 49, which designates the areas as "car-dependent" (Walk Score, 2024). Housing supply in Texas is supply elastic due to the "vast supply of land and relatively few building regulations" (Assanie, 2014; Nijskens *et al.*, 2019). The planning regulation that does exist promotes low-density, car-centric development (Gray and Furth, 2019). This paired with growth-oriented policies, leads to rapid horizontal expansion (Clark, 2021a). A study of multifamily property growth from the 1970s to the 2010s in the Texas Triangle found that multifamily development clustered in suburban, middle-income areas rather than distressed downturn or inner cities area (Walter and Caine, 2019). Though this trend of horizontal expansion is decreasing and now development compactness is increasing and clustering in urban areas (Guo and Zhang, 2021). After decades of rapid sprawl, it then follows that the apartments in Texas in the Triangle are more car-dependent and therefore lower Walk Scores. The change in this trend offers the opportunity for and is perhaps indicative of the greater promotion of walkability and Third Places in the Texas Triangle.

Chapter 3 – Literature Review

This chapter will first review the hedonic model and discuss why it is the appropriate framework for this study's objective and limitations, then the literature review will focus on the theoretical framework and hedonic results of Walk Scores, Third Places, and social amenities.

1.4 Hedonic Model

Posited by Lancaster, (1966) and Rosen, (1974), the hedonic model estimates the price of a product based on its various characteristics, even though the prices of these individual characteristics are not directly observable. The hedonic model is widely used in property research as it allows for the estimate of individual property characters, like those in Figure 2, effects on prices while holding other factors constant (Chau and Chin, 2003; Herath and Maier, 2010).

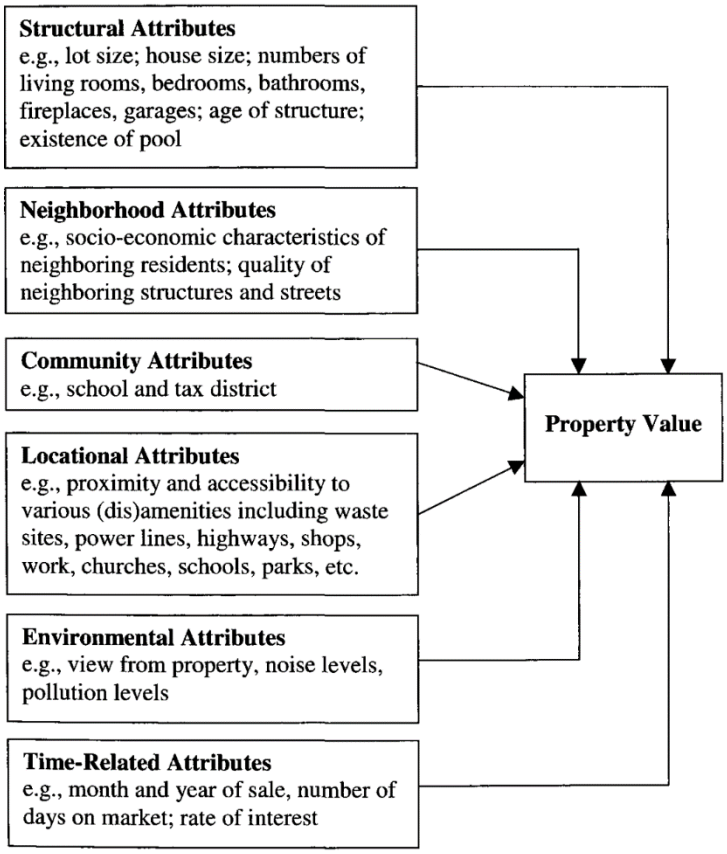

Figure 2. Hedonic Model for Property (Nicholls and Crompton, 2005).

The hedonic model is not without its drawbacks. Hedonic models have the assumptions that housing and also buyer preference are homogenous and that the area analyzed is a single, and efficient, market where buyers would move anywhere within, though these assumptions in practice are often unrealistic (Chau and Chin, 2003; Nicholls and Crompton, 2005; Owusu-Ansah, 2013). In the context of housing, hedonic models may face issues with omitted variables, which can result in endogeneity. Therefore, it is important to incorporate control variables for properties' physical and locational characteristics (De Haan and Diewert, 2013; Hill, 2013). Furthermore, the hedonic model may not adequately account for the quality of a property or its specific attributes (Bover and Velilla, 2002). Hedonic models must also be wary of choosing the correct variable transformations (Blomquist and Worley, 1981). The log-log transformation is beneficial because it provides estimates of elasticities and allows for greater normality of variables (Herath and Maier, 2010).

1.5 Walk Scores

Walkability has a variety of definitions and measures; therefore, it is important to the methodology of this study to establish a definition of walkability and understand the limitations and advantages of the measure of walkability chosen (Forsyth, 2015; Lefebvre-Ropars and Morency, 2018). This study will utilize Pivo and Fisher's (2011) definition of walkability as the degree to which a location promotes walking to other locations and will use Walk Score as the measure of walkability as a review of studies found that "proximity to potential destinations" is the most common definition (Saelens and Handy, 2008).

Walk Score is a valid and reliable tool to measure distances to walkable amenities (Carr, Dunsiger and Marcus, 2011; Duncan *et al.*, 2011, 2013).Though findings show Walk Score® is not an objective measure of walkability; however, there is a correlation between Walk Score and perceived walkability (Hall and Ram, 2018; Kim, Won and Kim, 2019; Arellana *et al.*, 2020; Koohsari *et al.*, 2021). Bereitschaft (2018) seconds this correlation and finds that Walk Score® overestimates suburban walkability. Subjectivity is important, as residents in walkable areas who prefer not to walk wouldn't attribute any value to additional walkability (Frank *et al.*, 2007).

Walk Score is judged based on the distance to 13 different location types: “grocery stores, coffee shops, restaurants, bars, movie theatres, schools, parks, libraries, book stores, fitness centres, drug stores, hardware stores, clothing/music stores” (Carr, Dunsiger and Marcus, 2011). Walk Score values range from 0 to 100 with 5 different groupings designating walkability or car-dependency as seen in Table 2 below:

Walk Score	Walk Score Grouping	Description
90 to 100	Walker’s Paradise	Daily errands do not require a car
70 to 89	Very Walkable	Most errands can be accomplished on foot
50 to 69	Somewhat Walkable	Some errands can be accomplished on foot
25 to 49	Car-Dependent	Most errands require a car
0 to 24	Car-Dependent	Almost all errands require a car

Table 2. Walk Score Designations and Descriptions (Source: Walk Score Methodology, 2024).

Hedonic studies regressing Walk Scores or Walkability have tended to focus on single-family housing and have had mixed results resulting in significant, negligible, positive, or negative coefficients, see Table 3. (Saderion, Smith and Smith, 1994). Overall, these findings highlight the nuanced role of walkability in real estate markets, suggesting that while it is generally valued, its impact can be context-specific, influenced by factors like regional market dynamics, property type, demographics, and socio-economic conditions (Pivo and Fisher, 2009, 2011; Manaugh and El-Geneidy, 2011). The value and extent walkability varies from context to context with some studies finding poorer areas are more walkable, but then other studies finding that this walkability is valued less (King and Clarke, 2015; Gunn *et al.*, 2022).

Table 3. Review of Studies Regressing Walkability or Walk Scores (Author's Own).

Author, Year	Property Type	Case Study	Exploratory Variable	Result
Pivo and Fisher, 2009	All Types	USA	lnSale per sq. ft.	Walk Scores had a significant positive coefficient of 0.48% in Apartments, 0.82% in retail, 0.67% in Office, 0.63% in industrial, and 0.63% in all types.
Pivo and Fisher, 2011	All Types	USA	lnSale per sq. ft.	Walk Scores had a significant positive coefficient of 0.12% in Apartments, 0.89% in retail, 0.91% in Office, 0.87% in industrial, and 0.11% in all types.
Kim and Kim, 2020	Multi-Family	Seoul, Korea	lnSale per sq. m.	Walk Score had a significant negative coefficient of 0.6% for properties in areas with high prices and a significant positive coefficient of 0.2% for properties in areas with low prices.
Gabe et al., 2023	Multi-Family	50 CBSAs, USA	lnRent	Walk Scores had a significant positive coefficient of 0.2%.
Gabe, Robinson and Sanderford, 2022	Multi-Family	35 CBSAs, USA	lnRent	Walk Scores had a significant positive coefficient of 0.7%.
Gabe, Robinson and Sanderford, 2018	Multi-Family	50 CBSAs, USA	lnRent	Walkability had negligible and insignificant effect in full model, but a significant positive coefficient of 0.19% in the base model.
Leinberger and Alfonzo, 2012	Multi-Family Single-Family	Washington, D.C. Metro., USA	Rent Sale per sq.ft.	1 IMI increase resulted in a monthly rent increase of $301.76 and home sale value per sq. ft. increase of $81.54
Rauterkus and Miller, 2011	Single-Family	Jefferson County, USA	lnLand Sale per sq. ft.	Walk Scores had a significant positive coefficient of 3.9%
Washington, 2013	Single-Family	MSAs with pop. > 100,000, USA	lnMedian Sale	Walk Scores had a significant positive coefficient of 0.5%.
Li et al., 2015	Single-Family	Austin, USA	lnSale	Walkability had negligible and insignificant effect in car-dependent neighborhoods.
Gunn et al., 2022	Single-Family	Melbourne, Australia	Sale	Walkability increases of 1 point increase sale price by overall by A$39,060, A$11,410 in the most disadvantaged areas, and A$37,910 in the most advantaged areas.
Gilderbloom, Riggs and Meares, 2015	Single-Family	Louisville, USA	lnSale	Walk Score had a significant positive effect on median assessed value of 8.4%, 13% and 9.5% in years 2000, 2006, and 2009, respectively.
Cortright, 2009	Single-Family	15 Cities in USA	Sale	Walk Score had a significant positive coefficient for 13 cites, a negative coefficient for 1, and an insignificant coefficient for 1.
Chernobai and Ma, 2022	Single-Family	Orange County, USA	Sale	Walk Score had negligible and insignificant effect.
Boyle, Barrilleaux and Scheller, 2014	Single-Family	Miami, USA	Sale	Walk Score is insignificant after adjusting for fixed effects.
Greene, 2009	Single-Family	Gresham, USA	Sale	Walk Score increase of 1 point had a significant $2,651 reduction.

1.6 Third Places

Posited by Ray Oldenburg, Third Spaces are local places between home and work where people gather regularly (2023). Walkability or accessibility is important for Third Places (Yuen and Johnson, 2017; Oldenburg, 2023). Studies find that 0.18-miles is the typical trip for social events (Yang and Diez-Roux, 2012). Studies have been done regarding Third Places' social dimensions their positive impact on street life, their role in promoting socialness and health, preventing isolation, higher quality of life, and higher neighborhood satisfaction (Rosenbaum, 2006; Hur and Morrow-Jones, 2008; Jeffres *et al.*, 2009; Mehta and Bosson, 2010; Campbell, 2017; Yuen and Johnson, 2017; Finlay *et al.*, 2019; Rhubart *et al.*, 2022; Rudman and Aldrich, 2022). Third Places are adjacent to theoretical frameworks like social capital, social infrastructure, and a sense of community or sense of place, which are mutually interconnected (Littman, 2022). Social dimensions of Third Places include enjoyment, regularity, pure sociability, and diversity of users (Yuen and Johnson, 2017). These dimensions highlight the importance of the quality of Third Places (Kleeman *et al.*, 2022). Developers also see types of social facilities or Third Places as key aspects of a new community (Buckman *et al.*, 2017).

The benefits of Third Places may not be applicable across all contexts. Findings show Third Places promote socialness in only certain areas or neighborhoods, specifically very poor neighborhoods, counter to Oldenburg's (2023) claim that Third Places are ubiquitous (Williams and Hipp, 2019). Different demographics and communities need different Third Places and these needs change over time (Crick, 2011; Markiewicz, 2020)..

Some studies find concentration and diversity of urban amenities can drive rental values (Shimizu *et al.*, 2014). However, the literature specifically on the relation of Third Places and property values and rental premiums presents a gap in academic research; however, there are studies that regressed Third Place types. Examples of Third Places are community centers, coffee shops, restaurants, parks, churches, libraries, shopping centers, schools, bars, recreation centers, and beauty shops, for a full list see Table 4. (Jeffres *et al.*, 2009). An overview of Third Place types and relevant hedonic studies is presented in Table 4.

Table 4. Review of Studies Regressing Third Place Types (Author's Own).

Author Year	Property Type	Case Study	Exploratory Variable	Result
Kim et al., 2023	Single-Family	Tokyo Metro. Area, Japan	lnSale	Amenities with positive coefficients are cafés, restaurants (in Models 1 and 2), hobby classes, parks, gyms and fitness clubs, convenience stores, schools, childcare facilities, retail shops, welfare facilities for older adults, hospitals, pharmacies (in Models 1 and 3), bus stops (in Models 1 and 3), and stations (in Model 1), while amenities with negative coefficients, include bars, cultural institutions, and pharmacies (in Model 2).
Miwa, Shibayama and Tajima, 2024	Multi-Family Single-Family	Vienna, Austria	lnSale	Surface area of parks nearby parks were insignificant.
Song and Knaap, 2003	Single-Family	Washington County, USA	lnSale	Golf course had a statistically significant, but negligible effect on sale price.
Yang et al., 2018	Multi-Family	Xiamen, China	lnSale	Number of elementary schools, shopping centers, and sports or cultural centers within 0.5 mile walk-in catchment area had significant positive coefficients of 0.9%, 0.8%, and 1.8%, respectively.
Aziz et al., 2023	Multi-Family	Gujrat, Pakistan	Sale	Distance to market, access to facilities, and nature of surrounding community were insignificant.
Crompton, 2005	Single-Family	Austin, USA	Sale	Being within a natural area park, urban park, or specialty park/facility increase sale values by 16.1%, 1.8%, and 8.5%.
Des Rosiers and Thériault, 1996	Multi-Family	Quebec, Canada	lnRent	Distance to a shopping center lowered monthly rents by -CA$9.15 to -CA$10.37.
Shimizu et al., 2014	Single-Family	Tokyo Metro. Area, Japan	lnRent	Number of amenity types within 500 meter mesh block had a significant positive coefficient of 0.1%, with total amount of amenities have a positive effect of 0.3% to 0.4%. Restaurants and parks had significant positive relationship with prices. Cemeteries, video arcades, and restaurant has negative externalities.
Wittowsky et al., 2020	Multi-Family	Dortmund, Germany	lnRent per sq. m.	Adapted Walk Score to Restaurants had a positive significant coefficient of 11.2% in the OLS model and 6.8% in the spatial lag model.
Li et al 2016	Single-Family	Salt Lake City, USA	lnSale	log transformed distance to library had a significant coefficient of -2.5%. Log transformed distance to worship and park had insignificant results.
Nicholls and Crompton, 2005	Single-Family	Austin, USA	Sale	Distance to park/recreation area and distance to school entrance were insignificant in all study areas, and greenbelt entrance with 0.5 mile had a negative coefficient of -3.97 in one study area.

1.7 On-Property Social Amenities

Social Amenities explored in this study stem from Jeffres *et al.* (2009) three neighborhood Third Place types of neighborhood outdoors, a neighborhood inside, and neighborhood parties and Markiewicz's (2020) theoretical framework of Third Places in the Home. Respondents cited neighborhood outdoors and indoors as Third Places more than shopping centers, bars, recreation centers, and clubs, which indicates the relevance of on-property social amenities (Jeffres *et al.*, 2009).

Commonly regressed single-family social or neighborhood amenities include a clubhouse, pool, tennis court, golf course, and playground, with all but the golf course having significant, positive effects on sale value (Benefield, 2009). Swimming pools were the most common significant amenity in the studies (Guntermann and Norrbin, 1987; Sirmans, Sirmans and Benjamin, 1989; Jud and Winkler, 1991; Benefield, 2009). The presence of a pool and miscellaneous amenities like saunas and hot tubs have been shown to also have significant, positive effects, while other studies found saunas insignificant (Guntermann and Norrbin, 1987; Sirmans, Sirmans and Benjamin, 1989). This shows that the preference for social amenity types is not universal, though an overview of hedonic studies on luxury amenities like patio, pool, sauna, fitness room, and tennis courts cited 11 papers that also found that these amenities had a positive effect. Fitness rooms have a significant positive coefficient, while barbeques were not significant (Guntermann and Norrbin, 1987). Meeting rooms, courtyards, and indoor or outdoor event spaces were found to have positive effects, with the courtyard having the highest magnitude of the effect (Tajima, 2019).

Chapter 4 – Data Collection and Methodology

1.7.1 Property Data and Walk Score

The property data for this study was obtained from CoStar, a comprehensive commercial real estate database widely used in the industry for property research and market analysis (*About CoStar*, 2024). The focus was on multifamily properties, defined as residential buildings comprising five or more units. The selection criteria for the dataset were properties listed within the CoStar database within the MSAs and transacted during the years 2018 and 2023.

Property information excluding current asking rent and Walk Score were exported from CoStar. Currently, as of June 2024, asking rents and Walk Scores were manually inputted. Properties with incomplete information for sale values were excluded. Affordable or rent-controlled units and senior housing properties were also excluded. Lastly, properties with sales conditions such as portfolio or bulk sale, distress sale, ground lease, deferred maintenance, and debt assumptions were excluded. Properties transacted with Section 1031, a deferred gains tax-like-kind exchange, and sale condition were included.

1.7.2 Third Place Proximities Data

Distance to Third Places is based on Yang and Diez-Roux's (2012) research on walking distance by purpose and subgroup in U.S. Residents. The results of 43,724 U.S. residents and 98,192 walking trips found that the average walking distance for social events was 0.18-miles, or 289 meters, per trip or 4.3 minutes duration, slightly less than the perceived average of 0.25 miles, or 400 meters, or 5 minutes duration (*Ibid.*). A Python script was written which takes the address and coordinates for each property searches for nearby Third Places within a 0.25-mile radius, then filters out then finds the Third Places that are within a 0.18-mile walking distance from the coordinates. Then exports an Excel file with the addresses, coordinates, number of Third Places within a 0.25-mile radius, and number of Third Places within a 0.18-mile walking distance. The address, latitude, and longitude of each property were imported from the Excel file exported from CoStar. See Appendix 1 for full Python code. Third Place types were based on research done by Jeffres *et al.* (2009) and mapped to the tags of features, or

nodes, in OpenStreetMap, as seen in Table 5. Node data from OpenStreetMap, an open-source map, was queried using Overpass API, an API that handles queries, reads OpenStreetMap data, and then returns corresponding data (OpenStreetMap, 2024a; OpenStreetMap contributors, 2024). There are over 9 billion nodes in OpenStreetMap, which ensures breadth and robustness of capturing Third Places within the proximity of the study properties (OpenStreetMap, 2024b).

Third Place Type	Overpass API Tag(s)
Community centers, town meetings	community_centre
Coffee shops	cafe
Restaurants and cafes	restaurant, cafe
Churches	place_of_worship
Parks and outdoor recreation	park
~~**Neighborhood outdoors, streets, neighbors' yards**~~	
~~**Neighborhood inside, homes, apartments, party room**~~	
Clubs and organizations	social_centre, club
Libraries	library
Shopping centers, stores, malls, and markets	marketplace, mall, supermarket
Schools, colleges, universities	school, college, university
Bars and pubs	bar, pub
Recreation centers (YM/YWCA, pool, movies, bingo)	recreation_ground, leisure=fitness_centre, leisure=sports_centre
~~**Neighborhood parties, block parties, cookouts, barbecues**~~	
Senior centers	social_facility
~~**Media, online, newspapers, phone, bulletin boards**~~	
Hair salons, barbers, and beauty shops	hairdresser, beauty

Note: Strikethrough Third Place types will be discussed in the next section.

Table 5. Third Place Types Correlated with Overpass API Tag(s) (Jeffres *et al.*, 2009).

This method resulted in irresolvable outliers; therefore, the Third Place data was transformed into a discrete variable. An issue with the Overpass API tag method was double counting. A single node can have two tags, and if it does the method used in this paper would count the node as two Third Places. For example, if a Third Place was tagged as sports_centre and a fitness_centre because it included facilities for both, the Third Place was counted twice. Another example is if a park had a cemetery or dog park inside of it, two parks would be counted.

Three types of Third Place are proposed by Jeffres *et al.*, (2009) were not correlated with Overpass API tags. Neighborhood outdoors, streets, neighbors' yards; neighborhood inside, homes, apartments, party room; and neighborhood parties, block parties, cookouts, and barbecues will be covered in the next section as social amenities. Media, online, newsletters, newspapers, phone, and bulletin boards were omitted as Third Places due to their poor relation to real estate and the built environment. Third Place types that were not present in the proximity of any of the observations were excluded from the Models.

1.7.3 On-Property Social Amenities

The three neighborhood Third Place types seen as strikethroughs in Table 5, were included in this study as within-building social amenities. Amenity descriptions for each property were exported along with the other property data from CoStar. Socially relevant amenities based on the Third Place Types were extracted from the description text using IF functions in Excel. 25 on-property social amenities and were correlated to Third Place types based on the Jeffres *et al.*, (2009), see Table 6 below.

Third Place Type	On-Property Social Amenities
Neighborhood outdoors, streets, neighbors' yards	Cabana, Courtyard, Pet Play Area, Picnic Area, Playground, Sundeck, Basketball Court, Fitness Center, Pool, Putting Greens, Tennis Court, Spa, Volleyball Court, Walking/Biking Trails
Neighborhood inside, homes, apartments, party room	Business Center, Breakfast/Coffee, Clubhouse, Conference Room, Lounge, Multi use Room, Media Centre/Movie Theatre, Recreation Room
Neighborhood parties, block parties, cookouts, barbecues	Grill, Planned Social Activities

Table 6. Third Place Types Correlated with On-Property Social Amenities (Jeffres *et al.*, 2009; CoStar Group, 2024b).

1.8 Research Ethics

This research follows ethical guidelines by using publicly available data from sources such as CoStar and OpenStreetMap, ensuring no personal or sensitive information is involved. Since no human participants are directly involved, informed consent is not required. All data are anonymized, and proper citations are used to acknowledge data sources. This research complies with institutional ethical standards, including completing a Risk Assessment and Ethical Clearance Questionnaire to address potential risks.

1.9 Model Evaluation

This study used Statistical software for social sciences (SPSS) for data evaluation, descriptive statistics, regression, and robustness checks. To ensure the robustness, accuracy, and integrity of the dataset and to ensure the assumptions of the linear regression were upheld in the models the data and models were evaluated for multiple criteria as described in this section.

Box plots were generated for the variables to visually inspect for outliers. Identified outliers were carefully examined to determine whether they represented genuine variations, data entry errors, or potential data anomalies. The Mahalanobis test was used to assess and manage multivariate outliers, ensuring that they were not disproportionately influencing the results (Mahalanobis, 1936).

To ensure compliance with the assumptions of linear regression continuous variables were examined using histograms to ensure a normal distribution and Q-Q plots to ensure data was plotted along the 45-degree line (Hair *et al.*, 2010). Normal probability, P-P, the plot of the regression standardized residuals was generated to ensure residuals were plotted along the 45-degree line (*Ibid.*).

To check for collinearity, a correlation matrix was created and checked for correlations higher than 0.9 (Hair *et al.*, 2010). No variables in the final models exhibit correlations higher than this value. To evaluate the presence and extent of multicollinearity, a combination of diagnostic techniques was employed. The Variance Inflation Factor (VIF) and tolerance values for each independent variable were checked. The models were checked to ensure that the variables' VIF values were less than 5 and Tolerance values were greater than 0.1 (*Ibid.*), see Appendix 2. To ensure no

autocorrelation, the Durbin-Watson statistics for the models range between 1 and 3, see Durbin-Watson statistics in Appendix 2 (Brooks and Tsolacos, 2010).

To avoid heteroskedasticity, partial regression plots for each independent variable were analyzed to ensure an elliptical distribution (Hair *et al.*, 2010). Additionally, White's Test and Breusch-Pagan Tests were conducted. Models 1 and 2 exhibited heteroskedasticity, see Table 7.

	White Test			Breusch-Pagan Test		
Model	**Chi-Square**	**df**	**Sig.**	**Chi-Square**	**df**	**Sig.**
Model 1	223.120	140	0.000	0.537	1	0.464
Model 2	285.124	140	0.000	0.015	1	0.903
Model 3	593.992	565	0.193	0.001	1	0.974
Model 4	573.045	557	0.310	0.208	1	0.649

Table 7. Tests for Heteroskedasticity (Source: Author's Own).

Models 1 and 2 do not pass the White null test and therefore do not meet the regression assumption of homoskedasticity. To ensure no distortion of estimators and to correct bias, robust standard errors, with the Third Variance Estimate, HC3, were used for these models (Jochmans, 2020).

1.10 Hedonic Regression

This section sets out the hedonic equation and the dependent and independent variables used in the hedonic model.

1.10.1 Hedonic Equation

Following Rosen (1974) the hedonic equation used in the multivariate linear regression models in this study are:

$$\ln(Sale_i) = \beta_0 - \beta_1 \ln(BuildingSF_i) + \beta_2 \ln(Floors_i) - \beta_3 \ln(Age_i) + \beta_{\_4}\ Location\ Type_i + \beta_5\ MSA_i + \beta_6\ Building\ Class_i + \beta_7\ Year_i + \beta_{\_8} \ln(Walk\ Score_i) + \beta_9\ Third\ Places_i + \beta_9\ Social\ Amenities_i + \varepsilon_i$$

$$\ln(Rent_i) = \beta_0 - \beta_1 \ln(BuildingSF_i) + \beta_2 \ln(Floors_i) - \beta_3 \ln(Age_i) + \beta_{\_4} \text{ Location Type}_i + \beta_5 MSA_i + \beta_6 \text{ Building Class}_i + \beta_7 \text{ Year}_i + \beta_{\_8} \ln(\text{Walk Score}_i) + \beta_9 \text{ Third Places}_i + \beta_9 \text{ Social Amenities}_i + \varepsilon_i$$

Where the natural of sale per sq. ft. or rent per sq. ft. are regressed on property's physical characteristics, location controls, MSA controls, building class or quality controls, the natural log of Walk Score, Third Places within a 0.18-mile walking distance, and on-property Social Amenities. The coefficient measures the impact of each independent variable, while the error term captures the variation in sale prices not explained by the model.

1.10.2 Variables

Variables were chosen to ensure a 10:1 ratio of observations to variables, so a minimum of 10 observations per variable (Hair *et al.*, 2010). At least one type of on-property social amenity was present in all observations, therefore a Social Amenity dummy variable was not used in the hedonic models. Variables BuildingSF and Age are expected to have negative signs, as seen in Table 8 below. Location controls and sale year controls are expected to have a positive relative to the reference variables. Austin is expected to have a positive sign relative to Dallas MSA, while Houston and San Antonio signs are negative. WalkScore, ThirdPlaces, Third Place types, and social amenities are all expected to have positive signs.

Variable	Description	Sign
Dependent		
Sale	Natural log of sale price per S.F.	
Rent	Natural log of asking rent per S.F. as of July 2024	
(Constant)	Coefficient to be estimated	
Control		
BuildingSF	Natural log of total Rentable Building Area (RBA) in S.F.	-
Floors	Natural log of the number of floors in the building.	+
Age	Natural log of the age of the building based on the current year, 2024.	-
Suburban	Reference variable for suburban location type.	
Urban	Dummy variable equal to 1 if location type is urban.	+
CBD	Dummy variable equal to 1 if location type is Central Business District (CBD).	+

Dallas	Reference for MSA Dallas.	
Houston	Dummy variable equal to 1 if the MSA is Houston	-
Austin	Dummy variable equal to 1 if the MSA is Austin	+
San Antonio	Dummy variable equal to 1 if the MSA is San Antonio	-
A	Dummy variable equal to 1 if the building class is A	+
B	Reference for building class B	
C	Dummy variable equal to 1 if the building class is B	-
2018	Reference for sale year 2018	
2019	Dummy variable equal to 1 if sale year is 2019	+
2020	Dummy variable equal to 1 if sale year is 2020	+
2021	Dummy variable equal to 1 if sale year is 2021	+
2022	Dummy variable equal to 1 if sale year is 2022	+
2023	Dummy variable equal to 1 if sale year is 2023	+
Walk Score		
Walk Score	Natural log of the property's Walk Score	+
Third Places		
Third Place	Dummy variable equal to 1 if there is a Third Place within 0.18-miles.	+
Bar	Dummy variable equal to 1 if there is a Bar within 0.18-miles.	+
Beauty	Dummy variable equal to 1 if there is a Beauty Parlor within 0.18 mi.	+
Cafe	Dummy variable equal to 1 if there is a Cafe within 0.18-miles.	+
Fitness center	Dummy variable equal to 1 if there is a Fitness Center within 0.18-miles.	+
Hairdresser	Dummy variable equal to 1 if there is a Hairdresser within 0.18-miles.	+
Place of Worship	Dummy variable equal to 1 if there is a Place of Worship within 0.18-miles.	+
Park	Dummy variable equal to 1 if there is a Park within 0.18-miles.	+
Pub	Dummy variable equal to 1 if there is a Pub within 0.18-miles.	+
Restaurant	Dummy variable equal to 1 if there is a Restaurant within 0.18-miles.	+
School	Dummy variable equal to 1 if there is a School within 0.18-miles.	+
Supermarket	Dummy variable equal to 1 if there is a Supermarket within 0.18-miles.	+
Social Amenities		
Basketball Court	Dummy variable equal to 1 if property has a Basketball Court.	+
Breakfast/Coffee	Dummy variable equal to 1 if property has a Breakfast or Coffee service.	+
Business Center	Dummy variable equal to 1 if property has a Business Center.	+
Cabana	Dummy variable equal to 1 if property has a Cabana.	+
Clubhouse	Dummy variable equal to 1 if property has a Clubhouse.	+
Conference Rooms	Dummy variable equal to 1 if there are Conference Rooms.	+
Courtyard	Dummy variable equal to 1 if property has a Courtyard.	+

Fitness Center	Dummy variable equal to 1 if property has Fitness Center.	+
Grill	Dummy variable equal to 1 if property has a communal Grill.	+
Lounge	Dummy variable equal to 1 if property has a Lounge.	+
Media/Movie Room	Dummy variable equal to 1 if property has a Media or Movie Room.	+
Multi Use Room	Dummy variable equal to 1 if property has a Multi-Use Room.	+
Patio	Dummy variable equal to 1 if property has a Patio.	+
Pet Play Area	Dummy variable equal to 1 if property has a Pet Play Area.	+
Picnic Area	Dummy variable equal to 1 if property has a Picnic Area.	+
Social Activities	Dummy variable equal to 1 if property has Planned Social Activities.	+
Playground	Dummy variable equal to 1 if property has a Playground.	+
Pool	Dummy variable equal to 1 if property has a Pool.	+
Putting Greens	Dummy variable equal to 1 if there are Putting Greens.	+
Recreation Room	Dummy variable equal to 1 if property has a Recreation Room.	+
Spa	Dummy variable equal to 1 if property has a Spa.	+
Sundeck	Dummy variable equal to 1 if property has a Sundeck.	+
Tennis Court	Dummy variable equal to 1 if property has a Tennis Court.	+
Volleyball Court	Dummy variable equal to 1 if property has a Volleyball Court.	+
Walk/Bike Trails	Dummy variable equal to 1 if property has Walking or Biking trails.	+

Note: Reference variables were not included in the hedonic models but are listed for clarity.

Table 8. Hedonic Variables (Source: Author's Own)

Chapter 5 – Findings and Analysis

1.11 Descriptive Statistics and Frequencies

Due to there being two dependent variables evaluated in this study with different number of observations, two sets of descriptive statistics, which were used to describe scale variables, and frequencies, which were used to describe discrete variables, were provided below. Furthermore, though the model is logarithmic, the variables in descriptive statistics are at their original scale.

1.11.1 Sale Price Per Sq. Ft. Descriptives and Frequencies

Below in Tables 9 and 10, are the descriptives and frequencies for Models 1 and 3, which have the natural log of Sales Prices per sq. ft. as the dependent variable. The average sale price for properties in this study was $152.08 per sq. ft. and with an average building size of 250,763 sq. ft., the approximate average total sales price could be $38,136,010. The average property had close to 3 floors and was around 32 years old. The average Walk Score was 49.70, which is just below the threshold for being somewhat walkable. Walk Scores below 49 are designated as “car-dependent” while scores above 50 are designated as “somewhat walkable” (Walk Score, 2024). The majority of properties were located in suburban areas, following the results of Walter and Caine, (2019). Dallas contained the largest number of properties in this sample and Class B properties were the most common.

Variable	Mean	Std. Deviation	No. of Observations
Sale	152.08	60.86	948
BuildingSF	250,762.82	171,348.07	948
Floors	2.85	1.56	948
Age	31.56	19.51	948
WalkScore	49.70	20.88	948

Table 9. Sale Price per Sq. Ft. Descriptive Statistics (Adapted from CoStar Group, 2024b).

Walk Scores were higher in the CBD of each MSA, with properties Austin’s in CBD being designed as walker’s paradises and properties in the other MSA’s CBD

being “very walkable, see Figures 3 and 5. Urban properties in the MSAs were all “somewhat walkable.” (Walk Score, 2024). Suburban properties had Walk Scores between “somewhat walkable” and “car-dependent” (*Ibid.*)

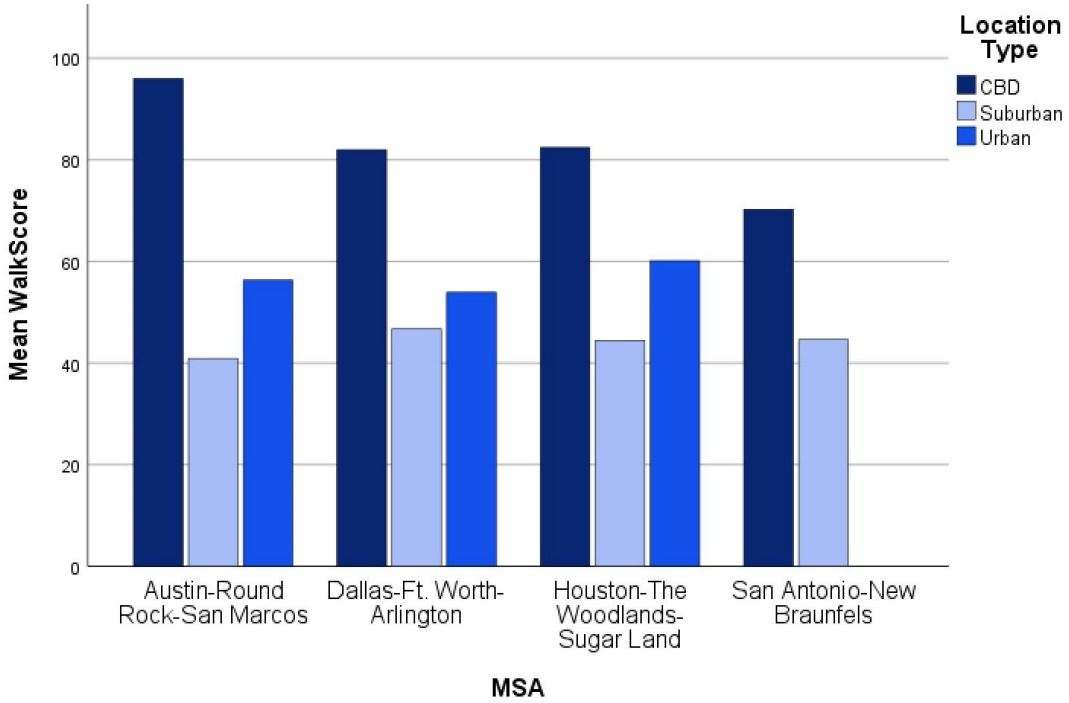

Figure 3. Mean Walk Score by MSA and Location Type (CoStar Group, 2024).

Higher Walk Scores were associated with the presence of a Third Place within a 0.18-mile walking distance, as seen in Figure 4 below, indicating possible overfitting and less reliable coefficients, though both variables passed multicollinearity checks.

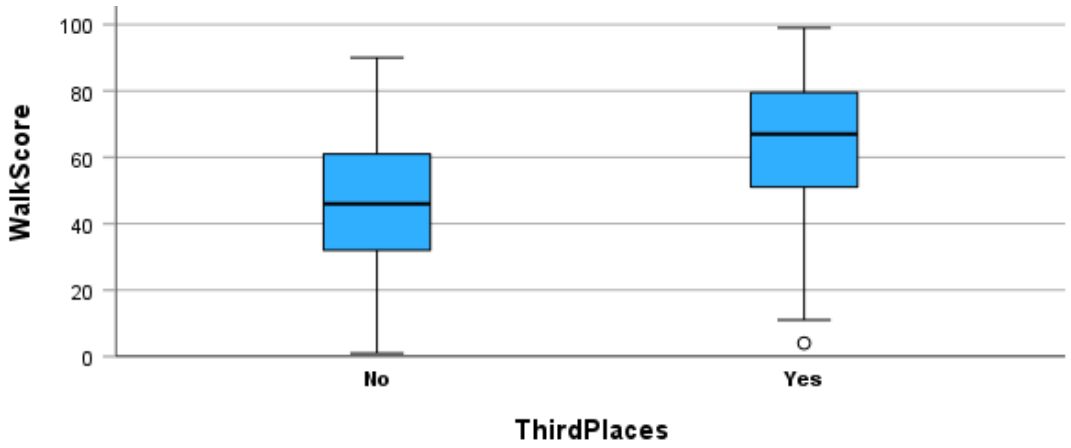

Figure 4. Boxplot of WalkScore by ThirdPlaces (Adapted from CoStar Group, 2024b).

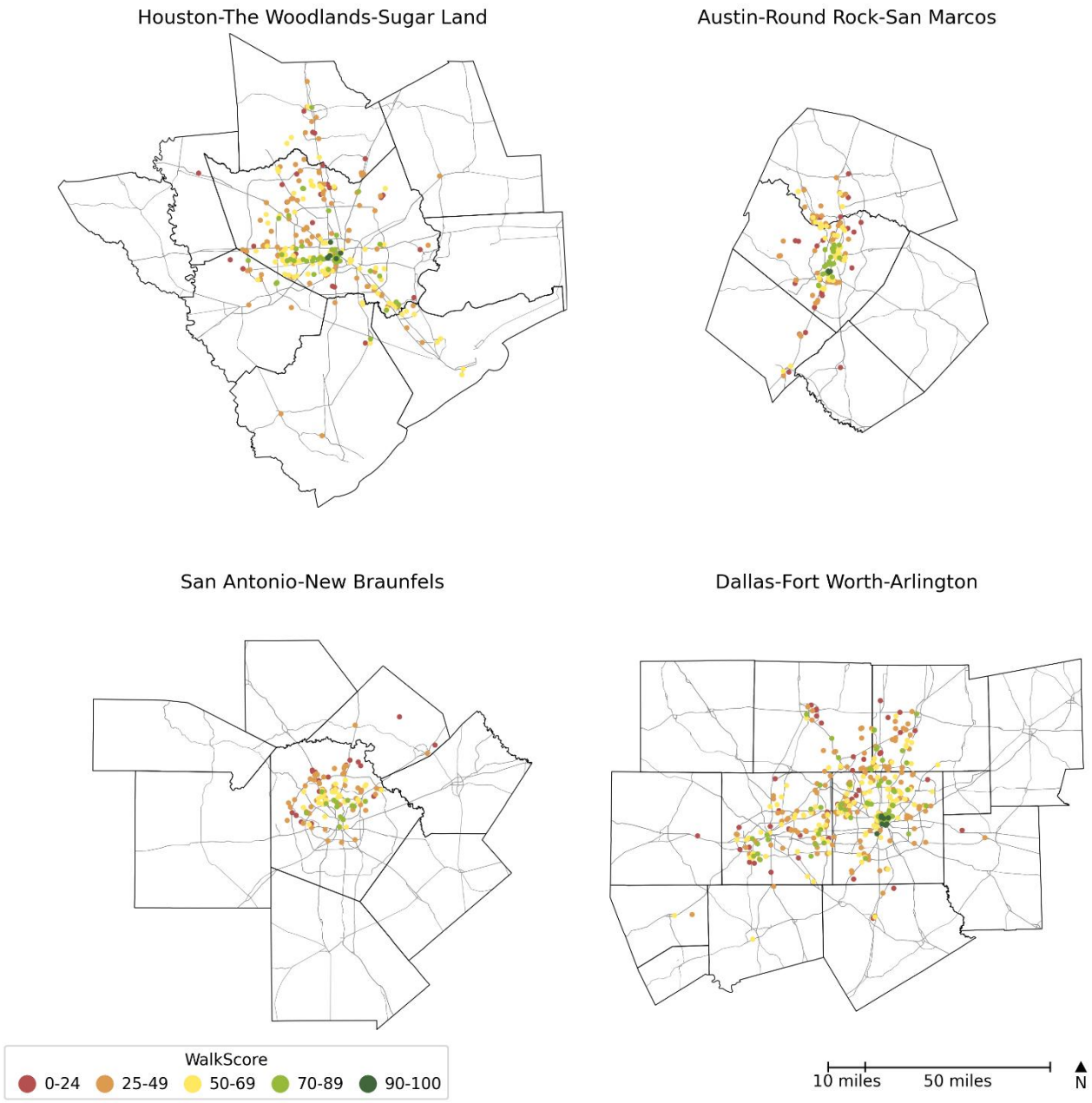

Figure 5. MSA Walk Scores Map (Adapted from CoStar Group, 2024).

Third Places within a walking distance of 0.18-miles could be found at 21.8% of properties, indicating that Third Places near multi-family properties are not very prevalent. See Figure 6 for MSA distributions of Third Places. The most common Third Place types were: Park, with a frequency of 11.8%; Restaurant, with a frequency of 8.2%; Place of Worship, with a frequency of 4.1%; and Café, with a frequency of 3.27%; Bar and Beauty with 1.9% each; and Fitness Center, with 1.6%. Several Third

Place types including Club, College, Community Center, Library, Marketplace, Mall, Recreation Ground, Social Center or Facility, Sports Center, and University were not in the proximity of any observations. Third places were clustered in a higher density in CBD and urban areas, as seen in Figure 4, due to the likely higher density of shops, facilities, services, and gathering places in urban areas and CBDs.

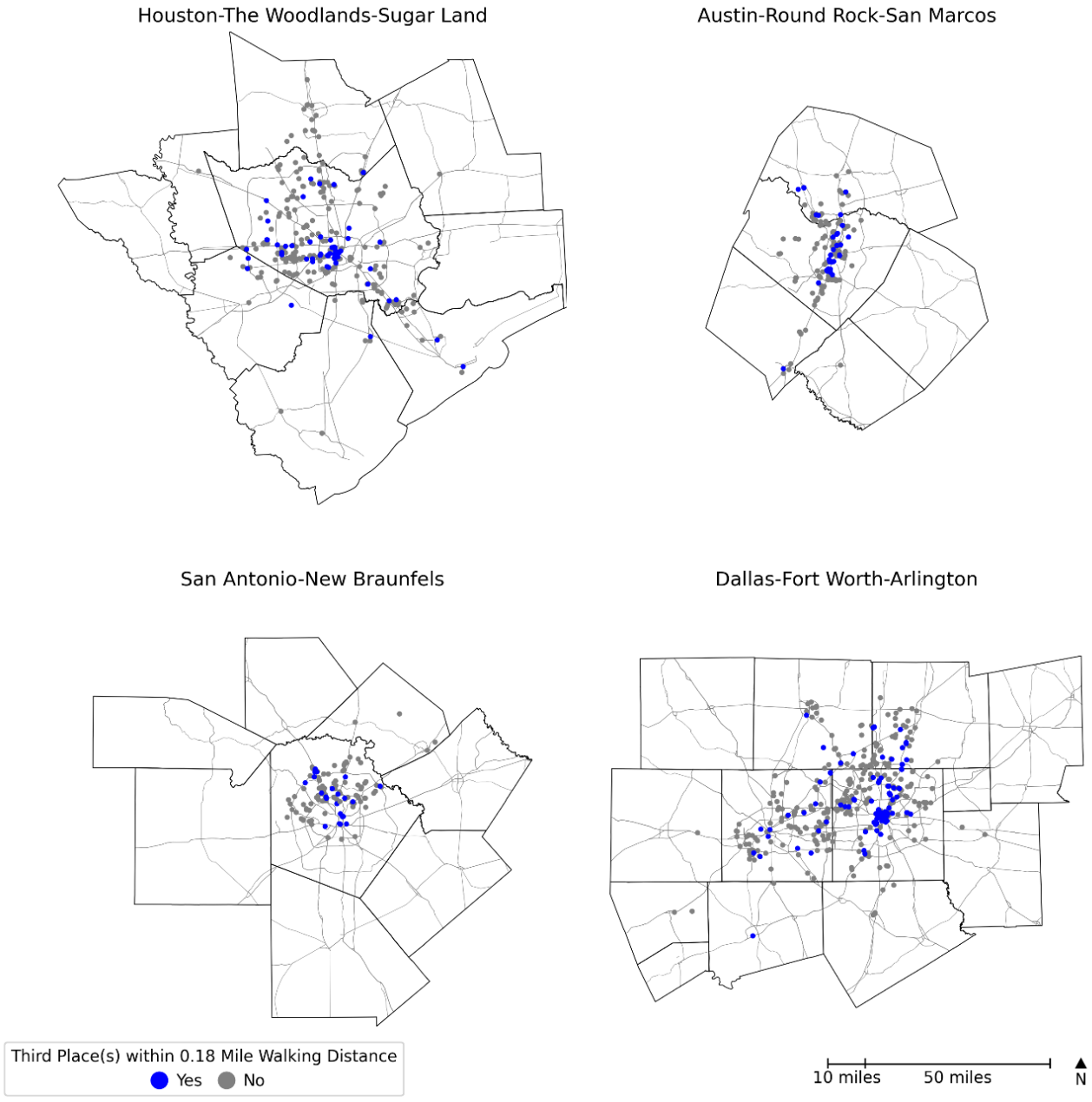

Figure 6. MSA Third Places Map (OpenStreetMap contributors, 2024).

All observations had at least one type of on-property social amenity, the five most common types being: Fitness Room, with a frequency of 69.2%; Clubhouse, with a frequency of 54.4%; Business Center; with a frequency of 48.3%; Pool, with a frequency of 47.9%; and Picnic Area, with a frequency of 31.1%. The least common, with frequencies of less than 1%, were Putting Greens and Recreation Room. See these frequencies in Table 10 below.

Dummy Variable	No.	Frequency	No. of Observations
Suburban	612	64.56%	948
Urban	309	32.59%	948
CBD	27	2.85%	948
Dallas	410	43.25%	948
Houston	269	28.38%	948
Austin	146	15.40%	948
San Antonio	123	12.97%	948
A	276	29.11%	948
B	380	40.08%	948
C	292	30.80%	948
2018	264	27.85%	948
2019	250	26.37%	948
2020	92	9.70%	948
2021	186	19.62%	948
2022	115	12.13%	948
2023	41	4.32%	948
ThirdPlace	207	21.84%	948
Bar	18	1.90%	948
Beauty	18	1.90%	948
Cafe	31	3.27%	948
Club	0	0.00%	948
College	0	0.00%	948
Community Center	0	0.00%	948
Fitness Center	15	1.58%	948
Hairdresser	16	1.69%	948
Library	0	0.00%	948
Marketplace	0	0.00%	948
Mall	0	0.00%	948
Place of Worship	39	4.11%	948
Park	112	11.81%	948
Pub	10	1.05%	948
Recreation Ground	0	0.00%	948
Restaurant	78	8.23%	948
School	10	1.05%	948

Social center	0	0.00%	948
Social facility	0	0.00%	948
Sports center	0	0.00%	948
Supermarket	6	0.63%	948
University	0	0.00%	948
Basketball Court	67	7.07%	948
Breakfast/Coffee	130	13.71%	948
Business Center	453	47.78%	948
Cabana	104	10.97%	948
Clubhouse	513	54.11%	948
Conference Rooms	59	6.22%	948
Courtyard	205	21.62%	948
Fitness Room	655	69.09%	948
Grill	448	47.26%	948
Lounge	185	19.51%	948
Media/Movie Room	64	6.75%	948
Multi Use Room	30	3.16%	948
Patio	198	20.89%	948
Pet Play Area8	279	29.43%	948
Picnic Area	295	31.12%	948
Social Activities	52	5.49%	948
Playground	226	23.84%	948
Pool	449	47.36%	948
Putting Greens	7	0.74%	948
Recreation Room	4	0.42%	948
Spa	184	19.41%	948
Sundeck	210	22.15%	948
Tennis Court	72	7.59%	948
Volleyball Court	91	9.60%	948
Walk/Bike Trails	48	5.06%	948

Table 10. Sale Price per Sq. Ft. Dummy Variable Frequencies (Source: Author's Own).

1.11.2 Asking Rent Per Sq. Ft. Descriptives and Frequencies

Below in Tables 11 and 12, are the descriptives and frequencies for Models 1 and 3. The values presented are in their original scale. Models 2 and 4 have 919 observations due to the removal of repeat sales. The descriptive statistics for the 919, asking rent per sq. ft. observation were approximate to the larger sale per sq. ft. sample of 948 observations.

The average rent per sq. ft. per month was $1.59. Taking the average unit size of 863.35 sq. ft. from the 919 observations from the CoStar dataset results in an approximate monthly rent per average unit of $1,372.73.

Variable	Mean	Std. Deviation	No. of Observations
Rent	1.59	0.31	919
BuildingSF	252,385.92	172,478.08	919
Floors	31.37	19.56	919
Age	2.86	1.57	919
WalkScore	49.67	21.01	919

Table 11. Rent per Sq. Ft. Descriptive Statistics

Due to the frequencies of the 919 observations in the rent per sq. ft. dataset being approximate to the sale per sq. ft. dataset, they will not be described again, see Table 12 below.

Dummy Variable	No.	Frequency	Total No. of Observations
Suburban	593	64.53%	919
Urban	299	32.54%	919
CBD	27	2.94%	919
Dallas	397	43.20%	919
MSA - Houston	263	28.62%	919
Austin	138	15.02%	919
San Antonio	121	13.17%	919
A	270	29.38%	919
B	372	40.48%	919
C	277	30.14%	919
2018	251	27.31%	919
2019	238	25.90%	919
2020	91	9.90%	919
2021	183	19.91%	919
2022	115	12.51%	919
2023	41	4.46%	919
ThirdPlaces	203	22.09%	919
Bar	18	1.96%	919
Beauty	18	1.96%	919
Cafe	31	3.37%	919
Club	0	0.00%	919
College	0	0.00%	919
Community Center	0	0.00%	919
Fitness Center	15	1.63%	919
Hairdresser	16	1.74%	919
Library	0	0.00%	919
Marketplace	0	0.00%	919
Mall	0	0.00%	919
Place of worship	37	4.03%	919

Park	110	11.97%	919
Pub	10	1.09%	919
Recreation Ground	0	0.00%	919
Restaurant	78	8.49%	919
School	10	1.09%	919
Social center	0	0.00%	919
Social facility	0	0.00%	919
Sports center	0	0.00%	919
Supermarket	6	0.65%	919
University	0	0.00%	919
Basketball Court	64	6.96%	919
Breakfast/Coffee	129	14.04%	919
Business Center	444	48.31%	919
Cabana	100	10.88%	919
Clubhouse	500	54.41%	919
Conference Rooms	58	6.31%	919
Courtyard	200	21.76%	919
Fitness Room	636	69.21%	919
Grill	434	47.23%	919
Lounge	185	20.13%	919
Media/Movie Room	63	6.86%	919
Multi Use Room	30	3.26%	919
Patio	193	21.00%	919
Pet Play Area8	270	29.38%	919
Picnic Area	286	31.12%	919
Social Activities	51	5.55%	919
Playground	220	23.94%	919
Pool	440	47.88%	919
Putting Greens	7	0.76%	919
Recreation Room	4	0.44%	919
Spa	177	19.26%	919
Sundeck	204	22.20%	919
Tennis Court	70	7.62%	919
Volleyball Court	85	9.25%	919
Walk/Bike Trails	48	5.22%	919

Table 12. Rent per Sq. Ft. Dummy Variable Frequencies

Regression Results

1.11.3 Base Models 1 – Sale and 2 – Rent Results

Of the scaled variables in Model 1 – Sale Base, BuildingSF, Age, Floors, and WalkScore, were all highly, less than 1%, significant with BuildingSF and Age being negative coefficients meaning older and larger properties have lower sale values, see Table 13 below. Properties with more floors demanded increased sale values. Of the four scaled variables, Floor count and Age drove the highest percent change in sale values with 16.7% and -12.5, respectively. A 1% relative change in Walk Score raises sale values by 4.5% while a 1% change in BuildingSF lowers sale values by 4.7%.

The scaled values in Model 2 – Rent Base, were also highly significant, except for BuildingSF, which has a significance of less than 10%. The coefficient signs followed Model 1 but at different magnitudes. Relative increases in Age and BuildingSF reduced rent values by 6.7% and 1.2%, respectively. Relative increases in WalkScore and Floor count increased rent values by 3.8% and 12.2%, respectively.

The hypothesis that increases in Walk Score result in increases in Sale and Rent values is supported by the results. Relative increases in Walk Scores increase sales and rent per sq. ft. values.

	Model 1 – Sale		Model 2 – Rent	
Variable	**Coefficient**	**Robust Std. Error**	**Coefficient**	**Robust Std. Error**
(Constant)	5.443***	0.164	0.553***	0.092
BuildingSF	-0.047***	0.012	-0.012*	0.007
Floors	0.167***	0.042	0.121***	0.022
Age	-0.125***	0.017	-0.067***	0.009
Suburban	REF		REF	
Urban	0.076***	0.020	0.048***	0.011
CBD	0.078	0.079	0.118***	0.038
Dallas	REF		REF	
Houston	-0.137***	0.020	-0.143***	0.011
Austin	0.26***	0.027	0.015	0.015
San Antonio	-0.095***	0.027	-0.13***	0.014
A	0.094***	0.023	0.036***	0.011
B	REF		REF	
C	-0.109***	0.025	-0.001	0.013
2018	REF		REF	
2019	0.031	0.024	0.017	0.013

2020	0.020	0.031	- 0.014	0.015
2021	0.249***	0.025	0.01	0.013
2022	0.365***	0.027	0.012	0.016
2023	0.328***	0.049	0.069**	0.028
WalkScore	0.045***	0.015	0.038***	0.007
ThirdPlaces	0.027	0.024	0.025*	0.013
No. of Observations	948		919	
Adjusted *R*-Square	0.542		0.480	

Note: ***, **, and * stand for the significance at 1%, 5%, and 10% level.

Table 13. Model 1 and 2 Linear Regression Results (Source: Author's Own Creation).

Due to the regression equation being semilogarithmic, meaning a log-transformed dependent variable and linear dummy variables, significant discrete variables have been transformed for more accurate interpretation using the following equation (Halvorsen and Palmquist, 1980):

$$\text{Percentage Change} = (e^{\beta} - 1) \times 100$$

The transformation results in the following interpretation of significant dummy variables from Models 1 and 2, as seen in Table 14 below. The results should be interpreted as holding other factors constant, the dummy variable results in a sale or rent value per S.F. a percentage higher or lower than the reference category or the properties with a null value for that variable as seen in the following examples.

In Model 1 – Sale base, holding other factors constant, properties in urban areas have a 7.95% higher sale price per S.F. compared to the Suburban reference category. Perhaps CBD was an insignificant variable due to the small frequency of 2.9%. Properties in the Austin MSA sold for significantly more per S.F., at 29.71% higher, than properties in the reference category Dallas MSA, while properties in Houston and San Antonio MSAs traded for lower values than those in the Dallas MSA, at 12.77%, and 9.08% less. The results follow price differences in the 4 MSA markets (CoStar Group, 2024a). Class A properties sold for over 10% more than Class B, while Class C sold for 10%. Coefficients for sales years 2019 and 2020 were not significant. Sales year 2022 had the highest magnitude at 44%, even higher than the succeeding year,

2023 which was at 38%. These results also follow expectations with sale values reaching their peak in all MSAs in 2023 (CoStar Group, 2024a).

In Model 2 – Rent Base, urban properties demanded higher rent values per sq. ft. with properties in CBDs demanding even higher rents per sq. ft. While the results for rents in Austin were insignificant, Houston and San Antonio had lower rents than the reference category Dallas. Class A properties had rents per sq. ft. 3.6% higher than the reference category Class B. Class C results were statistically insignificant. Perhaps non-significance is the result of omitted variable bias, the inclusion of irrelevant variables that do not affect rent, or the high variance in rent in Austin or Class C properties. Though only accounting for 4.3 of observations, properties sold in 2023 had statistically significant higher rents than those transacted in the reference category 2018 at 7.1% higher. This could be the result of new owners renovating newly purchased properties, increasing amenitization, or simply raising rents.

Important to this study's hypothesis, the presence of a Third Place within a 0.18-mile walking distance of a property did not have a statistically significant impact on sale values. However, the presence of a Third Place did increase rent per sq. ft. values by 2.53%, suggesting there is a willingness to pay by tenants for proximity to Third Places.

Dummy Variable	Model 1 - Sale	Model 2 - Rent
(Constant)		
Urban	7.95%	4.87%
CBD		12.50%
Houston	-12.77%	-13.31%
Austin	29.71%	
San Antonio	-9.08%	-12.15%
A	9.87%	3.63%
C	-10.31%	
2021	28.22%	
2022	44.08%	
2023	38.84%	7.11%
ThirdPlaces		2.53%

Table 14. Model 1 and 2 Transformed Significant Dummy Variables (Source: Author's Own Creation).

Comparing the two sale or rent models, the results were comparable, except for the differences in significant coefficients and Third Places. While their presence within

a 0.18-mile walking distance did not significantly impact sale values, it did increase rent values per square foot by 2.53%. These models suggest that renters value proximity to amenities like cafes and community centers, which enhance daily living and walkability, making them willing to pay a premium for such features, while in contrast, real estate investors and property owners, focused on factors like property appreciation, return on investment, and long-term profitability, may not prioritize Third Places as much in purchasing decisions. Models 3 and 4 will now seek which Third Places drive added value.

1.11.4 Model 3 – Sale and Model 4 – Rent Results

Since results for the variables for the properties' physical, location, and financial attributes were discussed in Models 1 and 2 and since the results are somewhat similar bar the results described in this paragraph below, the description for the coefficients of Models 3 and 4 will focus on the Third Place types and On-Property Social Amenities.

Model 3 – Sale had similar results for variables Floors, Age, and WalkScore. In this model, BuildingSF had a higher coefficient at 10.2%, which can be attributed to Model 3 not using robust standard errors, perhaps BuildingSF exhibited heteroskedasticity. Model 4 – Rent also had similar results for Floors, Age, and WalkScore. BuildingSF was not significant in this model. See Table 15.

	Model 3 – Sale		Model 4 – Rent	
Variable	**Coefficient**	**Std. Error**	**Coefficient**	**Std. Error**
(Constant)	5.925***	0.159	0.503***	0.088
BuildingSF	- 0.102***	0.012	- 0.008	0.007
Floors	0.138***	0.034	0.107***	0.019
Age	- 0.113***	0.017	- 0.056***	0.010
Suburban	REF		REF	
Urban	0.084***	0.019	0.046***	0.011
CBD	0.103*	0.055	0.106***	0.030
Dallas	REF		REF	
Houston	- 0.145***	0.020	- 0.140***	0.011
Austin	0.213***	0.025	0.002	0.014
San Antonio	- 0.102***	0.027	- 0.125***	0.015
A	0.073***	0.023	0.032**	0.013
B	REF		REF	
C	- 0.070***	0.023	0.003	0.013
2018	REF		REF	

2019	0.039*	0.022	0.012	0.012
2020	0.033	0.030	- 0.024	0.017
2021	0.271***	0.025	- 0.003	0.014
2022	0.387***	0.028	0.012	0.015
2023	0.363***	0.042	0.067***	0.023
WalkScore	0.044***	0.015	0.033***	0.008
Third Place				
ThirdPlaces				
Bar	0.192***	0.070	0.038	0.038
Beauty	0.042	0.077	- 0.003	0.042
Café	- 0.003	0.051	0.090***	0.028
Fitness Center	0.201***	0.071	0.126***	0.039
Hairdresser	- 0.140*	0.075	- 0.021	0.041
Place of Worship	- 0.065	0.042	- 0.046**	0.023
Park	- 0.018	0.030	0.028*	0.017
Pub	0.02	0.081	- 0.047	0.044
Restaurant	0.079**	0.036	0.021	0.020
School	- 0.153*	0.081	- 0.069	0.044
Supermarket	- 0.05	0.111	0.017	0.061
Social Amenity				
Basketball Court	0.025	0.035	0.009	0.019
Breakfast/Coffee	0.003	0.025	- 0.004	0.014
Business Center	0.029	0.020	- 0.003	0.011
Cabana	0.043	0.028	0.013	0.016
Clubhouse	0.071***	0.020	0.010	0.011
Conference Rooms	0.000	0.038	0.034	0.021
Courtyard	0.005	0.021	0.000	0.012
Fitness Room	0.123***	0.027	- 0.009	0.015
Grill	0.044**	0.020	0.001	0.011
Lounge	0.019	0.024	0.012	0.013
Media /Movie Room	- 0.049	0.034	- 0.012	0.019
Multi Use Room	0.007	0.050	- 0.021	0.027
Patio	- 0.009	0.022	0.008	0.012
Pet Play Area8	0.018	0.021	- 0.007	0.012
Picnic Area	- 0.009	0.021	0.003	0.012
Social Activities	- 0.008	0.037	- 0.008	0.020
Playground	- 0.039*	0.021	- 0.033***	0.012
Pool	0.003	0.018	0.011	0.010
Putting Greens	0.084	0.095	- 0.028	0.052
Recreation Room	0.125	0.127	- 0.024	0.069
Spa	0.005	0.023	0.001	0.013
Sundeck	0.011	0.021	- 0.010	0.012
Tennis Court	0.024	0.034	- 0.006	0.019
Volleyball Court	0.052*	0.030	0.002	0.017
Walk/Bike Trails	0.017	0.038	0.016	0.021

No. of Observations	948	919
Adjusted *R*-Square	0.588	0.497

Note: ***, **, and * stand for the significance at 1%, 5%, and 10% level. REF denotes the reference variable.

Table 15. Model 3 and 4 Linear Regression Results (Source: Author's Own Creation)

Models 3 and 4 were also semilogarithmic, therefore the significant dummy variables should also be transformed with the Halvorsen and Palmquist, (1980) formula, resulting in Table 16 below.

Compared to the base Model 1 – Sale, Model 3 – Sale had similar but slightly greater in magnitude results for dummy variables Urban, Houston, and sale years 2021, 2022, and 2023. In Model 3 – Sale, CBD results were significant are sold for 10.9% more per sq. ft. than the reference category Suburban. Austin exhibited a lower transformed coefficient at 23.8%. Building Class A and C coefficients had lower magnitudes in Model 3 – Sale compared to the reference Class B. The sales year 2019 was significant in this model at 4% compared to the sales year 2018.

In Model 3 – Sale, several Third Place within a walking distance of 0.18-miles and in-property social amenities had statistically significant positive results, supporting this study's hypothesis. However, some Third Places and social amenities resulted in lower sale values per sq. ft. Of the 11 Third Places variables in the model, 5 had statistically significant results. The presence of Third Places like a Bar, Restaurant, and Fitness Center resulted in an increase in the sale price of 21.1%, 8.5%, and 1.7%. Third Place like Hairdressers and Schools resulted in decreased sale values at -13.1% and -14.2%, respectively. These results nullify the main hypothesis that the presence of any Third Place increase sale values. Of the Third Place with significant variables, all but Restaurant had frequencies of less than 2%, so the sensitivity to influential cases or outliers is higher, possibly resulting in significant, large, transformed coefficients.

Of the 25 on-property social amenities, 5 had a statistically significant impact on sale per sq. ft. value. The presence of most on-property social amenities resulted in increases in sale value per sq. ft., though one, Playground, resulted in a decrease in sale value of – 3.78%. This might be due to apartments geared toward younger people. The presence of a Clubhouse and Fitness Room in apartments resulted in higher sale values

of 7.4% and 13%, respectively, while the presence of a communal Grill or Volleyball court on the property resulted in an increase in sale values of 4.5% and 5.3%. The presence of a clubhouse, which typically houses a lease office, might offer more value to the owners than the tenants. Other social amenities, like a Grill, Fitness Room, and a Volleyball court might be perceived by owners as offering marketing or differential value, though not being valued by tenants.

Model 4 – Rent, compared to the base Model 2 – Rent, held similar results for the Urban, CBD, Houston, San Antonio, Class A, and 2023 variables. Similarly to Model 3 –Sale, Model 4 – Rent resulted in some Third Places with positive and negative coefficients. Of the Third Place, proximity to a Fitness Center, like a gym, drove the largest increase in rent per sq. ft. at 13.4%. Proximity to a Cafe increased rent per sq. ft. value by 9.5%. Lastly, proximity to a Park resulted in a rental value increase of 2.8%. One Third Place resulted in decreased rent per sq. ft. values. Proximity to a Place of Worship resulted in a decrease in rent of -4.5%.

In Model 4 – Rent, only one Social Amenity had a statistically significant impact on rents. The presence of a Playground on the property resulted in a -3.3% decrease in rent per sq. ft. value. These results, especially of the insignificance of pool, courtyard, and tennis court, do not echo the findings of previous studies on building amenities.

Dummy Variable	Model 3 - Sale	Model - Rent
Urban	8.81%	4.70%
CBD	10.90%	11.24%
Houston	-13.48%	-13.08%
Austin	23.76%	
San Antonio	-9.71%	-11.71%
A	7.58%	3.25%
C	-6.76%	
2019	3.97%	
2021	31.08%	
2022	47.27%	
2023	43.74%	6.88%
Bar	21.11%	
Café		9.45%
Fitness Center	22.23%	13.41%
Hairdresser	-13.07%	
Place of Worship		-4.49%
Park		2.79%

Restaurant	8.19%	
School	-14.15%	
Clubhouse	7.35%	
Fitness Room	13.05%	
Grill	4.46%	
Playground	-3.78%	-3.28%
Volleyball Court	5.32%	

Table 16. Model 3 and 4 Transformed Significant Dummy Variables (Source: Author's Own)

Comparing both Models 3 and 4 shows that Walk Scores have a consistent and positive impact, reflecting the value placed on walkability by both buyers and renters. Regarding Third Places, the results diverge with Fitness Centers being the only statistically significant Third Places value in both the sale and rental models. Perhaps property has a discrepancy between what multi-family real estate owners, developers, or investors believe tenants value and what Third Place tenants actually value, or potentially property has issues with sensitivity due to low frequencies.

On-property social amenities also show varied effects with real estate professionals valuing amenities and renters not valuing them. The presence of a Playground on the property had a similar negative effect in both models. This could be due to renters typically being child-free due to unit sizes, the average size being 863.35 sq.ft., and the lack of sufficient bedrooms. Additionally, younger people in the US, more unlikely to have children compared to people 35 and older, are more likely to be renters (DeSilver, 2021). These results, especially of the insignificance of pool, courtyard, and tennis court, do not echo the findings of previous of studies on building amenities.

Chapter 6 – Conclusion

1.12 Summary

This dissertation examines how walkability, proximity to Third Places, and on-property social amenities affect the sale and rental values of multi-family properties in the car-dependent Texas Triangle region. The study is driven by public health concerns related to sedentary lifestyles and loneliness, which can be mitigated by promoting walkable environments and providing social spaces. Using a hedonic pricing model, the research analyzed data from multi-family properties in the major metropolitan areas of Dallas-Fort Worth-Arlington, Houston-The Woodlands-Sugarland, Austin-Round Rock, and San Antonio-New Braunfels. The hypothesis was partially supported by the results and partially rejected.

The findings indicate that higher Walk Scores are associated with increased sales and rental values, highlighting the appeal of walkable neighborhoods for both renters and property buyers. Walkability offers convenience, aligns with lifestyle preferences, reduces transportation costs, and meets environmental considerations. Notably, Walk Scores had a slightly greater impact on sale values compared to rental values, suggesting that developers and property investors may perceive walkability as adding more long-term value than what tenants might initially prioritize.

The analysis of Third Places varied impacts on property values. While proximity to Third Places generally boosted rental values, their effect on sale values was mixed, depending on the specific type of Third Place. For instance, being close to fitness centers and restaurants increased property values, whereas proximity to hairdressers or schools was associated with lower sale prices. These results indicate that the specific nature and quality of Third Places significantly influence property desirability and value.

On-property social amenities also added value to properties, with amenities such as fitness rooms and clubhouses particularly enhancing property appeal. Conversely, some amenities like playgrounds were linked to lower property values, suggesting that developers must carefully consider which amenities align with the preferences of their target demographic.

1.13 Limitations

This study, while offering important insights into the relationships between walkability, Third Places, and social amenities on property values, does have several limitations that must be acknowledged.

1.13.1 Correlation of Walk Score and Third Places

Another limitation is the potential overlap between the metrics of Walk Score and the presence of Third Places. Walk Score inherently measures proximity to amenities, many of which could be Third Places. This overlap may lead to difficulties in isolating the specific contributions of walkability versus the distinct benefits provided by Third Places. While the study suggests that both walkability and Third Places contribute to higher property values, it is difficult to delineate the independent effect of each factor. This interdependence could potentially lead to either an underestimation or overestimation of the value added by Third Places, therefore complicating the interpretation of the results.

1.13.2 Lack of Qualitative Measure of Walkability, Third Places, and Social Amenities

While the Walk Score provides a useful quantitative measure of walkability, it may not fully capture the subjective experience of walking in a particular area. Although Walk Score is widely used and offers a standardized way to quantify walkability, it has been critiqued for not fully capturing the qualitative aspects of the walking experience, such as pedestrian safety, aesthetic appeal, and the quality of sidewalks (Hall and Ram, 2018). Walk Score primarily considers proximity to amenities without accounting for the diversity or quality of these amenities, which can vary significantly in different urban contexts (Bereitschaft, 2018). Likewise, this study does not consider the quality of Third Places, nor the quality of on-property social amenities. Factors such as safety, aesthetic appeal, and the quality of pedestrian infrastructure can significantly influence an individual's perception of walkability. Properties could be near Third Places, but if they are all of low quality or unlikely to be frequented by tenants, then they would add little aesthetic, convenience, or social value. Therefore, the relationship between walkability and property values might be more complex than what is captured through Walk Score, Third Place proximity, and Social Amenities alone.

1.14 Recommendations

Based on the insights gained from this study, investors and developers should consider the following strategic recommendations to maximize the value and appeal of multi-family properties.

1.14.1 Enhance Walkability to Boost Property Value

Walkability has a proven positive impact on both sales and rental values. Developers should prioritize projects in areas where walkability can be enhanced or is already high. Additionally, advocating for or participating in local government initiatives to improve pedestrian infrastructure, such as sidewalks, crosswalks, and traffic calming measures, can significantly increase the attractiveness of a development. Furthermore, developers

1.14.2 Integrate Third Places into Development Projects

The presence of Third Places, such as cafes, parks, and fitness centers, is shown to increase rental values, highlighting the demand for social and recreational spaces. Co-location with fitness centers is especially valuable to both rent and sale values. Where walkability is feasible, but the property has a lack of Third Places, developers and investors should consider incorporating Third Places that also drive rent like café, restaurant, and gym space on the ground floor to enhance Walk Scores, Third Place proximity, and sense of community.

1.14.3 3. Provide Targeted On-Property Social Amenities

On-property social amenities can significantly enhance property appeal and value. Developers should carefully consider which amenities align best with the target demographic and which amenities bring the most value relative to their cost. Moreover, developers should be mindful of tenant willingness to pay for each type of on-property social amenities because as this study finds, while amenities may drive increased sale values, and be valued by investors, they may not drive differential value for tenants.

1.15 Implications for Future Work

Future research should focus on differentiating the impact of distinct types and qualities of Third Places on property values, as well as incorporating subjective

perceptions of walkability, such as convenience and aesthetic appeal. Exploring demographic preferences could reveal how different groups prioritize walkability and amenities, guiding targeted development strategies. Finally, assessing the broader economic and social benefits of walkability and Third Places, such as increased local economic activity and improved public health, will underscore the broader value of creating social, walkable communities.

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Appendix 1 – Third Place within 0.18 miles Code

```
import os
import time
import openpyxl
import requests

# OpenRouteService API key (redacted)
ors_api_key = 'redacted'

# Load addresses and coordinates from Excel (redacted)
input_file_path = (r"redacted")
output_file_path = (r"redacted")

# Find amenities around 0.25 miles coordinate
def find_amenities(lat, lon, radius=400):
    overpass_url = "http://overpass-api.de/api/interpreter"
    overpass_query = f"""
    [out:json];

node["amenity"~"community_centre|cafe|restaurant|place_of_worship|park|social_centr
e|club|library|marketplace|mall|supermarket|school|college|university|bar|pub|recreation_
ground|fitness_centre|sports_centre|social_facility|hairdresser|beauty"](around:{radius},
{lat},{lon});
    out body;
    """
    response = requests.get(overpass_url, params={'data': overpass_query})
    data = response.json()
    amenities = []

    if 'elements' in data:
        for element in data['elements']:
```

```
            amenities.append((element['lat'], element['lon']))

    return amenities


# Check if found amenities are within 0.18 miles walking distance from coordinate
def is_within_walking_distance(lat1, lon1, lat2, lon2, distance=289):
    ors_url = "https://api.openrouteservice.org/v2/directions/foot-walking"
    headers = {
        'Authorization': ors_api_key,
        'Content-Type': 'application/json'
    }
    body = {
        "coordinates": [[lon1, lat1], [lon2, lat2]],
        "format": "geojson"
    }
    response = requests.post(ors_url, json=body, headers=headers)
    data = response.json()
    if 'routes' in data and data['routes']:
        route_distance = data['routes'][0]['summary']['distance']
        return route_distance <= distance

    return False

# Load the workbook and select the active sheet
wb = openpyxl.load_workbook(input_file_path)
sheet = wb.active

# Extract addresses and coordinates from columns B, AZ, and BA, rows 2 to 800
addresses = []
for row in range(2, 800):
    address = sheet[f'B{row}'].value
```

```
    latitude = sheet[f'AZ{row}'].value
    longitude = sheet[f'BA{row}'].value
    if address and latitude and longitude:
        addresses.append((address, latitude, longitude))

# Create a new excel
new_wb = openpyxl.Workbook()
new_sheet = new_wb.active
new_sheet.append(
    ["Address", "Latitude", "Longitude", "Amenities in Proximity", "Amenities in
Walking Distance"])

# Put new data (amenities count) in excel
request_count = 0
for address, lat, lon in addresses:
    if request_count >= 60:
        time.sleep(60)  # Wait for 1 minute to respect the API rate limit
        request_count = 0

    amenities = find_amenities(lat, lon)
    request_count += 1

    amenity_proximity_count = len(amenities)
    amenity_walking_count = 0
    for amenity_lat, amenity_lon in amenities:
        if request_count >= 60:
            time.sleep(60)  # Wait for 1 minute to respect the API rate limit
            request_count = 0

        if is_within_walking_distance(lat, lon, amenity_lat, amenity_lon):
            amenity_walking_count += 1
        request_count += 1
```

```
    new_sheet.append([address, lat, lon, amenity_proximity_count,
amenity_walking_count])

# Save the new workbook
new_wb.save(output_file_path)
```

Appendix 2 – Hedonic Models

1.16 Model 1 – Sale Pricer Per SF Base Regression

Variable	Coefficient	Robust Std. Error*	*t*-statistic	Prob.
C	5.443	0.164	33.169	0.000
BuildingSF	-0.047	0.012	-3.977	0.000
Floors	0.167	0.042	3.962	0.000
Age	-0.125	0.017	-7.143	0.000
Urban	0.076	0.020	3.841	0.000
CBD	0.078	0.079	0.990	0.323
Houston	-0.137	0.020	-6.810	0.000
Austin	0.260	0.027	9.693	0.000
San Antonio	-0.095	0.027	-3.562	0.000
A	0.094	0.023	4.021	0.000
C	-0.109	0.025	-4.272	0.000
2019	0.031	0.024	1.326	0.185
2020	0.020	0.031	0.650	0.516
2021	0.249	0.025	9.812	0.000
2022	0.365	0.027	13.763	0.000
2023	0.328	0.049	6.677	0.000
WalkScore	0.045	0.015	3.012	0.003
ThirdPlaces	0.027	0.024	1.144	0.253

***R*-Squared**	0.551	**Mean dependent variable**	4.952
Adjusted *R*-Square	0.542	**S.D. dependent variable**	0.281
S.E. of regression	0.256	**Akaike info criterion**	-2562.305
Sum squared residual	61.162	**Schwarz criterion**	-2474.927
Log likelihood	-46.001	***F*-statistic**	67.037
Durbin-Watson	2.052	**Prob(*F*-statistic)**	0.000

Note: HC3 Method

1.17 Model 1 – Heteroscedasticity Test

	Chi-Square	df	Prob.
White Test	223.120	140	0.000
Breusch-Pagan	0.537	1	0.464

1.18 Model 2 – Rent per SF Base

Variable	Coefficient	Robust Std. Error*	*t*-statistic	Prob.
C	0.553	0.092	6.015	0.000
BuildingSF	-0.012	0.007	-1.839	0.066
Floors	0.121	0.022	5.465	0.000
Age	-0.067	0.009	-7.731	0.000
Urban	0.048	0.011	4.393	0.000
CBD	0.118	0.038	3.091	0.002
Houston	-0.143	0.011	-13.233	0.000
Austin	0.015	0.015	1.062	0.288
San Antonio	-0.130	0.014	-9.304	0.000
A	0.036	0.011	3.155	0.002
C	-0.001	0.013	-0.081	0.935
2019	0.017	0.013	1.326	0.185
2020	-0.014	0.015	-0.911	0.362
2021	0.010	0.013	0.746	0.456
2022	0.012	0.016	0.735	0.462
2023	0.069	0.028	2.444	0.015
WalkScore	0.038	0.007	5.386	0.000
ThirdPlaces	0.025	0.013	1.948	0.052

***R*-Squared**	0.490	**Mean dependent variable**	0.444
Adjusted *R*-Square	0.480	**S.D. dependent variable**	0.131
S.E. of regression	0.135	**Akaike info criterion**	-3660.207
Sum squared residual	16.466	**Schwarz criterion**	-3573.388
Log likelihood	544.099	***F*-statistic**	50.841
Durbin-Watson	1.975	**Prob(*F*-statistic)**	0.000

Note: HC3 Method

1.19 Model 2 – Heteroscedasticity Test

	Chi-Square	df	Prob.
White Test	285.124	140	0.000
Breusch-Pagan	0.015	1	0.903

1.20 Model 3 – Sale per SF

Variable	Coefficient	Std. Error	*t*-statistic	Prob.	Tolerance	VIF
C	5.925	0.159	37.277	0.000		
BuildingSF	0.044	0.015	2.984	0.003	0.700	1.429
Floors	-0.102	0.012	-8.465	0.000	0.374	2.671
Age	0.138	0.034	4.033	0.000	0.430	2.326
Urban	-0.113	0.017	-6.547	0.000	0.290	3.448
CBD	0.084	0.019	4.389	0.000	0.772	1.296
Houston	0.103	0.055	1.889	0.059	0.750	1.334
Austin	-0.145	0.020	-7.186	0.000	0.754	1.326
San Antonio	0.213	0.025	8.547	0.000	0.775	1.291
A	-0.102	0.027	-3.735	0.000	0.736	1.358
C	0.073	0.023	3.164	0.002	0.564	1.775
2019	-0.070	0.023	-2.988	0.003	0.532	1.879
2020	0.039	0.022	1.770	0.077	0.658	1.519
2021	0.033	0.030	1.088	0.277	0.760	1.315
2022	0.271	0.025	10.862	0.000	0.627	1.594
2023	0.387	0.028	13.848	0.000	0.741	1.350
WalkScore	0.363	0.042	8.624	0.000	0.846	1.182
Bar	0.192	0.070	2.728	0.007	0.679	1.472
Beauty	0.042	0.077	0.544	0.587	0.568	1.762
Cafe	-0.003	0.051	-0.067	0.947	0.763	1.311
Fitness centre	0.201	0.071	2.824	0.005	0.794	1.260
Hairdresser	-0.140	0.075	-1.865	0.062	0.667	1.500
Place of worship	-0.065	0.042	-1.563	0.118	0.921	1.086
Park	-0.018	0.030	-0.585	0.559	0.659	1.518
Pub	0.020	0.081	0.245	0.806	0.909	1.100
Restaurant	0.079	0.036	2.173	0.030	0.630	1.586
School	-0.153	0.081	-1.880	0.060	0.908	1.102
Supermarket	-0.050	0.111	-0.448	0.654	0.807	1.239
Basketball Court	0.025	0.035	0.722	0.470	0.790	1.266
Breakfast/Coffee	0.003	0.025	0.121	0.904	0.851	1.176
Business Center	0.029	0.020	1.476	0.140	0.635	1.574

Cabana	0.043	0.028	1.525	0.128	0.825	1.211
Clubhouse	0.071	0.020	3.539	0.000	0.620	1.614
Conference Rooms	0.000	0.038	-0.009	0.993	0.747	1.339
Courtyard	0.005	0.021	0.224	0.823	0.849	1.177
Fitness Center	0.123	0.027	4.543	0.000	0.396	2.526
Grill	0.044	0.020	2.163	0.031	0.613	1.630
Lounge	0.019	0.024	0.823	0.411	0.712	1.405
Media/Movie Room	-0.049	0.034	-1.431	0.153	0.859	1.164
Multi Use Room	0.007	0.050	0.140	0.888	0.824	1.214
Patio	-0.009	0.022	-0.425	0.671	0.795	1.258
Pet Play Area	0.018	0.021	0.867	0.386	0.700	1.428
Picnic Area	-0.009	0.021	-0.407	0.684	0.652	1.533
Planned Social Activities	-0.008	0.037	-0.207	0.836	0.885	1.130
Playground	-0.039	0.021	-1.834	0.067	0.773	1.293
Pool	0.003	0.018	0.187	0.852	0.792	1.263
Putting Greens	0.084	0.095	0.885	0.376	0.936	1.068
Recreation Room	0.125	0.127	0.986	0.324	0.926	1.080
Spa	0.005	0.023	0.229	0.819	0.774	1.292
Sundeck	0.011	0.021	0.536	0.592	0.796	1.257
Tennis Court	0.024	0.034	0.719	0.472	0.770	1.298
Volleyball Court	0.052	0.030	1.757	0.079	0.824	1.213
Walk/Bike Trails	0.017	0.038	0.444	0.657	0.900	1.111

***R*-Squared**	0.525	**Mean dependent variable**	4.952
Adjusted *R*-Square	0.497	**S.D. dependent variable**	0.296
S.E. of regression	0.243	**Akaike info criterion**	-2627.537
Sum squared residual	53.031	**Schwarz criterion**	-2370.256
Log likelihood	21.615	***F*-statistic**	26.695
Durbin-Watson	2.066	**Prob(*F*-statistic)**	<0.001

1.21 Model 3 – Heteroscedasticity Test

	Chi-Square	df	Prob.
White Test	593.992	565	0.193
Breusch-Pagan	0.001	1	0.974

1.22 Model 4 – Rent per SF

Variable	Coefficient	Std. Error	*t*-statistic	Prob.	Tolerance	VIF
C	0.503	0.088	5.687	0.000		
BuildingSF	0.033	0.008	4.115	0.000	0.700	1.429
Floors	-0.008	0.007	-1.173	0.241	0.374	2.671
Age	0.107	0.019	5.683	0.000	0.430	2.326
Urban	-0.056	0.010	-5.867	0.000	0.290	3.448
CBD	0.046	0.011	4.306	0.000	0.772	1.296
Houston	0.106	0.030	3.550	0.000	0.750	1.334
Austin	-0.140	0.011	-12.542	0.000	0.754	1.326
San Antonio	0.002	0.014	0.171	0.864	0.775	1.291
A	-0.125	0.015	-8.241	0.000	0.736	1.358
C	0.032	0.013	2.497	0.013	0.564	1.775
2019	0.003	0.013	0.193	0.847	0.532	1.879
2020	0.012	0.012	0.971	0.332	0.658	1.519
2021	-0.024	0.017	-1.426	0.154	0.760	1.315
2022	-0.003	0.014	-0.189	0.850	0.627	1.594
2023	0.012	0.015	0.766	0.444	0.741	1.350
WalkScore	0.067	0.023	2.881	0.004	0.846	1.182
Bar	0.038	0.038	0.984	0.325	0.679	1.472
Beauty	-0.003	0.042	-0.082	0.935	0.568	1.762
Cafe	0.090	0.028	3.245	0.001	0.763	1.311
Fitness centre	0.126	0.039	3.239	0.001	0.794	1.260
Hairdresser	-0.021	0.041	-0.508	0.611	0.667	1.500
Place of worship	-0.046	0.023	-1.976	0.048	0.921	1.086
Park	0.028	0.017	1.655	0.098	0.659	1.518
Pub	-0.047	0.044	-1.050	0.294	0.909	1.100

Restraurant	0.021	0.020	1.044	0.297	0.630	1.586
School	-0.069	0.044	-1.554	0.121	0.908	1.102
Supermarket	0.017	0.061	0.277	0.782	0.807	1.239
Basketball Court	0.009	0.019	0.467	0.641	0.790	1.266
Breakfast/Coffee	-0.004	0.014	-0.258	0.797	0.851	1.176
Business Center	-0.003	0.011	-0.293	0.770	0.635	1.574
Cabana	0.013	0.016	0.841	0.401	0.825	1.211
Clubhouse	0.010	0.011	0.924	0.356	0.620	1.614
Conference Rooms	0.034	0.021	1.615	0.107	0.747	1.339
Courtyard	-1.077E-05	0.012	-0.001	0.999	0.849	1.177
Fitness Center	-0.009	0.015	-0.626	0.532	0.396	2.526
Grill	0.001	0.011	0.096	0.924	0.613	1.630
Lounge	0.012	0.013	0.896	0.370	0.712	1.405
Media /Movie Room	-0.012	0.019	-0.636	0.525	0.859	1.164
Multi Use Room	-0.021	0.027	-0.757	0.449	0.824	1.214
Patio	0.008	0.012	0.639	0.523	0.795	1.258
Pet Play Area	-0.007	0.012	-0.571	0.568	0.700	1.428
Picnic Area	0.003	0.012	0.255	0.798	0.652	1.533
Planned Social Activities	-0.008	0.020	-0.389	0.698	0.885	1.130
Playground	-0.033	0.012	-2.851	0.004	0.773	1.293
Pool	0.011	0.010	1.076	0.282	0.792	1.263
Putting Greens	-0.028	0.052	-0.535	0.593	0.936	1.068
Recreation Room	-0.024	0.069	-0.341	0.733	0.926	1.080
Spa	0.001	0.013	0.059	0.953	0.774	1.292
Sundeck	-0.010	0.012	-0.807	0.420	0.796	1.257
Tennis Court	-0.006	0.019	-0.317	0.752	0.770	1.298
Volleyball Court	0.002	0.017	0.142	0.887	0.824	1.213
Walk/Bike Trails	0.016	0.021	0.763	0.446	0.900	1.111

***R*-Squared**	0.525	**Mean dependent variable**	0.444
Adjusted *R*-Square	0.497	**S.D. dependent variable**	0.136
S.E. of regression	0.132	**Akaike info criterion**	-3657.223
Sum squared residual	15.308	**Schwarz criterion**	-3401.589
Log likelihood	577.607	***F*-statistic**	18.442

Durbin-Watson	1.952	**Prob(*F*-statistic)**	<0.001

1.23 Model 4 – Heteroscedasticity Test

	Chi-Square	df	Prob.
White Test	59730.045	557	0.310
Breusch-Pagan	0.208	1	0.649

Ethical Clearance Form

Submission Details

1. **Name of programme of study:**

International Real Estate and Planning

2. **Please indicate the type of research work you are doing (Delete that which do not apply):**
   - Dissertation in Planning (MSc)

3. **Please provide the current working title of your research:**

Impact of walkability scores on Capitalization Rates and Rental Premiums of Build-to-Rent Properties in Texas Metropolitan Areas

4. **Please indicate your supervisor's name:**
   Dr. Quilin Ke

Research Details

5. **Please indicate here which data collection methods you expect to use. (Tick all that apply/or delete those which do not apply.)**

   - **Collection/use of sensor or locational data**

6. **Please indicate where your research will take place (delete that which does not apply):**
   - UK and overseas

7. **Does your project involve the recruitment of participants?**
   No

Appropriate Safeguard, Data Storage and Security

8. **Will your research involve the collection and/or use of personal data?**

   No

9. **Is your research using or collecting:**

No

10. **Do you confirm that all personal data will be stored and processed in compliance with the General Data Protection Regulation (GDPR 2018)? (Choose one only, delete that which does not apply)**

    - I will not be working with any personal data

11. **I confirm that:**

- The information in this form is accurate to the best of my knowledge.
- I will continue to reflect on and update these ethical considerations in consultation with my supervisor.

Yes

RISK ASSESSMENT FORM

FIELD / LOCATION WORK

DEPARTMENT/SECTION:

LOCATION(S):

PERSONS COVERED BY THE RISK ASSESSMENT:

BRIEF DESCRIPTION OF FIELDWORK (including geographic location): COMPLETE HERE

COVID-19 RELATED GENERIC RISK ASSESSMENT STATEMENT:

Coronavirus disease (COVID-19) is an infectious disease caused by coronavirus SARS-CoV-2. The virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes. Droplets fall on people in the vicinity and can be directly inhaled or picked up on the hands and transferred when someone touches their face. This risk assessment documents key risks associated fieldwork during a pandemic, but it is not exhaustive and will not be able to cover all known risks, globally. This assessment outlines principles adopted by UCL at an institutional level and it is necessarily general. Please use the open text box 'Other' to indicate any contingent risk factors and control measures you might encounter during the course of your dissertation research and writing.

Please refer to the Dissertation in Planning Guidance Document (available on Moodle) to help you complete this form.

Hazard 1: Risk of Covid -19 infection during research related travel and research related interactions with others (when face-to-face is possible and/or unavoidable)

Risk Level - Medium /Moderate

Existing Advisable Control Measures: Do not travel if you are unwell, particularly if you have COVID-19 symptoms. Self-isolate in line with NHS (or country-specific) guidance.

Avoid travelling and face-to-face interactions; if you need to travel and meet with others:

- If possible, avoid using public transport and cycle or walk instead.

- If you need to use public transport travel in off-peak times and follow transport provider's and governmental guidelines.
- Maintain (2 metre) social distancing where possible and where 2 metre social distancing is not achievable, wear face covering.
- Wear face covering at all times in enclosed or indoor spaces.
- Use hand sanitiser prior to and after journey.
- Avoid consuming food or drinks, if possible, during journey.
- Avoid, if possible, interchanges when travelling - choose direct route.
- Face away from other persons. If you have to face a person ensure
that the duration is as short as possible.
- Do not share any items i.e. stationary, tablets, laptops etc. If items need to be shared use disinfectant wipes to disinfect items prior to and after sharing.
- If meeting in a group for research purposes ensure you are following current country specific guidance on face-to-face meetings (i.e rule of 6 etc.)
- If and when possible meet outside and when not possible meet in venues with good ventilation (e.g. open a window)
- If you feel unwell during or after a meeting with others, inform others you have interacted with, self-isolate and get tested for Covid-19
- Avoid high noise areas as this mean the need to shout which increases risk of aerosol transmission
of the virus.
- Follow one way circulation systems, if in place. Make sure to check before you visit a building.
- Always read and follow the visitors policy for the organisation you will be visiting.
- Flush toilets with toilet lid closed.
-'Other' Control Measures you will take (specify):

NOTE: The hazards and existing control measures above pertain to Covid-19 infection risks only. More generalised health and safety risk may exist due to remote field work activities and these are outlined in your Dissertation in Planning Guidance document. Please consider these as possible 'risk' factors in completing the remainder of this standard form. For more information also see: Guidance Framework for Fieldwork in Taught and MRes Programmes, 2021-22

Consider, in turn, each hazard (white on black). If **NO** hazard exists select **NO** and move to next hazard section.

If a hazard does exist select **YES** and assess the risks that could arise from that hazard in the risk assessment box.

Where risks are identified that are not adequately controlled they must be brought to the attention of your Departmental Management who should put temporary control measures in place or stop the work. Detail such risks in the final section.

ENVIRONMENT	**The environment always represents a safety hazard. Use space below to identify and assess any risks associated with this hazard**
e.g. location, climate, terrain, neighbourhood, in outside organizations, pollution, animals.	NO

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**
	work abroad incorporates Foreign Office advice
	only accredited centres are used for rural field work
	participants will wear appropriate clothing and footwear for the specified environment
	refuge is available
	work in outside organisations is subject to their having satisfactory H&S procedures in place
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EMERGENCIES	Where emergencies may arise use space below to identify and assess any risks
e.g. fire, accidents	NO

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
	participants have registered with LOCATE at http://www.fco.gov.uk/en/travel-and-living-abroad/
	contact numbers for emergency services are known to all participants
	participants have means of contacting emergency services
	a plan for rescue has been formulated, all parties understand the procedure
	the plan for rescue /emergency has a reciprocal element
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

EQUIPMENT	Is equipment used?	NO	If 'No' move to next hazard If 'Yes' use space below to identify and assess any risks
e.g. clothing, outboard motors.	Examples of risk: inappropriate, failure, insufficient training to use or repair, injury. Is the risk high / medium / low ?		

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	the departmental written Arrangement for equipment is followed
	participants have been provided with any necessary equipment appropriate for the work
	all equipment has been inspected, before issue, by a competent person
	all users have been advised of correct use
	special equipment is only issued to persons trained in its use by a competent person
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

LONE WORKING	**Is lone working a possibility?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. alone or in isolation *lone interviews.*	Examples of risk: difficult to summon help. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**

	the departmental written Arrangement for lone/out of hours working for field work is followed
	lone or isolated working is not allowed
	location, route and expected time of return of lone workers is logged daily before work commences
	all workers have the means of raising an alarm in the event of an emergency, e.g. phone, flare, whistle
	all workers are fully familiar with emergency procedures

☐ OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

ILL HEALTH	The possibility of ill health always represents a safety hazard. Use space below to identify and assess any risks associated with this Hazard.
e.g. accident, illness, personal attack, special personal considerations or vulnerabilities.	NO

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk
	all participants have had the necessary inoculations/ carry appropriate prophylactics
	participants have been advised of the physical demands of the research and are deemed to be physically suited
	participants have been adequate advice on harmful plants, animals and substances they may encounter
	participants who require medication should carry sufficient medication for their needs
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

TRANSPORT	Will transport be required	NO	X	Move to next hazard
		YES		Use space below to identify and assess any risks
e.g. hired vehicles	Examples of risk: accidents arising from lack of maintenance, suitability or training Is the risk high / medium / low?			

CONTROL MEASURES	Indicate which procedures are in place to control the identified risk

	only public transport will be used
	the vehicle will be hired from a reputable supplier
	transport must be properly maintained in compliance with relevant national regulations
	drivers comply with UCL Policy on Drivers http://www.ucl.ac.uk/hr/docs/college_drivers.php
	drivers have been trained and hold the appropriate licence
	there will be more than one driver to prevent driver/operator fatigue, and there will be adequate rest periods
	sufficient spare parts carried to meet foreseeable emergencies
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

DEALING WITH THE PUBLIC	**Will people be dealing with public**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. interviews, observing	Examples of risk: personal attack, causing offence, being misinterpreted. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**
	all participants are trained in interviewing techniques
	advice and support from local groups has been sought
	participants do not wear clothes that might cause offence or attract unwanted attention
	interviews are conducted at neutral locations or where neither party could be at risk
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

WORKING ON OR NEAR WATER	**Will people work on or near water?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. rivers, marshland, sea.	Examples of risk: drowning, malaria, hepatitis A, parasites. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**
	lone working on or near water will not be allowed
	coastguard information is understood; all work takes place outside those times when tides could prove a threat
	all participants are competent swimmers
	participants always wear adequate protective equipment, e.g. buoyancy aids, wellingtons
	boat is operated by a competent person
	all boats are equipped with an alternative means of propulsion e.g. oars
	participants have received any appropriate inoculations
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

MANUAL HANDLING (MH)	**Do MH activities take place?**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. lifting, carrying, moving large or heavy equipment, physical unsuitability for the task.	Examples of risk: strain, cuts, broken bones. Is the risk high / medium / low?		

CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**
	the departmental written Arrangement for MH is followed
	the supervisor has attended a MH risk assessment course
	all tasks are within reasonable limits, persons physically unsuited to the MH task are prohibited from such activities
	all persons performing MH tasks are adequately trained
	equipment components will be assembled on site
	any MH task outside the competence of staff will be done by contractors
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

SUBSTANCES	**Will participants work with substances**	**NO**	**If 'No' move to next hazard** **If 'Yes' use space below to identify and assess any risks**
e.g. plants, chemical, biohazard, waste	Examples of risk: ill health - poisoning, infection, illness, burns, cuts. Is the risk high / medium / low?		
CONTROL MEASURES	**Indicate which procedures are in place to control the identified risk**		

	the departmental written Arrangements for dealing with hazardous substances and waste are followed
	all participants are given information, training and protective equipment for hazardous substances they may encounter
	participants who have allergies have advised the leader of this and carry sufficient medication for their needs
	waste is disposed of in a responsible manner
	suitable containers are provided for hazardous waste
	OTHER CONTROL MEASURES: please specify any other control measures you have implemented:

OTHER HAZARDS	**Have you identified any other hazards?**	**NO**	**If 'No' move to next section** **If 'Yes' use space below to identify and assess any risks**
i.e. any other hazards must be noted and assessed here.	Hazard: Risk: is the risk		
CONTROL MEASURES	**Give details of control measures in place to control the identified risks**		

Have you identified any risks that are not adequately controlled?	**NO**	**X**	**Move to Declaration**
	YES		**Use space below to identify the risk and what action was taken**

DECLARATION	The work will be reassessed whenever there is a significant change and at least annually. Those participating in the work have read the assessment.

Select the appropriate statement:

X	I the undersigned have assessed the activity and associated risks and declare that there is no significant residual risk
X	I the undersigned have assessed the activity and associated risks and declare that the risk will be controlled by the method(s) listed above

NAME OF SUPERVISOR Dr. Quilin Ke **2nd April. 2024**