NEIGHBORHOOD DESIGN AND TURNOVER

A Dissertation

by

YUN MI PARK

Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Chair of Committee,	George O. Rogers
Committee Members,	Chanam Lee
	Dudley L. Poston
	Forster Ndubisi
Head of Department,	Forster Ndubisi

December 2014

Major Subject: Urban and Regional Sciences

ABSTRACT

This study seeks to find empirical evidences whether or not neighborhood and context designs influence neighborhood turnover in Austin, Texas, using multilevel linear modeling. The study originated from the notion that neighborhoods are a multilevel phenomenon comprised of different sizes. In this study, ‘neighborhoods’ and ‘contexts’ are theoretically and operationally defined by scale. Neighborhoods represent residential neighborhoods, while contexts are larger neighborhoods that may include several residential neighborhoods, which are often called institutional neighborhoods. For the operation, subdivisions were employed to characterize neighborhoods and census tracts for contexts. Further, this study also tries to identify the independent roles and magnitudes of neighborhood design elements into structural (i.e., density, land use, housing mix, and street patterns) and ecological design components (i.e., nature, open space, and landscape patterns) in both neighborhoods and contexts. Using five years of deed data, neighborhood turnover was measured by the average change in ownership of single-family homes.

This study found that even though preferences are determined by multiple conditions, neighborhood and context designs do have an influence on residents’ location decisions. Neighborhoods have a greater impact than contexts, but the influence of contexts also plays unique roles in neighborhood turnover. The study also found that the specific combinations of neighborhood and context designs can increase or decrease neighborhood turnover. Another distinctive finding of this study was that the same

design principles could be perceived as desirable or undesirable depending on the spatial scales. For example, density is a critical element in explaining neighborhood turnover, but the trends contrast. Low-density is preferable in neighborhoods, but is not desirable in contexts. Further, the importance of structural and ecological features appears different. Structural components are the most significant in neighborhoods and contexts, while a set of ecological features shows a significant role only in neighborhoods. In summary, people are not willing to sacrifice their typical suburban-style neighborhoods, but they are more likely to stay homes in contexts that allow them various functions and services as current planning guides pursue.

The findings urge planners to address more scale sensitive design principles and find fundamental reasons for the two different ends of residents' preferences in different scales of neighborhoods.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. George O. Rogers, and my committee members, Dr. Dudley, Dr. Forster, and Dr. Lee for their guidance and support throughout the course of this research. I am especially indebted to Dr. George Rogers for five years of guidance toward my development as a scholar in the United States.

Thanks also go to my friends and colleagues, DiCamillo and Hovde family, Gabriel Burns, Han Park, Hyunwoo Kim, Joey Kasper, Jaekyung Lee, Jaewon Park, Jihyeon Kim, Minjung Kim, Myungsik Choi, Russell Blessing, Ryunjung Lee, Saheum Hong, Seyoung Sung, Seungkyum Kim, Shi-kai Hung, Tristan Wu, Wayne Day, and Will Mobley, for making my time at Texas A&M University a great experience. I was never alone thanks to them.

Finally, eternal thanks to my parents for their supports and willingness to participate in this grand journey and to my sister for her constant encouragement.

TABLE OF CONTENTS

	Page
ABSTRACT	ii
ACKNOWLEDGEMENTS	iv
TABLE OF CONTEXTS	v
LIST OF FIGURES	viii
LIST OF TABLES	x
CHAPTER I INTRODUCTION	1
1.1 Background	1
1.2 Research Aims and Approaches	2
1.3 Significance	3
1.4 Organization of the Dissertation	5
CHAPTER II LITERATURE REVIEW	7
2.1 Introduction	7
2.2 Neighborhood	7
2.3 Neighborhood Design	11
2.4 The Impacts of Neighborhood Design	21
2.5 Other Indicators Determining Neighborhood Quality	33
2.6 Research Gap	35
CHAPTER III THEORY DEVELOPMENT	40
3.1 Introduction	40
3.2 Context Sensitive Design	40
3.3 Structural vs. Ecological Design	43
3.4 Neighborhood Turnover	45
CHAPTER IV RESEARCH DESIGN	48
4.1 Introduction	48
4.2 Conceptual Framework	48
4.3 Hypotheses	50

4.4 Settings 53
4.5 Unit of Analysis 55
4.6 Analytical Method 57
4.7 Sample Size 63
4.8 Data 66
4.9 Measurement 69
4.10 Variables Selection 84

CHAPTER V RESULTS 88

5.1 Introduction 88
5.2 Descriptive Statistics 88
5.3 The Variance of Neighborhood Turnover Occurred within and across Contexts 94
5.4 The Independent Impacts of Neighborhoods on Neighborhood Turnover 96
5.5 The Independent Impacts of Contexts on Neighborhood Turnover 101
5.6 The Spontaneous Impacts of Neighborhoods and Contexts on Neighborhood Turnover 104

CHAPTER VI CONCLUSION 117

6.1 Introduction 117
6.2 Summary of Findings 117
6.3 Discussion 122
6.4 Planning Implications 133
6.5 Conclusion 138
6.6 Limitation and Further Study 139

REFERENCES 143

APPENDIX A. CREATING LAND COVER 173

APPENDIX B. HOW TO AFFIRM A NEIGHBORHOOD BOUNDARY 176

APPENDIX C. TRANSFORMATION 180

APPENDIX D. POWER ANALYSIS 182

APPENDIX E. DESIGN EFFECT 184

APPENDIX F. CENTERING 185

APPENDIX G. DETERMINING RANDOM AND FIXED EFFECTS 187

APPENDIX H. RANDOM-COEFFICIENT MODELS 189

APPENDIX I. MEANS-AS-OUTCOMES MODELS 192

APPENDIX J. NEIGHBORHOOD AGE AND POPULATION DENSITY 194

APPENDIX K. OLS REGRESSIONS AT TWO SEPARATE LEVELS 196

APPENDIX L. DISAGGREGATED AND AGGREGATED OLS 199

APPENDIX M. FEW NEIGHBORHOODS IN AUSTIN 202

APPENDIX N. THE CENTRALITY OF NEIGHBORHOODS IN CONTEXTS 208

APPENDIX O. THE VARIABILITY WITHIN NEIGHBORHOODS 210

LIST OF FIGURES

Page

Figure 2-1. Examples of Spatial Guideline 20

Figure 4-1. Conceptual Framework 49

Figure 4-2. Tested Hypotheses 52

Figure 4-3. Study Area: Austin, TX in Travis County 53

Figure 4-4. Planning and Projects Related to Neighborhood Planning in Austin since the Mid 1990s 55

Figure 4-5. Unit of Analysis and Data Collection 57

Figure 4-6. Multilevel Models Used to Test Each Hypothesis 61

Figure 4-7. Diagrammatic Representation when Considering Neighborhood or Context Only 62

Figure 4-8. Diagrammatic Representation when Considering Neighborhood and Context Together 63

Figure 4-9. Neighborhoods and Contexts for This Study 65

Figure 4-10. Example: Differences in Shannon's Index 73

Figure 4-11. Example: The Different Values of Network Index α, β, and γ 75

Figure 4-12. Example: PLAND, ED, and PD 78

Figure 5-1. The Distributions of CVs: Development Age, Housing Price, Lot Size, and House Size 90

Figure 5-2. Some Circumstances of the Minimum Value of Zero 92

Figure 6-1. An Example: How to Enhance Ecological Design Features in Developed Neighborhoods 136

Figure 6-2. An Example: How to Enhance Overall Density in Contexts 137

Figure 6-3. Example from Columbia New Town, MD: The Conceptual Diagram to Show How to Aggregate Neighborhoods to the Next Larger Units, from a Housing Cluster to a Town 138

Figure A-1. Land Cover Data with Five Classifications :Water, Developed, Tree, Grass, and Barren 174

Figure A-2. Examples of Irregular Shaped Neighborhood Boundaries 178

Figure A-3. Process of Affirming Neighborhoods for the Study 179

Figure A-4. Total Number of Contexts when n=3, α=0.05, ρ=0.05, and δ=0.5 183

Figure A-5. Age of Neighborhoods and Density of Contexts 194

Figure A-6. The Distribution of Old and High-Density Areas 195

LIST OF TABLES

Page

Table 2-1. Neighborhood and Community Park Criteria 18

Table 2-2. The Impacts of Neighborhood Designs on Stated Preferences (Neighborhood Satisfaction Survey) 31

Table 2-3. The Impacts of Neighborhood Designs on Revealed Preferences (Housing Premium) 32

Table 2-4. Determinants of Neighborhood Quality 35

Table 4-1. Data Source and Date 69

Table 4-2. Research Constructs and Variables 70

Table 4-3. Links and Nodes Measures: α, β, and γ 75

Table 4-4. Measures of Landscape Patterns 78

Table 4-5. Measurements of Neighborhood Conditions 82

Table 4-6. Measurements of Context Conditions 83

Table 4-7. Correlation Matrix 87

Table 5-1. Size of Neighborhoods and Contexts 89

Table 5-2. Descriptive Statistics of Potential Interest 93

Table 5-3. Estimated Random Effects on the Random-effects ANOVA Model 96

Table 5-4. Estimated Random Effects of the Random-Coefficient Models 98

Table 5-5. The Results of the Final Random-Coefficient Model 100

Table 5-6. Estimated Random Effects on the Regression with Means-as-Outcomes 103

Table 5-7. The Results of Final Regression with Means-as-Outcomes Model 104

Table 5-8. The Low and High Value of Affordable Housing, Median Income, and Crash 108

Table 5-9. The Low and High Value of Green Cover Ratio and Park Ratio 109

Table 5-10. The Low and High Value of Spillover Effect 110

Table 5-11. The Low and High Value of Population Density 112

Table 5-12. Estimated Random Effects on the Intercepts-and-Slopes-as-Outcomes Model 115

Table 5-13. Results of The Intercepts-and-Slopes-as-Outcomes Model 116

Table 6-1. Comparing Results of Separate Multilevel Model vs. Combined Model 121

Table 6-2. Comparing the Results of Single-level and Multilevel Model 132

Table A-1. Transformed Variables 181

Table A-2. Determining Random and Fixed Effects across Context 188

Table A-3. The Results of a Random-coefficient Model : Structural Design Feature Only 189

Table A-4. The Results of a Random-coefficient Model : Structural and Ecological Designs Only 190

Table A-5. The Results of Random-Coefficient Models 191

Table A-6. Results of Means-as-Outcomes Model : Structural Design Feature Only 192

Table A-7. Results of Means-as-Outcomes Model : Structural and Ecological Designs 193

Table A-8. Results of Means-as-Outcomes Models 193

Table A-9. Results of OLS at the Neighborhood Level 196

Table A-10. Results of OLS at the Context Level 197

Table A-11. The Value of Moran's I 198

Table A-12. Results of the Disaggregated OLS 199

Table A-13. Results of the Aggregated OLS 200

Table A-14. The Value of Moran's I 201

Table A-15. Revised Model: Including the Centrality of Neighborhood 209

Table A-16. Revised Model: Excluding Heterogeneous Neighborhoods in Lot Size 211

Table A-17. Revised Model: Excluding Heterogeneous Neighborhoods in Housing Size 212

Table A-18. Revised Model: Excluding Heterogeneous Neighborhoods in Housing Price 213

CHAPTER I

INTRODUCTION

1.1 Background

Designing better neighborhoods has been a long-term goal of urban planners (Harries 1998; Talen and Ellis 2002; Corbusier 1967; Jim and Chen 2010; Ellis 2010)alen and Ellis 2002; Corbusier 1967; Jim and Chen 2010; Ellis 2010). To provide desirable conditions for residents, some design values have recently been modified from the past to response to the challenges of auto-dependency, separation of land uses, homogeneous neighborhood environments, and sprawl (Fainstein 2000; Sternberg 2000; Madanipour 1997; Talen and Ellis 2002; Barnett 1982; Montgomery 1998; Lynch 1984; Saelens et al. 2003). Emerging concepts of “sustainable community design”—embraced by design concepts such as new urbanism, green urbanism, or compact city—open new paradigms for neighborhood design. Despite criticism, they have become some of the most influential physical planning movements and have been widely adopted by federal (e.g., HUD community design guidelines for Homeownership Zones and HOPE VI) and city level plans (e.g., urban growth boundary, comprehensive plans, or city codes and ordinances), as well as the private sector projects (e.g., subdivision developments or master planned communities).

The underlying assumption of these approaches is that ways to incorporate urban design components could affect the lives of people since spatial structure frames and distributions of human activities and flows. This hypothesis also leads practicing planners or planning theorists to believe that better designed neighborhoods result in better lives for residents. However, this statement requires some empirical evidence as to whether or not the planners' or theorists' beliefs are true.

1.2 Research Aims and Approaches

This study mainly seeks to whether or not neighborhood design effects residents' satisfaction. Particularly, it examines individual and interactive influences of neighborhoods and their contexts on neighborhood turnover as a proxy to measure residents' satisfaction in Austin, Texas. This dissertation is also concerned with the influence of a context as well as a neighborhood, quantitatively employing the assumption that a neighborhood and its context effect on residents independently and interdependently. Appointed "neighborhoods" and "contexts" in this study were theoretically defined by two different scales of neighborhoods in a hierarchy; contexts are larger neighborhoods, which indicate institutional neighborhoods, that include several residential neighborhoods.

This study also tries to classify the independent roles of neighborhood design elements into structural (i.e., density, mixed-use, and street patterns) and ecological design components (i.e., natural features, open spaces, and landscape patterns) in two different scale of neighborhoods. The classification is made by the degree of involvement of people to create them. The magnitude of the impacts of structural and ecological design components on neighborhood turnover was observed and compared in each neighborhood and context. These associations were structured and tested statistically by using a multilevel linear models.

1.3 Significance

Prior studies of neighborhood design are rich and varied. Similar to other research, this study also seeks to examine the extent to which neighborhood design impacts residents' lives. This study, however, suggests some different points.

From a planning theory perspective, the outcomes of this study show that the mutual interaction of a neighborhood and its context quantitatively. Planners both in academia and practice express that contextually sensitive planning is as important as understanding the role of a neighborhood design itself, while the evidence of this argument is rarely found. Observing the interactional relationships between neighborhoods and contexts could induce discussions about which design priciples perform more effectively at different spatial levels of neighborhoods. Existing neighborhood design theory often creates conflicts between recommendations and actual preferences because it does not specify design guidelines regardless of geographical differences. For instance, new urbanism mainly encourages social integration through a higher density and mixed land use, but is often described as "crowded" and causing stress in small neighborhoods.

The comparison of neighborhood design components also was conducted by different domains in different scales. It is true that neighborhood design is not completed without the harmonious implementation of all it's components. That is why both structural and ecological design components are often lumped together and are called by different names such as urban form, neighborhood design, or built environment. However, it is meaningful to separate and compare the different impacts of each design at the neighborhood and context levels. This study identifies which domains or specific components are relatively important in neighborhoods and contexts.

From a planning practice perspective, this study could help suggest the roles of public and private parties when designing neighborhoods. The private sector is mostly responsible for smaller scale developments that occur in neighborhoods. The public sector, on the other hand, is more involved with larger scale developments and planning policies that tend to happen in contexts. The public sector is also in charge of guiding neighborhood designs and experimenting with leading neighborhood development or redevelopment projects. The findings suggest evidence-based planning decisions for both the public and private sector. This in turn can create living environments that promote neighborhood satisfacion through several planning tools in different sizes of neighborhoods. In addition, finding relatively important designs in neighborhoods and contexts helps set priorities for communities that lack adequate economic or social resources.

A measure of this study, neighborhood turnover, also has merit for planning policy makers. Neighborhood turnover is more connected to the lives and experiences of residents than other measures of revealed preferences, although housing price is the most frequently used measure of satisfaction. Even though it is a good measure to assess preferences of residents, the economic benefit of a housing premium is less influential on the lives of people before they sell their homes and leave. Neighborhood turnover can be a better measure to capture actions than a stated preference measure, which usually expressed by ratings of neighborhood satisfaction. That is why the reported behaviors or intentions may not always result in actions. Moreover, neighborhood turnover provides more insight into policies that create stable communities, and is one of the primary goals of neighborhood planning. It is generally said that a stable community improves the quality of life due to the social capital created by friendship, informal social control, or place attachment (Schieman 2005; Ross et al. 2000).

1.4 Organization of the Dissertation

This dissertation is presented in six chapters. Chapter I introduces the outline of this study: backgrounds, research aims, approaches, and significance. Chapter II reviews previous studies that are drawn from three areas. First, the basic understanding of a neighborhood and its significance in planning. Second, a literature of neighborhood design and its influence. The characteristics of design elements in terms of structural and ecological design components are described, and their impacts reflected on neighborhood satisfaction in terms of revealed and stated preferences are stated. Third, a short explanation about other neighborhood quality indicators follows. After a literature review, the research gap in previous literature is discussed. In Chapter III, the theory that guides this study in order to fill the gaps of previous studies is described in three basic constructs. The first addresses the necessity of context sensitive design in scholarly research and methods of defining neighborhoods and contexts theoretically. The second stresses the need for integrated neighborhood design guidelines in terms of structural and ecological features. The third describes neighborhood turnover as an alternative measure of revealed preferences and its meaningful implication in planning. In Chapter IV, the conceptual framework and specific hypotheses are structured drawn from the developed theory. Research methods such as settings, units of analyses, analytical method, sample size, measurment, and variable selection are also presented. Chapter V provides descriptive statistics, and reports the results of the analyses to answer the four hypotheses of this study. Finally, Chapter VI presents the summary and discussions about the finding, implications of the findings in planning, and the conclusion. The opportunities for future study and challenges of this study are also discussed.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

The main concern of neighborhood design is shaping the physical conditions that could stimulate growth, development, and residents' activities (Talen and Ellis 2002; Madanipour 1997). Hence, neighborhood design is an area of study that takes into accounts the **components** and **guidance of neighborhood design**, **neighborhood impacts**, and other **determinants of neighborhood quality**. As a foundation for neighborhood study, the **definition of neighborhoods** and their distinct roles as **social and spatial units** are reviewed. These four parts of the literature are holistically explored to understand the nature of neighborhood design, its association with residents' lives, and to expose the gaps in the literature.

2.2 Neighborhood

2.2.1 General Definition

Bowden (1972) mentioned that even 11-year-old boys could draw neighborhood boundaries and innately possess the awareness of the concept of a neighborhood. Yet, a scholarly description is more elusive. The previous literature provides definitions into the conceptual nature of a neighborhood. A neighborhood is

- an "important organ of urban life," in which people are bound together, interlinked, and live interdependently like all living organisms (Mumford 1954, 260)

- a combination of geographical boundaries, ethnic, or cultural characteristics of the inhabitants, psychological unity, or concentrated use of an area's facilities (Keller 1968)
- a small urban area where residents are influenced by socio-economic effects and services within (Goodman 1977)
- a sub-territory of a larger area in which people reside and interact with each other (Hallman 1984)
- a geographical unit where inhabitants can share access to construction within (Chaskin 1997)

Even though each researcher elaborated on the meaning of neighborhood differently, overlapping key words exist: a cluster of residents, geographically defined place, and social and economic cohesion. Synthesizing these key words, we can define a neighborhood as a collection of people who share services and some level of cohesion in a geographically bounded place.

2.2.2 Neighborhood as Spatial and Social Units

Neighborhoods are seen as social or/and spatial units depending on which aspects of neighborhoods are highlighted (Smith 2010; Park 1952). One aspect of neighborhoods cannot complete the definition or mechanisms of a neighborhood, but planning policies and initiatives often focus on one or the other depending on planning goals.

2.2.2.1 Neighborhood as a Spatial Unit

As previously defined, neighborhoods are geographical units bounded on the ground. This is very different from a simple gathering of people. In this sense, the primary condition defining neighborhoods is to be spatially clustered. As cities grew, people migrated and clustered by economic status, the location of available jobs, and cultural and ethnic identities under the condition of affordability (Park 1952). These types of neighborhoods are formed by natural forces and are independent from administrative objects (Chaskin 1997; Park 1952). Within a human ecological perspective, these neighborhoods are called ‘natural areas’ or ‘urban villages.’ In this case, people get together to share a common purpose as a neighborhood is not solely a spatial unit. Spatial closeness enables them to communicate, recognize faces, and develop friendships. Thus, spatial clustering is the primary condition that makes neighborhoods social units. Particularly, physical distance created social distance and in turn affects the progress of communication in former days (Park 1952). Even though we have overcome the physical distance thanks to technology, the proximity or face-to-face interactions remain essential.

Another distinctive feature that makes neighborhood as a spatial unit is similar patterns of land use and form, which are the most distinct visual expression of spatial unity. “The fuller use of tree-lined streets and public open spaces, and the architecture style” of neighborhood design allows residents to differentiate and identify their neighborhood as a spatially clustered unit (Mumford 1954, 262; Chaskin 1998).

2.2.2.2 Neighborhood as a Social Unit

Neighborhoods are also units of social settlement that are not so much population aggregates. The major social features of neighborhoods are social ties, interpersonal relationships, and the official or unofficial associations among members. Although their individual characteristics are not necessarily similar, residents share common interests and act together for their common well-being (Park 1952).

The power of neighborhoods as social units has been highlighted in policies and projects of community development. Community development underscores the participation and empowerment of residents to work towards a shared agenda or their common needs (Craig and Mayo 1995). Therefore, to enhance residents' participation and empowerment, several planning tools have been suggested by the forms of community programs, initiatives (Gootman and Eccles 2002), community organizing, building (Gittell and Vidal 1998; Mowbray 2005), community assets, and community mapping of social and material capital (Parks and Straker 1996). Urban designers and planners proposed facilities or physical environments that could generate intensive social interactions with common meeting spots. Community centers or common local places in the center of neighborhoods are the most popular example. It was believed that core facilities could promote a sense of belongings and community involvement, but this concept has faded (Mumford 1954), but still remain in new urbanist idea. It has been well known that simple spatial aggregation is not sufficient to create neighborhoods that are complete social units.

2.3 Neighborhood Design

The qualities of individual design components are critical in determining the characteristics of a neighborhood. Frequently mentioned elements of neighborhood design are architecture, urban units (e.g., lots, blocks, streets, or roads), public realms (e.g., public buildings, plazas, or squares), and open spaces (e.g., playing lots, parks, greenways, or trees, often including nature and agriculture lands) (Evans et al. 1982; Southworth and Owens 1993; Lynch 1984; Cervero and Kockelman 1997; Handy 1996; Moudon et al. 1997). While the individual quality of neighborhood design components is important in determining a neighborhood's image, their spatial structure has been considered more important as spatial structure determines where human activities and flows occur (Rowley 1996; Jones et al. 2005; Handy 1996). Hence, planning tools and guidelines are mostly oriented toward how to organize, lay-out, and bind individual elements. The decisions of neighborhood design affect the neighborhood for a long time, and are difficult to alter once in place.

2.3.1 Two Domains of Neighborhood Design

Not all neighborhood design components can be assigned into two divergent categories, but for the sake of convenience, design principles were classified into two groups: 'structural design components' and 'ecological design components.' Design components that form the structure of neighborhoods were named structural design components, while green and natural features were called ecological design components.

2.3.1.1 Structural Design Components

Structural design components focus more on how to organize and to arrange major foundations of neighborhoods such as density, land use, and street patterns. Unfortunately, planning theories do not provide the universal criteria for good or bad conditions within neighborhoods (Sternberg 2000; Talen and Ellis 2002; Barnett 1982; Montgomery 1998). Guidance has changed along with the challenges and possible solutions of the era. Relatively low density development, segregated land uses, and long-winding streets were emphasized before, but current design strategies generally have moved in the opposite direction: a higher density, more mixed-use, and more connected street patterns (Jabareen 2006).

<u>Density</u>

Density is a measure of vertical and horizontal intensity of developments within occupied space. Density is usually expressed by land consumption per capita, and is calculated by the simple ratio of population, households, or dwelling units to land area (Malpezzi and Guo 2001; Galster et al. 2001). The degree of ground coverage was also mentioned as a measure of development intensity (Montgomery 1998). Density can also be reflected in lot size and the floor plans of housing, particularly at a neighborhood scale. If there are houses that have larger lots or bigger floor plans, this indicates a lower density (Song and Knaap 2004b).

Density is a primary planning tool to determine the degree of human activity and function within an area such as employment, retail sales, or commuting times in macro-scale areas and the housing size and even the level of psychological load in micro-scale areas (Cervero and Kockelman 1997; Porter 1998; Wassmer 2000). In the past, a low-density rural style of development was emphasized. Rural style development is in stark contrast to compact development realized in the form of present day suburbia. Today, a relatively denser form of development is advised. It is said that developments should be located close enough to each other so that various services and urban functions can be shared effectively (Frumkin 2002; Anderson et al. 1996; Williams et al. 2005; Williams et al. 2000). It is also related to the optimum use of resources such as land and energy by locating activities and development close enough to reach via walking or biking. Although the definition of ‘a higher-density’ differs among various societies and cultures, it is assumed that the proper density at certain thresholds—which is generally higher than that of current subdivision development in suburban areas—gives some benefits to neighborhoods (Nasar 2003).

Land Use

Land use is determined by the current and dominant conditions of a certain area, or by the intention of urban planners who initiate future land uses. In broad terms, land use can be classified into natural and non-natural uses. In urbanized areas, the term ‘land use’ refers to residential and non-residential land use (e.g., commercial, industrial, open space, or education). The mixed land uses denote the mixture of well-suited residential and non-residential land uses that could be located together. Arranging compatible land uses is one strategy to prevent land use conflicts. After zoning was legislated, planners put more value on segregated land uses—single detached units were designated different from other types of housing and residential from commercial were segregated—to maintain privacy and to sustain a quiet residential environment (Saelens et al. 2003). On the contrary, current urbanists suggest mixing several land uses with residential areas is a positive condition (Jabareen 2006; Song and Knaap 2004a; Galster et al. 2001; Berke 2008). This is exemplified in a building with several stacked uses that combines residential units, a small number of daily-need retail stores, community facilities, or offices. Some buildings are increasingly providing a range of housing choices, which can bring different types of households together in the community, and further implement mixed land use (Berke and Conroy 2000; Brown and Cropper 2001; Grant 2002). It is argued that unmixed homogenous land use increases travel distances between destinations and encourages automobile dependency (Matthews and Turnbull 2007). When people live near places where they can shop, eat, and play, it helps reduce the financial costs of automobiles and encourages pedestrian travel (e.g., walking or biking) and public transit use (Grant 2002; Alberti and Waddell 2000; Jabareen 2006; Brown and Cropper 2001; Lee and Moudon 2004). Mixed land use is also believed to increase natural surveillance. Jacobs (1961) suggested when stores and other public places are open at all hours, it increases the safety of the neighborhood thanks to the customers and employees of these stores and small businesses, which are "natural watchers and guardians in sufficient numbers" (Jacobs 1961, 36).

Street Patterns

Streets and blocks comprise the basic framework of a neighborhood and determine the basic layout of each individual housing unit (Southworth and Owens 1993). Hence, creating street patterns is one of the primary design elements at the neighborhood scale (Southworth and Owens 1993; Lee and Moudon 2004). Long and wide streets and blocks were recommended to provide larger lots for single-family homes, introverted neighborhood space, and privacy. Recent design suggestions, on the other hand, favor shorter streets and smaller blocks. The maximum length standard is said to be between 300 and 600 feet (Montgomery 1998; Dill 2004). It is four to six times shorter than the length of one side of a superblock in Radburn, New Jersey, where a standard unit of a super block was 1,200 feet by 1,800 feet (Smith 2000).

The connectivity of streets influences movement of people between destinations such as transportation transit stops, commercial uses, or schools, rather than a simple proximity. In terms of length of streets, a quarter mile, up to a half mile, network distance is a widely accepted standard for a plausible walking and cycling distance (Duany and Plater-Zyberk 1992; Southworth 1997; Duany et al. 1991; Gehl 2011; Song and Knaap 2003). With respect to shapes of streets, a grid pattern—two series of parallel streets that create rectangular blocks—usually provides more alternative routes than cul-de-sacs or looped streets (Duany et al. 2001; Matthews and Turnbull 2007; Southworth 1997). Even though a street layout is not a complete grid, broken-up streets contribute to having more transportation routes, especially when walking, and increasing the permeability of places (Montgomery 1998; Jacobs 1961). Pedestrian friendly environment is another circulation concern within neighborhoods. The route distance and condition to utilitarian destinations are determinants of pedestrian connectivity (Yang 2008).

2.3.1.2 Ecological Design Components

The endeavors of ecological design have also continued from decorating private gardens to introducing and integrating nature into a city. Some believe that the power of greenness is always the most visible and influential feature to residents and visitors. Even though ecological design components could include various ranges of features and living creatures, this study narrowly observed several ecological features such as nature, parks and greenways, and landscapes in neighborhoods.

Natural Features

Topography, mountains, hills, lakes, and creeks are the primary “given” conditions of neighborhood design. Therefore, most of the developments must but follow the first rule, nature (Ellis 2010). Sometimes, natural conditions create obstacles that constrain built forms (Friedman 2007), although topographical constraints have been overcome to some extent due to technological advances. They also characterize the fundamental local context and image of neighborhoods, which are often reflected in names of neighborhoods (e.g., Pebble Creek, Grand Lake, or Lowry Hill).

No matter the constraints or merits, the creation of harmonious connections to nature has been always a primary concern. In scholarly research, the inherent inclination to affiliate with nature, known as "biophilia", has been studied for a long time (Wilson 1984; Grinde and Patil 2009). Previous studies revealed that frequent exposure to nature increases positive effects: friendliness (Ulrich 1993; Matsuoka and Kaplan 2008), playfulness (Ulrich 1979; Grinde and Patil 2009), elation (Ulrich 1979), physical and psychological health (Grinde and Patil 2009; Ulrich 1993; Ulrich et al. 1991), livability in one's social and physical environments (Ulrich 1993), and overall human happiness (Coles and Bussey 2000; Nisbet et al. 2011). Responsible incorporation of nature into a community also results in other benefits such as conserving urban habitats (Walmsley 1995; Jabareen 2006; Chasan 1993), reducing pollution (Jabareen 2006), and promoting educational functions (Walmsley 1995).

Open Space

The term 'open space' is usually described as the counterpart of development or used land. Particularly, urban open space usually refers to parks, forests, meadows, watersheds, and wetlands that are open and unobstructed to the sky (McConnell and Walls 2005). Publicly owned and regulated parks, greenways, and nature preserves are most often mentioned urban open spaces in planning and design (Maruani and Amit-Cohen 2007; Barbosa et al. 2007; Lee et al. 2008). In addition to the general features having green features nearby, they provide recreational opportunities and social spaces that can bring people from different social classes together. They also help protect natural areas and living creatures (Thompson 2002; Mertes and Hall 1995).

The location, size, and facilities greatly influence the types, frequency, and intensity of activities (Giles-Corti et al. 2005). For instance, if parks and greenways have a variety of facilities such as play equipment, recreational grounds, sports fields, and commons, people will be able to get together for leisure and recreation purposes. If they are loosely designed with just esplanades or buffer strips, people may visit for sitting, strolling, or walking the dog. Urban open space is also classified into several different types of open space, and driven by scale. At the block level, play lots and pocket parks can be placed, while rights of ways and planting strips are at the street level (Girling and Kellett 2005). Meanwhile, at the neighborhood level, open space takes the form of neighborhood parks, playgrounds, drainage ways, playing fields, and greenways (Girling and Kellett 2005). Even though there is no all-embracing requirement for each type of urban space, some discussions about minimum size of area, population served, and service radius for neighborhood and community parks are found (Table 2-1).

Table 2-1. Neighborhood and Community Park Criteria

Spatial Level	Institutions		Min Area (Acres/1,000 ppl)	Population Served	Service Radius
Neighborhood	American Public Health Association	Single-family	1.5	1,000-5,000	
		Multi-family	2.0		
	National Recreation Association		1	4,000-6,000	½ mile
	Local Planning Administration		1	4,000-7,000	½ mile
	Athletic Institute		10 (for best result)		Walking Distance
	Recreation & the Town Plan		1		Walking Distance
Community	National Recreation Association		25	20,000-40,000	½ to 2 miles
	Guide for Planning Recreation Parks in California		1	5,000-25,000	1-1½ mile
	National Council on Pupils of School House (predicted construction)		Add 1 per 100 pupils	10,000-20,000	Jr. high: 1 mile Sr. high: 3 miles

Source from: American Society of Planning Officials (1965, 10 and 13)

Landscape Patterns

Landscape is an inclusive term that consists of various characteristics such as natural features, land cover, land uses, and even climate. With a narrow scope, land cover shaped by woody areas comprised of trees and grass are referred to as 'landscapes' in this study.

Finding good landscape patterns is a long-standing goal of researchers because landscape patterns—the structure of landscape including size, shape, arrangement, and distribution of individual landscape components—affect the function o and quality of the whole environment (Forman and Godron 1986; McGarigal and Marks 1995; Gustafson and Parker 1994). Particularly, it is believed that good landscape patterns enable the creation of more pleasant environments, foster a good quality of life, encourage people to spend more time outside, and protect habitats for other living creatures (Miller 1988; Dwyer et al. 1992).

No single absolute number or standard determines which landscape conditions are desirable, but several models of landscape ecology express better status. The Patch Matrix model (PM model) is the most widely accepted model to describe landscape structure, and it is frequently employed in planning and design projects (Ndubisi 2002). In the model, heterogeneity—quality and status of dissimilar or similar types of landscape—is highlighted; the higher the heterogeneity, the better the landscape (Turner 1989). The Habitat Network model focuses on sustaining interactions among species in landscape mosaics. This model operates through continued functional and locational connections of individual landscape patches, which could determine the functional flow

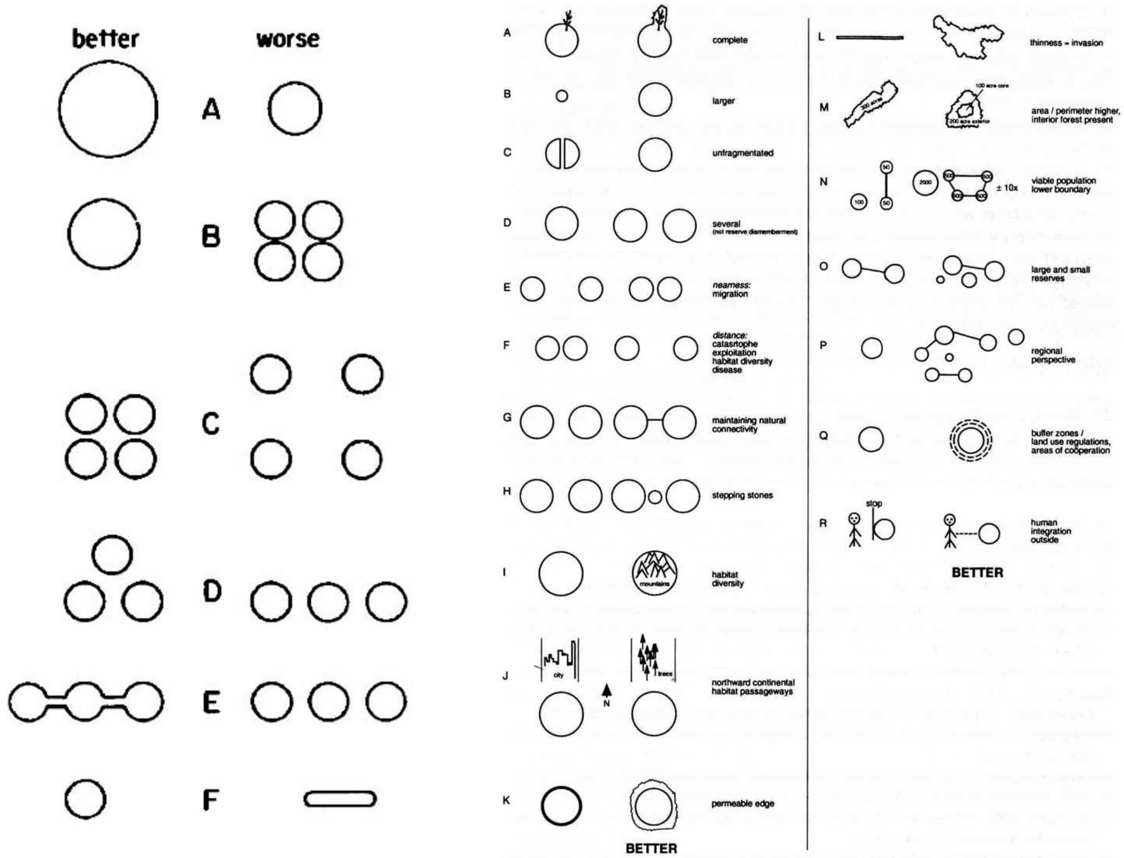


Figure 2-1. Examples of Spatial Guideline

Source from: Ndubisi (2002, 183) and Shafer (1994, 217)

and movement of materials, energy, and species (Kim 2011; Forman and Godron 1986). Enhancing interactions among landscapes is considered positive, and is a critical condition for nature preservation and land use plan (Ndubisi 2002; Botequilha Leitão and Ahern 2002). In land use planning, for example, enhancing greenway connections has received significant attention in promoting green networks. The Spatial Guideline model is developed based on landscape ecology. Its simplified and diagramed explanations have been criticized, but it is widely used as a simple tool for designing effective landscape patterns. Diamond (1975), later redefined by Shafer (1994) in greater detail, proposed geometric principles showing cases of graphic guidelines (Figure 2-1). Spatial guidelines provide a background for other disciplines that try to understand relationships between spatial patterns and human beings. Forman (1995) reorganized previous suggestions into comprehensive principles for a good landscape: 1) a few large patches, 2) wide corridors along major streams, 3) connectivity for movement, and 4) heterogeneous bits of nature through human-developed areas.

Although the underscored conditions vary depending on models, some shared notions such as larger, continuous, unfragmented, varying, and thicker landscape patches are assumed as optimal conditions.

2.4 The Impacts of Neighborhood Design

2.4.1 Influence on Well-being

Urban planning seeks to shape the physical environment that affects the human experience (Talen and Ellis 2002; Madanipour 1997). Originating from the view of environmental determinism, urban planners believe that human growth, development, and activities would be controlled by the physical environments to some extent (Alexander and Fairbridge 2006). The original idea of environmental determinism has been criticized because it ignored the complexity of society and human beings, and subsequently helped generate racism and imperialism (Peet 1985; Alexander and Fairbridge 2006). Yet, a part of environmental determinism has been still rooted in urban planning theory, which explains the associations of physical environment and human beings. Hence, in theory, urban planners insist that a "good design" enhances the quality of life (Corbusier 1967; Ellis 2010; Harries 1998; Jim and Chen 2010; Talen and Ellis 2002). The statement becomes more plausible when design factors are incorporated into explanations of outcomes with respect to social, economic, and cultural human activities.

Planners and researchers have provided supporting evidence to explain this association of neighborhood design on several domains of well-being, usually in the domains of material, physical, social, and environmental aspects. Material domains in terms of energy saving (Brownstone and Golob 2009; Echenique et al. 2012; Ewing and Rong 2008), land conservation (Ewing et al. 2003; Forsyth et al. 2007), cost efficiency (Asabere 1990; Echenique et al. 2012), and safety (Asabere 1990; Jacobs 1961), were studied well. Physical domains were observed in terms of physical activity (Lee and Moudon 2008; Frank and Engelke 2001; Lee and Moudon 2004; Handy 1996; Cohen et al. 2007), and mental health (Donovan et al. 2002; Ross et al. 2000; Kaplan 2001). Social domains frequently were concerned with social interactions, place attachment, sense of community (Southworth and Owens 1993; French et al. 2013; Talen 1999; Ewing 1997; Putnam 2001; Bramley and Power 2009; Churchman and Ginsberg 1984; Wilson and Baldassare 1996; Rogers and Sukolratanametee 2009), and privacy (Asabere 1990; Matthews and Turnbull 2007). Environmental domains mainly address the influences of design on air quality and habitat protection (Schweitzer and Zhou 2010; Newman 1999).

The direction of the impact of structural design components—a higher density, mixed-use, more connected street patterns—are controversial. The outcomes showed inconclusive results: no, positive, or negative impact. Higher density is generally considered a negative factor (Patterson 2004; Bradford 1993; Yang 2008; Frank and Engelke 2001; Donovan et al. 2002). Mixed land use has shown negative, positive, or not significant (Van Cao and Cory 1982; Geoghegan et al. 1997; Lee 2010). Street connectivity, particularly pedestrian oriented design elements, is often featured as positive (Hur et al. 2010; Matthews and Turnbull 2007; French et al. 2013; Asabere 1990; Handy 1996). In contrast to structural design, empirical studies mostly showed a positive impact for good ecological design such as being close to natural features and open spaces and having good landscape patterns (Jim and Chen 2010; Geoghegan et al. 1997; Luttik 2000; Dombrow et al. 2000; Sander et al. 2010; Hur and Morrow-Jones 2008; Lee et al. 2008).

2.4.2 Impact on Preference

The previous literature supports the idea that good neighborhood design has positive impacts on human well-being in several specific domains. Neighborhood satisfaction has also been studied to measure the overall well-being or quality of life in terms of revealed and stated preferences (Yang 2008). The stated preference approach mostly relies on surveys asking for evaluations of the neighborhood, while revealed preference approaches often look at market prices paid for properties in neighborhood design related studies. The outcomes from stated and revealed preferences do not always coincide with each other. Different outcomes from different studies maybe a result of diverse conditions among the study cases, data, measuring methods, the unit of analysis, and the variety of models researchers used on their studies. Or, this discrepancy may be occurred as the evaluation of current residents is different from future residents who purchase homes in new neighborhoods. Otherwise, the reported behaviors or intentions may not result in the actions that residents take.

2.4.2.1 Stated Preferences

A rating of perceived neighborhood satisfaction is one of the typical measures of a stated preference. Similar to other neighborhood designs and their impact related studies, the direction of preferences are inconclusive (Table 2-2).

Structural Design Components

Density is the most controversial issue between theory and practice. An inverse relationship between population size (high-density) and neighborhood satisfaction was often observed in empirical research. Between 1996 and 2006 in Dublin UK., Howley et al. (2009) surveyed randomly-chosen people who lived in various apartment complexes. The neighborhoods were defined by an average trip time of 15 to 20 minutes walking-distance to their place of work, or a 5 to 10 minute drive from their home. The study showed that density itself did not discourage neighborhood satisfaction. Rather, they discovered other issues mattered, such as lack of environmental quality, community involvement, services, facilities, or too much noise. Bramley and Power (2009) studied the impacts of the density of dwellings, mixture of housing types, and the density of cars on residents’ satisfaction. They used data from 20,000 households based on the Survey of English Housing from 1993 and 1994. They reported that compact forms tended to exacerbate neighborhood problems and decrease satisfaction. Yet, pedestrian-friendly features were generally seen as positive conditions. Lee (2010) found that high-density development was expressed as negative characteristics, but greater mixed-use and street connectivity had positive impacts on neighborhood satisfaction in the Seattle and Baltimore regions. Buys and Miller (2012) found a positive impact of walkability on neighborhood satisfaction in Brisbane, Australia. Patterson (2004) examined the relationships between pedestrian-friendly urban form and neighborhood satisfaction in Portland, Oregon. He created the new urbanism index to measure pedestrian-friendly urban form, and a quality of life index to measure neighborhood satisfaction. The model partially explained a positive relationship between new urbanism features and neighborhood satisfaction: distance to a grocery store, number of services within one mile from home, and the number of services accessible by walking and driving. Occasionally, mixed results have also been reported within the same study. Yang (2008) investigated the impacts of housing density, land use mix, variety of housing types, and street connectivity on neighborhood satisfaction. He compared two different metropolitan areas, Charlotte, North Carolina, and Portland, Oregon, but failed to obtain the same outcome from these areas.

Across these previous studies, structural design features have shown negative or positive effects on neighborhood satisfaction depending on the direction of design principles. High density was mostly blamed for lower satisfaction. Mixed land uses, street connectivity, and pedestrian access, however, often showed positive influences. As stated by Yang (2008), these results are sometimes associated with adverse social and economic issues in a given area, not the neighborhood design itself. Neighborhoods in or near a city center typically have a higher density and mixed land uses compared to neighborhoods in the suburbs. Social and economic problems are likely to be concentrated in urban cores. Hence, compact and mixed-use urban form settings would show more positive effects in new- or re-developments which are relatively free from social ills.

Ecological Design Components

The importance of contact with nature, open spaces, and landscapes has shown consistent and positive associations with neighborhood satisfaction ratings.

Kaplan (2001) reported a positive impact of views of nature and landscapes from homes on neighborhood satisfaction in Ann Arbor, Michigan. Sirgy and Cornwell (2002) surveyed 380 residents of western Virginia and revealed the positive role of landscapes in overall feelings toward life. Morrow-Jones et al. (2004) asked 1,257 residents in Franklin County to choose preferred neighborhood conditions. People preferred having parks, local agricultural land, and preserved cropland in their neighborhoods. Kearney (2006) mailed surveys to residents in master planned communities in Seattle and found that density and proximity to shared nature areas such as nature preserves, ponds, lakes, and trails did not have a significant impact on neighborhood satisfaction, but having views of nature from the home was critical and positive. Sugiyama et al. (2009) surveyed people aged 65 years or older in the U.K. and proposed that the distance (over and within a 10 minute walk) to neighborhood open spaces was relevant to the satisfaction of the older residents.

Lee et al. (2008) examined the association between neighborhood satisfaction and landscape structure in College Station, Texas. They found that larger patch size, less fragmentation, more connection, and irregular shapes were likely to be related to overall neighborhood satisfaction regardless of the size of the neighborhood, however, specific measures showed slightly different results by scale of neighborhoods. For example, patch density was not significant in decreasing neighborhood satisfaction in micro-scale neighborhoods, while critical in intermediate and macro-scale neighborhoods. Hur et al. (2010) examined the impact of actual and perceived naturalness and openness on satisfaction in Franklin County, Ohio. They found that physical and perceived vegetation directly contributed to promoting satisfaction. De Jong et al. (2012) also found a positive association between subjectively measured green neighborhood qualities and neighborhood satisfaction through survey data from suburban and rural Scania, Sweden.

2.4.2.2 Revealed Preferences

Examining how much consumers are willing to pay for their homes is one of the powerful ways to determine the quality of goods and services. Housing premiums, one of the measures of revealed preferences, is mostly used to analyze the influences of neighborhood designs on neighborhood satisfaction. Similar to stated preference studies, mutually inconsistent results were found in previous studies (Table 2-3).

Structural Design Components

Several previous studies revealed that a higher density, mixed land use, and greater street connections could create aggregated or discounted housing premiums.

Geoghegan et al. (1997) stated that high density was undesirable in micro-scale neighborhoods, which were defined as a 0.1-kilometer radius buffer from a parcel, and Song and Knaap (2003) supported the same idea by examining census block groups in Portland. Yet, Tu and Eppli (1999) argued high density is a favorable condition. They found that greater mixed land uses increased the housing price. Song and Knaap (2003) stated that people were less willing to pay premiums for houses where various kinds of land uses and housing types were located within the neighborhood. The follow-up work specified the measures of mixed land use and disagreed with conclusion of previous research. The reported that a mix of certain types of land uses (e.g., nearby commercial or public parks) could have a positive impact by increasing housing values (Song and Knaap 2004a). Jones et al. (2009) studied development viability developing two models, house price model and construction model in three English cities (Leicester, Oxford, and Sheffield) and two Scottish cities (Glasgow and Edinburgh). In four cities, with the exception of Oxford, the house price model revealed that housing price was likely to be higher when the number of single-family detached homes increased. Not surprisingly, having a higher percentage of rental homes decreased the housing price, but the effect was different in each city; the impact was much smaller in Sheffield. Tu and Eppli (1999) compared housing prices of homes in Kentland—which was developed with new urbanism concepts, particularly traditional neighborhood development—and nearby traditional subdivisions in Montgomery, Maryland. They found that homeowners were willing to pay premiums for houses in a neighborhood with new urbanist design features. Asabere (1990) argued that cul-de-sacs increased housing values. On the contrary, Matthews and Turnbull (2007) said that pedestrian-oriented neighborhoods and more gridiron-like street patterns were driving factors for increased house values. Meanwhile, in auto-oriented developments, a more gridiron-like street pattern reduced housing value.

Ecological Design Components

Beyond investigating the impacts of structural design principles on neighborhoods, ecological design components can also explain an increase or decrease in housing prices.

Geoghegan et al. (1997) found that the ratio of parks had a positive impact within neighborhoods defined by a 0.1-kilometer radius buffer, while there was a negative impact in a 1.0-kilometer radius buffer neighborhood. Dehring and Dunse (2006) revealed that the proximity to parks increased the prices of flats in Aberdeen, Scotland; the lower density of the surrounding urban development, however, reduced the effects of being near parks. Jim and Chen (2010) compared differences between transaction prices of high-rise residential buildings 800 meters inside and outside of neighborhood parks. Being close to a park had a positive impact on housing values. Luttik (2000) examined the contributions of ecological design factors such as water features, green strips, parks, open spaces, and pleasant views on house premiums in the Netherlands. Those specific ecological components produced an increase in housing prices. Song and Knaap (2003) found that a mountain view increased the housing price in Portland, Oregon. Hui et al. (2007) concluded that neighborhood parks and scenic views (e.g., harbors, mountains, or lakes) increased the transaction prices of high-rise residences in compact areas compared to low density areas in Hong Kong. Geoghegan et al. (1997) reported that high fragmentation (the extent of human changes on the landscape) within a neighborhood defined by a one-kilometer radius reduced housing prices. Dombrow et al. (2000) and Sander et al. (2010) reported that the presence of mature trees in urban tree cover had positive effects on the average home sales price. Maco and McPherson (2003) demonstrated that a public street tree population would generate almost 1.2 million dollars in net annual environmental values and benefit housing values. Mansfield et al. (2005) reported that the distance to an institutional or private forest and the proportion of trees on a parcel or in the neighborhood contributed to increased housing premiums.

Several researchers claimed a positive influence when neighborhood employed “good” ecological design components, The presence of or closeness to nature (e.g., water features, mountains, or a scenic view) and open spaces (e.g., parks, greenways, or trails) and having good—larger, unfragmented, scattered, or complex shape—landscape patterns (e.g., tree cover, tree canopy, or a forest/woody area) contribute to increasing housing values. While some reported positive impacts, other reported negative or inconclusive findings due to other outlying conditions. Even with better ecological design components, trade-offs between neighborhood designs components exist.

Table 2-2. The Impacts of Neighborhood Designs on Stated Preferences (Neighborhood Satisfaction Survey)

Structural Design			Ecological Design			Study Area	Unit of Data Collection	Author(s)
High Density	High Mixed-use	High Connectedness	Closer Nature	Closer/More Open Space	Better Landscape			
-						60 Metropolitan Areas, US	Metropolitan Area	Lee, B. A. and A. M. Guest (1983)
			+		+	Ann Arbor, MI	Apartment Community	Kaplan, R. (2001)
					+	VA	Individual	Sirgy, M. J. and T. Cornwell (2002)
-				+		Franklin County, OH	Perceived Neighborhood	Morrow-Jones, H. A., et al. (2004)
		+				Portland, OR	Census Tract	Patterson, P. (2004)
			+ (scenic view)			Seattle, WA	Subdivision	Kearney, A. R. (2006)
					+	College Station, TX	750ft / 1,500ft / 3,000ft Buffer	Lee, S.-W., et al. (2008)
- (tract)	+ (Charlotte)					Charlotte, NC & Portland, OR	Block (or Block Group) / Tract	Yang, Y. (2008)
-	+					U.K.	Individual	Bramley, G. and S. Power (2009)
			+			Dublin's Central City, UK	15-20 min. Walking / 5-10 min. Driving Buffer	Howley, P., et al. (2009)
				+		U.K.	Individual 65+	Sugiyama, T., et al. (2009)
-				+	+	Franklin County, OH	A-quarter-mile Buffer	Hur, M., et al. (2010)
-	+	+				Seattle, WA & Baltimore-Washington DC	Groups of Block Groups	Lee, S. M. (2010)
		+				Brisbane, Australia	Urban Higher Density Precincts	Buys, L. and E. Miller (2012)
			+	+	+	Malmö, Helsingborg, Lund & Kristianstad, Sweden	Individual	de Jong, K., et al. (2012)

+ refers to an increase of neighborhood satisfaction

Table 2-3. The Impacts of Neighborhood Designs on Revealed Preferences (Housing Premium)

Structural Design			Ecological Design					
High Density	High Mixed-use	High Connectedness	Closer Nature	Closer/More Open Space	Better Landscape	Study Area	Unit of Data Collection	Author(s)
	+					City of Tucson, AZ	Census Tract	Van Cao, T. and D. C. Cory (1982)
		-				Halifax, Canada	Neighborhood	Asabere, P. K. (1990)
-	-		+	+ (0.1km) - (1km)	+	Washington, DC	0.1 /1.0km	Geoghegan, J., et al. (1997)
+	+	+				Montgomery County, MA	Subdivision	Tu, C. C. and M. J. Eppli (1999)
					+	Baton Rouge, LA	Parcel	Dombrow, J., et al. (2000)
			+	+		Apeldoorn, Netherlands	Parcel	Luttik, J. (2000)
-	-	+	+ (scenic view)			Washington County, PO	Census Block Group	Song, Y. and G. J. Knaap (2003)
		+		+		Washington County, PO	Traffic Analysis Zone	Song, Y. and G. J. Knaap (2004a)
				+	+	North Carolina	Parcel	Mansfield, C., et al. (2005)
-				+		Aberdeen, Scotland	Parcel	Dehring, C. and N. Dunse (2006)
		+ (pedestrian) - (automobile)				King County, WA	Census Tract	Matthews, J. W. and G. K. Turnbull (2007)
			+ (scenic view)			Kowloon, Hong Kong	House	Hui, E., et al. (2007)
	+/- (by cities)					Edinburgh, Glasgow, Sheffield, Leicester, Oxford, UK	The Relevant Local Authority Area	Jones, C., et al. (2009)
			- (mountain view) + (harvor view)	+		Quarry Bay District, Hong Kong	Private Residential Developments	Jim, C. and W. Y. Chen (2010)
					+	Dakota and Ramsey Counties, MN	Neighborhood	Sander, H., et al. (2010)
					+	Davis, CA	Segmented Zone	Maco, S. E. and E. G. McPherson (2003)

+ refers to an increase of neighborhood satisfaction

2.5 Other Indicators Determining Neighborhood Quality

Previous literature introduced and examined various qualities of neighborhoods in addition to neighborhood designs. As shown in Table 2-4, researchers in planning often detail a level of adequacy (e.g., lack of maintenance or facilities) and thread of livability (e.g., trash, traffic, or noise). Sociology or socio-ecology frequently highlights a neighborhood's socio (e.g., race, education, tenure, or social network) and economic status (e.g., poverty rate income, housing values, or school quality).

In planning related studies, several physical conditions were examined. Lansing and Marans (1969) surveyed planners and residents about the physical settings of neighborhoods that determined the quality of a neighborhood. Planners mentioned that the physical condition of structures was the most important factor, while residents indicated level of maintenance. Grether and Mieszkowski (1974) reported that housing adequacy and structure were critical features to real estate values. Marans (1979) evaluated the conditions and services of neighborhoods to determine neighborhood quality in 60 metropolitan areas. He found that "bothersome conditions associated with a desire to move were crime, traffic, noise, industrial activities, abandoned and rundown housing, and odor and smoke" (p. 27). Connerly and Marans (1985) emphasized the great contribution of close social interactions in increasing neighborhood quality. Meanwhile, they also underscored objective neighborhood physical conditions such as the adequacy of streets, schools, police relations, recreation places, and accessibility to shopping. Hite et al. (2001) showed that being near open landfills reduced housing prices, while closed landfills did not. Weiss et al. (2011) found that disamenities such as poor traffic safety, pollution, and noxious land uses (e.g., a power plant, or landfill) lessened the benefits from parks. Paquin (2007) said that city renters considered a low vacancy rate as one of the important characteristics of better neighborhoods. He also stated that a high vacancy rate indicated that a neighborhood is suffering from financial and population loss, and has safety and crime issues.

The socio-economic status of individuals and neighborhoods as a whole was frequently used to express concentrations of various disadvantages, particularly regarding the impoverished and in children. Bartik et al. (1992) mentioned that good schools and safety allowed residents to continue their occupancy. Thus, the quality of schools was often expressed by student test scores, the turnover rate, and dropout rates were employed (Hayes and Taylor 1996). Greenberg (1999) also mentioned that crime or vandalism and school quality were determinants of neighborhood quality. Ellen and Turner (1997) reviewed the literature for the impacts of neighborhoods' socio-economic conditions on families and children. The importance of friends, socialization of residents, and social networks were highlighted across empirical research as well as quality of local services, crime and violence, and physical isolation. Newman and Schnare (1997) adopted several items to evaluate the success of housing programs used to neighborhood quality. Racial or ethnic composition and poverty rates were factors that determined the success or failure of housing programs in the U.S. Ricketts and Sawhill (1988) described disadvantaged neighborhoods as those with high-school dropouts, inconsistently employed prime working-age males, welfare recipients, and female heads of families. Van Zandt and Rohe (2006, 496) used several items such as "the proportion of femaleheaded families, median family income indexed to county median, proportion of persons living below the poverty line, homeownership rates, unemployment rates, median housing values indexed to the county median, and proportion of vacant housing units to describe disadvantaged neighborhoods."

Table 2-4. Determinants of Neighborhood Quality

Physical Conditions	Socio-Economic Conditions
• Housing Adequacy (e.g., lot size, building area, age, number of rooms, other equipment, yard) • Architectural Characteristics (e.g., style, front porch and/or balcony, garage on façade) • Deterioration / Maintenance • Presence of Unwanted Land Use (e.g., landfill, power plant, industrial activities) • Traffic • Noise, Odor, Smoke, Litter • Vacancy / Abandonment	• Age • Gender • Race / Ethnicity • Educational Attainment • Marital Status of Household Head • Presence of Children • Duration of Residence • Household Poverty Rate (e.g., welfare recipients, female heads, full or part-time job status) • Household Income (e.g., income, monthly rent) • Property Values • Relationships with Neighbors • School Quality (e.g., SAT score, student-teacher ratio, school drop-out rates) • Safety (e.g., crime, presence of police precincts)

2.6 Research Gap

The previous literature acknowledges the definition of neighborhoods, neighborhood design components, and impacts of neighborhood designs on residents' preferences with a range of perspectives. Yet, there are some points not thoroughly discussed in previous studies.

2.6.1 Neighborhood as a Single-level Unit

One weakness of previous studies is that they consider neighborhoods as single-level units. However, planning theorists and practicing planners highlight the contextual influence of neighborhoods. This occurs because the influences of neighborhoods cannot be limited within the designated borders of a certain neighborhood scale. The influence of contexts that act like a backdrop to neighborhoods cannot be ignored, although contexts may have less direct impact than do neighborhoods themselves. There have been few attempts to compare the impacts of neighborhood designs on different size of neighborhoods, but they failed to consider interactional relationships between them. Some studies have explored the contextual influence of neighborhoods in different spatial scales. Shin et al. (2011) observed the housing premium with houses and subdivisions. Subdivisions play as contexts of nested houses. This study, however, has limited the unit of analysis to houses and hosting subdivisions, without the consideration of different scales of neighborhoods. Another researcher, Yang (2008) showed some meaningful observations with two levels of neighborhoods—a group of households or parcels (blocks) and a neighborhood (census tracts)—on neighborhood satisfaction. This research was inspired by the richness of the two-level neighborhood approach, but found the theoretical basis for the two-level approach was lacking. In empirical studies, officially recognized geography has been used to represent neighborhoods for operation purposes such as census units, planned neighborhoods, planning districts, zip codes, subdivisions, and buffer neighborhoods drawn by Euclidean or network distance—usually a quarter-mile, a half-mile, and one-mile—around individual parcels. Even though the term neighborhood embraces all kinds of different geography, sometimes they remain small enough to maintain a shared identity, while are large enough to recruit people and services. In this sense, measures should match with appropriate theoretical and operational definitions of neighborhoods. For instance, measuring land use mix of commercial or business uses in blocks, and observing specific street shapes (i.e., cul-de-sacs or grid patterns) at the macro-neighborhood level are unlikely to produce meaningful results. Those specific design components are rarely implemented if the blocks are not located in an urban center. Matching the neighborhood level with the design features based on theory minimizes conceptual contamination and provides a better understanding of the impacts of the surrounding environments. Further, the specific interactional relationships between neighborhoods and contexts were not specified.

In summary, the spontaneous consideration of context is essential to understand the impacts of neighborhood design on residents' preferences because a neighborhood is not a single-level phenomenon. The theoretical definitions of neighborhood and contexts are critical to find well-suited design components.

2.6.2 Neighborhood Design Components

It is well known that both structural and ecological design components are associated with the quality of lives of residents. The impact of structural factors (i.e., density, land use, and the formation of blocks and streets) show inconclusive signs, but ecological design elements (i.e., natural features, open spaces, and landscape patterns) generally have a positive association with neighborhood satisfaction. Due to its importance and the substantial amount of research, ecological design has grown as a separate research branch beyond urban design issues (i.e., environmental planning, ecological planning, or landscape ecology). Yet, previous literature hardly compares the extent to which structural and ecological designs compete or augment each other. In addition, as shown in the study of Geoghegan et al. (1997), the impacts of each design component can vary considerably by scales of units of analysis. Thus, observing the magnitude of impacts of structural and ecological designs in different scales of neighborhoods is an important contribution of the present research when considering different scales of neighborhoods spontaneously.

2.6.3 Housing Price

Planning theory, practice, and research highlight the role of neighborhood design on several domains of people's lives. Further, examining the influences on overall preferences or satisfaction about neighborhoods is another critical interest. The housing value of single-family housing is the most frequently used non-survey based proxy for measuring neighborhood satisfaction. Housing price is useful as it can show the willingness of people to hold or add capital investments in the neighborhood (Song and Knaap 2003; Tu and Eppli 1999). Explaining the impacts of neighborhoods in dollar terms, however, may be less meaningful when planners want to directly adopt the results of empirical studies into policies. Even though the total or averaged values of all properties in a neighborhood reflect the willingness to own capital resources in the neighborhood, increased or decreased housing prices of some sold properties hardly affect the lives of others still living in the same neighborhood. Until the property is sold, the increased value of the property is not available to residents and thereby has a limited effect on them. In addition, homebuyers decide how much they are willing to pay for the expected neighborhood quality. Considering the fact that homebuyers are new to the neighborhood, housing price limits to reflect the evaluation about neighborhoods of existing residents and invisible neighborhood assets.

Moreover, from an analytical perspective, housing premium does not seem an appropriate medium when the unit of analysis is a neighborhood. The average or median value of all sold houses in one neighborhood can present the dollar value of a neighborhood, but this only expresses a numerical value. It is obvious that a neighborhood as a whole does not have a sales price. To control the structural condition of each house in the neighborhood, we also need to use average or median housing structure. However, this aggregation induces the loss of critical information. Hence, better measures that are more connected to the lives of residents than housing prices need to be developed.

CHAPTER III

THEORY DEVELOPMENT

3.1 Introduction

To overcome the gaps discussed—1) the limitation of treating a neighborhood as a single-level, 2) the unclear roles of structural and ecological designs in different scales of neighborhoods, and 3) the weakness of using a housing price as a proxy of neighborhood satisfaction—creating a theoretical foundation is necessary to develop a research framework. Three major research constructs were posited to help detail different ways to observe the associations between neighborhood designs and neighborhood satisfaction. First, the importance of **contextual influence** that can be theoretically supported by the idea through neighborhood hierarchy is presented. Second, an **integrated understanding of structural and ecological** design components are presented. Finally, the meaning and use of **neighborhood turnover** are explored an alternative proxy of neighborhood satisfaction. Theoretical arguments can help construct the research design.

3.2 Context Sensitive Design

For a neighborhood to be a truly self-contained community, it would have to be completely isolated, perhaps on an inaccessible island or a bubble neighborhood on the moon. So to the extent that neighborhoods are not self-contained, contexts are important in the real world. Planners and designers in practice recognize without difficulty that they are more likely to achieve desired outcomes by understanding interactions between neighborhoods and their contexts. Similar projects and interventions are likely to produce various outcomes, perhaps even considerably, under dissimilar contexts. Contexts often supplement incomplete neighborhoods, but an incomplete context cannot cause a positive influence on a neighborhood. Therefore, an actual design process usually begins with the analysis of both the general and specific contextual conditions. On the contrary, empirical studies rarely considered the interactions with context, although the researchers recognized the activities and influences are free from existing boundaries of neighborhoods. If we ignore the importance of interactional relationships between neighborhoods and contexts in empirical studies, we will miss the opportunity to develop a well-directed set of design guidelines.

Yet, the question remains, how can we define neighborhoods and contexts? Simply saying, contexts are larger areas including several neighborhoods. For the operation purpose, we could think of various ways to characterize the neighborhoods and contexts. They are often defined by the proximity (e.g., a quarter-, half-, full mile, or up to two mile buffer) from a house. Yet, as a context is not just a specific range but one type of a neighborhood, contexts made by buffers do not neatly match the unique definition of neighborhood, which is a geographically defined place. Thus, a context is hardly defined and even less so by a specific radius and should have a specific meaning.

Classifying neighborhoods into multiple hierarchies could help create the criteria for choosing neighborhoods and contexts for this research. A neighborhood placed into a higher hierarchy could be a context for a chosen neighborhood. The four recognizably and functionally different possible levels of neighborhoods—face-blocks, residential neighborhoods, institutional neighborhoods, and communities—suggested by Park and Rogers (2014) can be one possible option. They defined four scales of neighborhoods by main land use, size (population and area), core facilities, boundaries, and the level of homogeneity of socio-economic status. For example, residential neighborhoods can be contexts of face-blocks and institutional neighborhoods of residential neighborhoods.

Face-block neighborhoods refer to housing clusters in a square block or street segment. They are effective units for observing a social relationship because of their relatively small size. ***Residential neighborhood***s refer to neighborhoods that have a homogeneous character in terms of design, demography, and socio-economic status. It is big enough to have one or two small retail stores or core facilities such as a nursery, an elementary school, or community center. Extensive land use mix in residential neighborhoods approaches the near-zero limit. A typical residential neighborhood can have 500 to 5,000 people or as little as 15, and up to 500 acres of land. ***Institutional neighborhood***s are the largest planning units that can be called "neighborhoods," which introduce several services and functions. In general, their boundaries are recognizable, but are more modest than residential neighborhoods. Institutional neighborhoods contain several residential neighborhoods along with other types of land uses. Observing micro-scale design elements regarding architectural characteristics, street patterns for pedestrian circulation, or landscape patterning is not appropriate at this level. These neighborhoods are the starting point where the public planning sector can get involved with land use, transportation, economic development, open spaces, social services, commercial revitalization, or environmental issues. Theory and planning advocates 5,000 to 10,000 people with approximately 1,000 acres of land. The ***community*** is a group of townships, or a portion of a city with the loosest identity. The community usually provides services such as police, fire protection, or infrastructure that clearly spills over into the lower levels of neighborhoods, but are led and operated by the community or city as a whole. Community planning or city planning also takes place at this level. Land use, housing, transportation, community facilities, critical or sensitive area plans, or natural hazards are typically the major concerns. An institutional neighborhood and community are the contexts of residential neighborhoods. The community is a contextual area of institutional neighborhoods.

As suggested, a neighborhood is a complex set of interwoven functions and relationships which provide the richness that has come to be known as neighborhoods. Like real planning projects, scholarly research should consider the associations of neighborhoods and contexts simultaneously to draw better results. The hierarchy of neighborhood concept would guide the decisions of researchers to find the most appropriate size and characteristics that fit with their conceptual and operational definitions of neighborhoods.

3.3 Structural vs. Ecological Design

Presumably, one of the ultimate goals of planning is to discover better sets of design guidelines that successfully contribute to enhancing the quality of life. Yet, current planning theory has diverged into two main streams depending on what kind of environment the theory highlights. These dichotomous separations are also reflected on empirical research.

On one hand, new urbanism—an umbrella term that encompasses traditional neighborhood development (TND), the urban village model, transit orientation development (TOD), or a sustainable urban matrix (SUM)—advocates design-based strategies stemming from traditional urban forms. These strategies help decrease suburban sprawl and inner city decline through building or remodeling neighborhoods. It emphasizes structural design components such as adequate density to reduce energy consumption, create a sufficient mix of housing types and land uses for diversity, and promote adequate street connectivity for walking or biking (Nasar 2003; Katz 1994; Talen 1999). Ecological designs, on the other hand, are embraced by several different terms such as landscape ecology, green urbanism, sustainable design, or environment planning. They highlight a greenly responsible and environmentally friendly incorporation with natural features to create an appealing and pleasant place for human beings and other creatures (Walmsley 1995; Jabareen 2006; Ulrich et al. 1991). Due to its importance, ecological design has grown into its own research branch.

However, striking a good balance between structural and ecological designs is critical because neither can account for neighborhood satisfaction on its own. Therefore, design guidelines need to integrate both structural and ecological design elements that are aesthetically and functionally complementary. Yet, when we look at them by comparisons, we can understand their unique roles and sense in a neighborhood. Possibly, the impacts of structural design components vary, while ecological components are more important at the micro-level because residents have direct and frequent contacts are critical. Several previous studies support these ideas. Usually, the impacts of structural design components have been measured by a range of ways and their impacts vary by study areas or size and characteristics of neighborhoods. Meanwhile, the visual access and closeness to ecological design components, especially to natural features and open space, have been mostly tested by researchers who reported positive effects. Particularly, the work done by Geoghegan et al. (1997) gives an inspiration that each design domain could have different roles depending on spatial scales. They found that larger parks have positive impacts on neighborhood satisfaction in small areas, while negative in larger areas. Thus, examining the independent responsibilities of each design domain in different neighborhood scale is necessary for a better understanding of the impacts of neighborhood design.

3.4 Neighborhood Turnover

Neighborhood turnover usually tracks the number of people who move in and out of communities (Fitchen 1994). It includes migration of both homeowners and renters, but is often operationalized in terms of the frequency of property turnover for owner-occupied housing (Molotch 1969). This approach is usually justified because home owners are likely to purchase home in areas that they are satisfied with conditions of houses and a neighborhood (Galster and Hesser 1981; Boehm 1982; Butler et al. 1969). In this sense, neighborhood turnover is a reflection of neighborhood satisfaction as residents are likely to make longer-term connections when they are satisfied with the neighborhood's environment. Less neighborhood turnover implies satisfaction.

Neighborhood turnover is also a direct indicator of neighborhood stability. There are two ends of neighborhood stability: a cohesive perspective and a social isolation perspective. From a cohesiveness perspective, neighborhood stability is good (Ross et al. 2000). The more stable neighborhoods were reported to have the roots to bond social capital such as social cohesion, place attachment, or social control formed by intimate relationships (Aneshensel and Sucoff 1996; Drukker et al. 2005; Schieman 2005). To make emotional and social connections and develop a sense of belonging, residents need to spend sufficient time in their neighborhood (Fleury-Bahi et al. 2008). A short residency is likely to weaken social and emotional connections and often breaks down social controls (Ross et al. 2000; Brown et al. 2003). Neighborhood stability is regarded as particularly important in disadvantaged areas where social pathologies tend to be concentrated due to its mediating role in social ills. Fitchen (1994) said a higher turnover had negative impacts on school systems and social programs because of frequent disruptions. The study done by Sampson et al. (1997) in Chicago showed that collective efficacy formed by longer residency lessened violence.

From a social isolation perspective, stable neighborhoods are seen as disadvantaged neighborhoods full of residents who do not afford to move, particularly residents in poor urban neighborhoods. These residents are more likely to be isolated from the mainstream of society and create more problems (Ross et al. 2000). In this case, the informal social ties may not be powerful enough to reduce the various pathologies (Pattillo 1998). Ross et al. (2000) found that a lower neighborhood turnover reduced distress in affluent neighborhoods, while the opposite results were found in poor neighborhoods. This indicates that the power of social capital appears different according to the ethnic composition as well as socio-economic status of a neighborhood. Schieman (2005) found a disadvantaged neighborhood was positively affected by donated and accepted support among black women, while supports from neighbors were negatively associated with white men.

A series of studies reveal that neighborhood turnover can be a good indicator of neighborhood satisfaction and stability; both of which are ends goals of neighborhood planning. One question remains. Are more shifts in neighborhoods good? The answer is "no." Lower neighborhood turnover mostly represents higher satisfaction, and has a positive effect on residents' because of the increased social capital. The outcome is only different in the especially economically deprived neighborhoods or in very specific ethnic groups.

CHAPTER IV

RESEARCH DESIGN

4.1 Introduction

In this chapter, **research questions**, a **conceptual framework**, and **hypotheses** are presented. Research **settings** and **methods** such as study area, time period, units of analysis, analytical methods, sample size, measurements, data, and variable selection follow.

4.2 Conceptual Framework

4.2.1. Research Question

Planners who are involved in neighborhood design should understand the roles of neighborhoods and contexts as well as structural and ecological design components for better neighborhood satisfaction. Thus, the fundamental premise of this research is that the designs of neighborhoods and contexts are linked independently and simultaneously to neighborhood satisfaction reflected on neighborhood turnover rate. This study particularly asks whether:

- *neighborhood designs alone influence neighborhood satisfaction;*
- *context designs alone influence neighborhood satisfaction;*
- *designs of neighborhoods and contexts simultaneously impact neighborhood satisfaction;and*
- *structural or ecological designs have different roles in neighborhoods and contexts.*

4.2.2 Conceptual Framework

To answer these research questions, this research examined the impacts of structural and ecological design features in two spatial levels, neighborhoods and contexts, on neighborhood turnover. The conceptual framework for this research is shown in Figure 4-1.

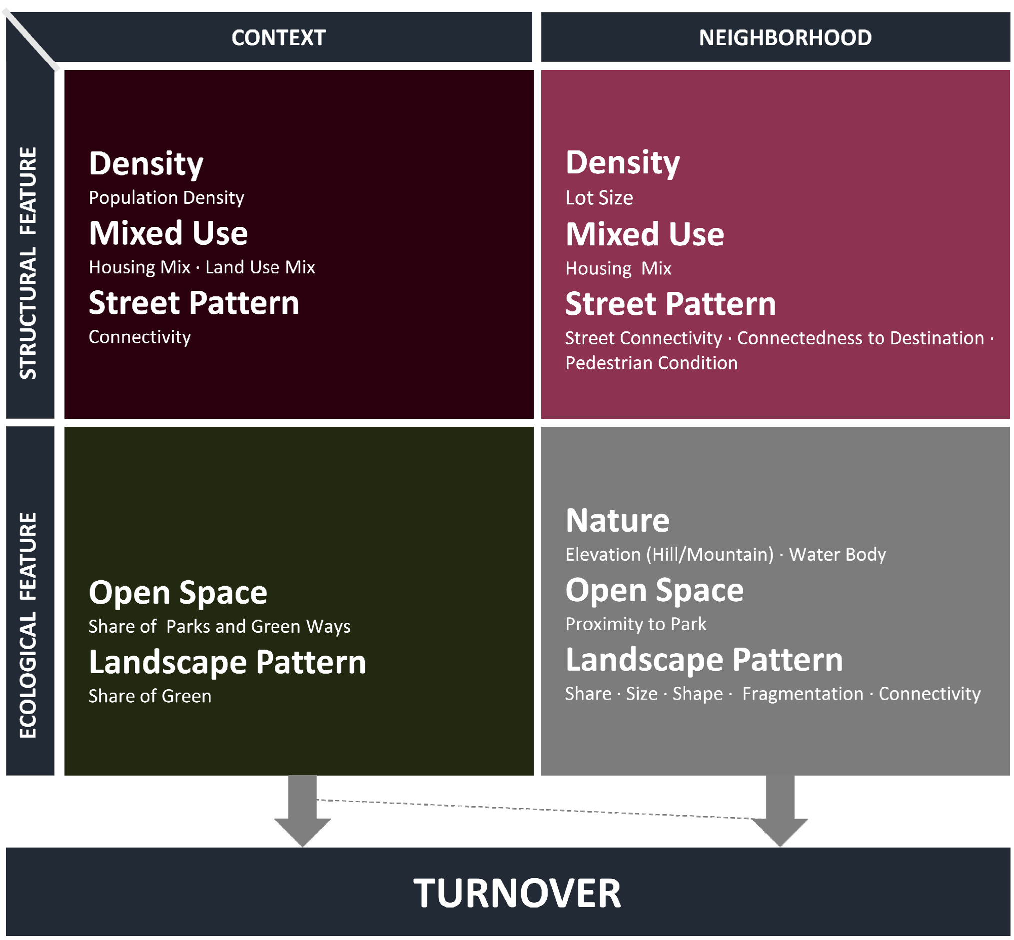


Figure 4-1. Conceptual Framework

4.3 Hypotheses

The four main hypotheses tested in this study are developed as (Figure 4-2):

Hypothesis 1. Neighborhood design alone has an influence on neighborhood turnover.

People are willing to own their houses longer in a neighborhood with positive conditions (Rohe and Stewart 1996; Galster 1987; Rohe et al. 2002; Rohe and Stegman 1994; Lam 1985; Haurin et al. 2005). If a neighborhood is perceived to have a desirable design and to provide a positive living experience, homeowners tend to retain their ownership in the neighborhood or to make longer-term connections, resulting in a lower neighborhood turnover rate. The reverse happens in opposite circumstances. Neighborhood dissatisfaction is likely to increase neighborhood turnover.

Hypothesis 2. Context design alone has an impact on neighborhood turnover.

When people make staying or moving decisions, they consider what would be the best contextual surroundings such as closeness to work, access to major services, or good schools (Yun et al. 2012). If a neighborhood is perceived to have a desirable context design, people will be less likely to move away. In short, context design determines whether or not people invest in and become a part of a neighborhood.

Hypothesis 3. Context design influences the relationships between the neighborhood design and its turnover.

The influences of neighborhood and context designs are not confined within a delineated boundary (Galster et al. 2001; Goodman 1977; Martin 2003). The conditions of contexts mediate or augment the impact of neighborhood designs reflected in owner alterations. For instance, in a neighborhood with desirable design within a poorly designed context, the association between neighborhood design and neighborhood turnover is expected to become weaker. In other words, the turnover rate in a neighborhood may increase. Conversely, a well-designed neighborhood nested in a well-designed context would be expected to have a lower turnover.

Hypothesis 4. Ecological features are the most influential factors in neighborhoods, while structural features are the most important factors in contexts.

Previous literature draws upon the impacts of structural and ecological design components, but does not compare the extent to which each balances, augments, or interacts in their impacts on neighborhood turnover. The relative importance of structural and ecological design components may vary depending on the scales of neighborhoods. Ecological design components such as natural features, open spaces, and landscaping may be more beneficial when they are visible within immediate surroundings or residents can have more frequent contacts with them. The contribution of ecological design become meaningful when associated with creating tranquil and pleasant residential environments. On the other hand, close to amenities, services, and facilities (e.g., jobs, schools, hospitals, or shopping centers) from contexts are essential to ease daily lives, while ecological design components in contexts has less influences because they are not visible and residents have fewer contacts with them.

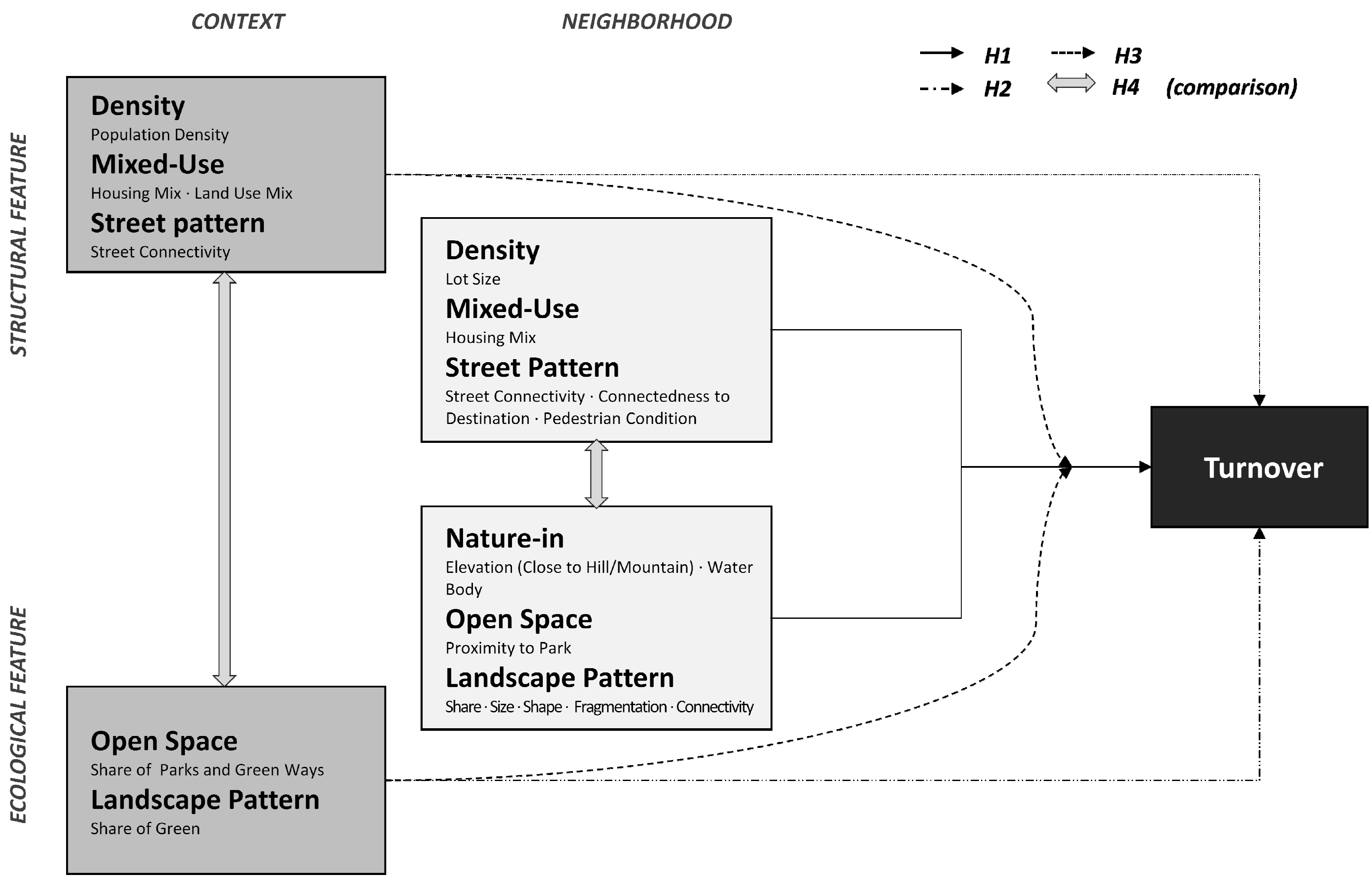


Figure 4-2. Tested Hypotheses

4.4 Settings

4.4.1 Study Area

The study area is a part of the city of Austin in Travis County, Texas, which comprises 94.9 percent of Austin. Austin encompasses 297.9 square miles and includes parts of Williams and Hays Counties and the whole of Travis County (Figure 4-3). In 2010, Austin was the eleventh most populous city and one of the fastest growing cities in the U.S. in terms of economic and population growth (Fisher 2012; Christie 2007). According to the U.S. Bureau of Census in 2010, Austin's population increased from

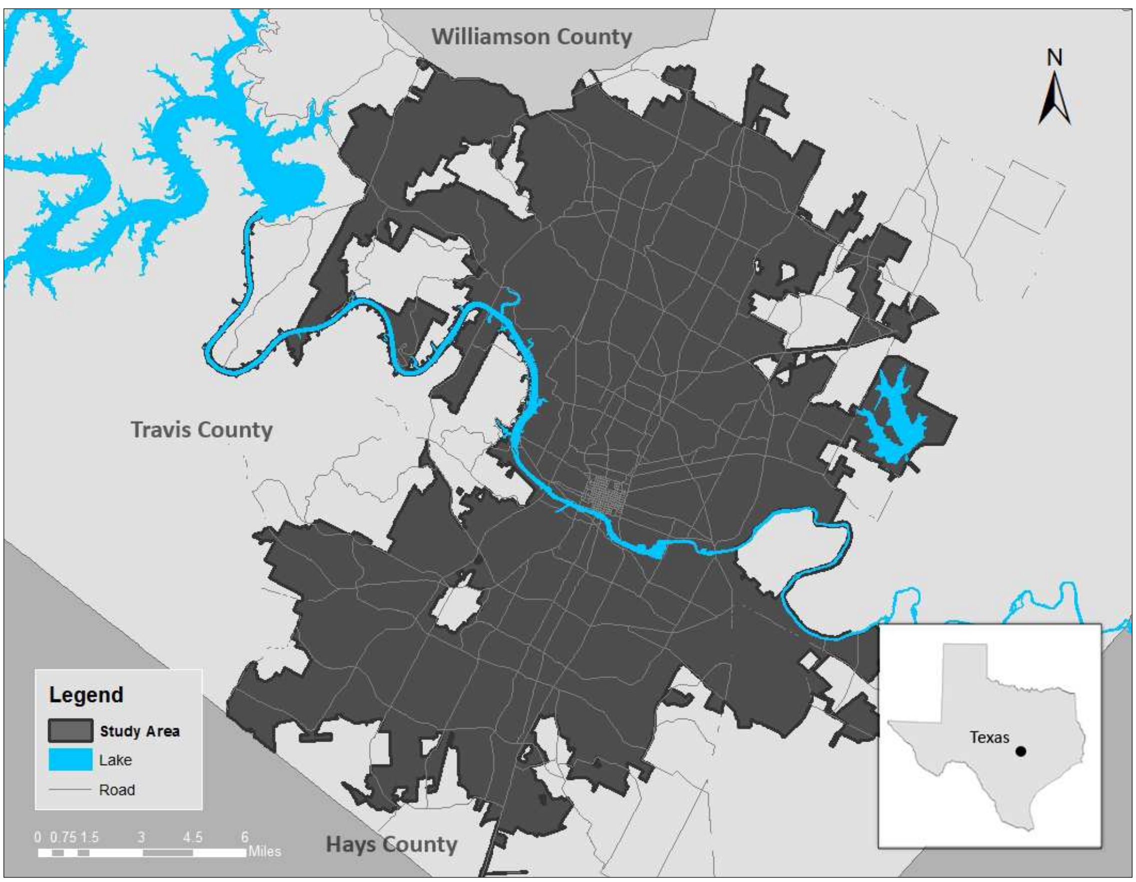


Figure 4-3. Study Area: Austin, TX in Travis County

656,562 in 2000 to 790,390 in 2010; this was almost a 20 percent growth. Seventy-one percent of this growth is accounted for by an influx of Hispanic and Asian populations (U.S. Bureau of the Census 2010).

The total number of home sales in Austin has also almost doubled over every decade since 1981. Home sales increased from 57,510 from 1981 to 1990, to 125,415 from 1991 to 2000, and to 227,764 from 2001 to 2010 (Texas A&M Real Estate Center 2013). The variation in an active housing market is helpful in explaining the different preferences of homeowners toward certain neighborhoods and contexts conditions, which determine the variance of neighborhood turnover.

4.4.2 Time Period

This is a cross-sectional study, but neighborhood turnover was averaged for five years, from 2005 to 2010. The period of five years reveals a constant turnover trend that reflects preferences for neighborhood and context designs, not economic fluctuations. Further, considering average turnover is acceptable as neighborhood and context design have rarely experienced radical changes for a short period. I do not claim that there has been no change, but its design characteristics such as lot size, street patterns, surrounding nature, and ecological elements remain almost the same when once a neighborhood is built. Context design has also been stable during this period in Austin. Even though planners have started discussing issues such as increasing density, mixed land uses, street connectivity, parks, and landscape through neighborhood plans, zoning codes, tree ordinances, and development projects since 2000s (Figure 4-4), the results of these considerations have not yet matured. In addition, it is well known that census tracts reveal less of urban form changes over time due to aggregation (Song and Knaap 2003).

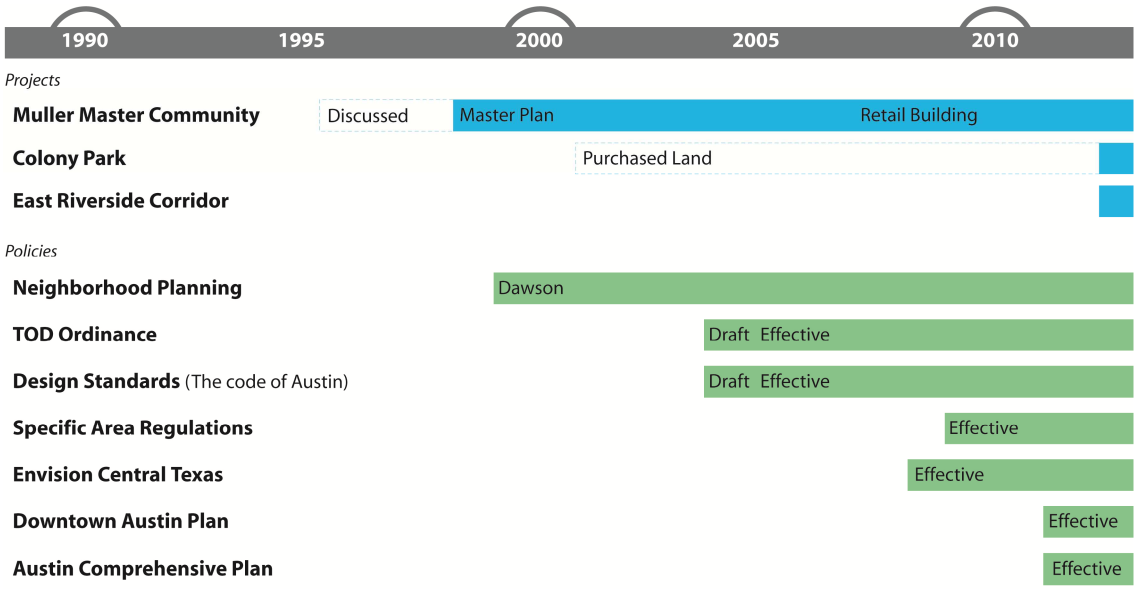


Figure 4-4. Planning and Projects Related to Neighborhood Planning in Austin since the Mid 1990s

4.5 Unit of Analysis

The units of analyses of this study are neighborhoods and contexts. A residential and an institutional neighborhood were chosen from a four level neighborhood hierarchy suggested by Park and Rogers (2014) to provide theoretical guidelines to choose an appropriate unit of data collection for a neighborhood and a context, respectively (Figure 4-5). Residential neighborhoods are the minimum planning units that have effective self-governing ability and in which planning initiatives can get involved. Residential neighborhoods are relatively homogeneous physical and socio-economic places, which are designed primarily as residential areas with similar street design and architecture. They often share similar housing values that serve people with similar incomes and life cycles, creating a relatively homogeneous ambience. Institutional neighborhoods are composed of several residential neighborhoods with different services and functions like schools, health centers, recreational and social facilities, and shopping centers. Institutional neighborhoods are the largest neighborhood that can be called "neighborhoods" with demarcated boundaries in a geographic space.

For data collection and operation, subdivisions and census tracts were selected to represent each neighborhood and context. Subdivisions are the most relevant units and conform to the definition of residential neighborhoods because they primarily serve residential purposes and have some level of homogeneity and identity (Shin et al. 2011). To illustrate, a subdivision shares the same name and location and have a similar age of development, patterns of urban form, income levels, and life-cycles (Blake and Arreola 1996). Subdivisions are often developed and managed under shared covenants, building codes and codes of conduct, or deed restrictions of homeowners' associations by-laws. Census tracts are one of the most relevant units of analysis to represent institutional neighborhoods. Even though census-based units do not represent institutional neighborhoods exactly, they have some theoretical and empirical merits. Census units have a clear boundary and a large amount of data, which can be easily aggregated with other administrative data into census geography (Van Zandt and Rohe 2006; Coulton et al. 2001; Sampson et al. 2002). In addition, census tracts meet several critical requirements to be considered as institutional neighborhoods: a relatively large size, different functions and services, and distinctive boundaries. Census tracts are usually large enough to include several subdivisions. One census tract typically has an average population of about 4,000 in urban areas and ranges between 1,500 and 8,000 people (U.S. Bureau of the Census 1994), which enables the area to provide several functions and services (Bailly 1959; Park and Rogers 2014). Moreover, census tracts are typically delineated in the consideration of visible physical features (e.g., roads, streams, and railroad tracks), political boundaries (e.g., townships, school districts, county limits, or short line-of-sight extensions of roads), or historical boundaries (Sawicki and Flynn 1996; Coulton et al. 2001), which are likely to limit the perceptions and activities of residents to some degree.

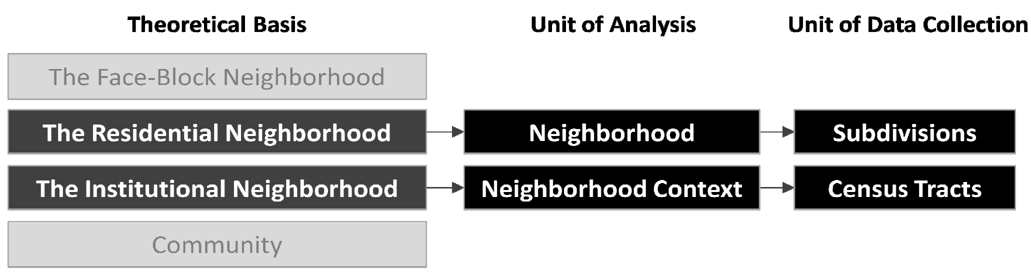


Figure 4-5. Unit of Analysis and Data Collection

4.6 Analytical Method

To analyze the cross-level data, data of neighborhoods and contexts, this study employed two-level multilevel linear modeling. HLM 7 software package (Raudenbush, Bryk, et al. 2011) was used to perform the analyses.

4.6.1 Brief Explanation of Multilevel Linear Modeling

4.6.1.1 Why Do We Use Multilevel Linear Models?

Several statistical approaches could be employed to analyze the associations of multilevel data. The first possible approach is disaggregating contextual information down to each neighborhood. For example, context characteristics would be assigned to nested neighborhoods and then an ordinary least squared regression (OLS) would be conducted. This approach, however, violates the assumption of independent observations of OLS. In this case, the standard errors between the explanatory variables and the dependent variable would need to be adjusted (Wech and Heck 2004). The second approach is aggregating the neighborhood level characteristics up to the hosting context. The main problem with this approach is that aggregating specific characteristics would discard important neighborhood information.

To overcome these weaknesses, multilevel models were used to analyze the multilevel data, which adjusts the standard errors of the relationships and does not violate the independency assumption. It simultaneously examines the relationships within and across levels and does not waste information in the lower order units (Raudenbush, Bryk, et al. 2011).

4.6.1.2 Brief Explanation of Multilevel Models

A two-level multilevel linear modeling concurrently tests the effects on the outcome at both levels and produces better estimates of the predictor variables of the level-1 (neighborhood, the lower level) outcome by borrowing information from level-2 (context, the higher level). A multilevel linear modeling works in an OLS framework, which performs regressions of a regression. Regressions are done at the neighborhood level within units of the context level separately. The intercepts and slopes from these equations are averaged across the context level and then weighted by the inverse of the standard error of each estimate (Arnold 1992). These steps consider the variances of the parameters at the neighborhood level by estimating the parameters and their variances at the context level.

4.6.2 Multilevel Models Used

4.6.2.1 How Can We Compare the Magnitude?

Comparing the magnitude of several variables is not an easy task in a multilevel model because it is difficult to standardize the standard deviation of Y at each level (Bloom et al. 2008). Statistical packages rarely produce standardized coefficients in multilevel models because there are no common agreements about this issue.

Researchers have suggested various approaches depending on their assumptions and the software they use. The easiest way of standardizing the effect of each parameter is to calculate the relative contribution for a set of predictor variables in determining variance at each level and subtract the variance of the “null” model from the variance of the “fitted” model with a set of explanatory variables on top of the “null” model (Heck 2012). Observing the differences of the variance from growth models—which adds predicting variables one by one and observes the change in variance—is an appropriate approach when looking at sets of variables in the same construct. This is not, however, the best way to find the variables that have the most influence on turnover because the statistical package may not make a very good initial estimate depending on the nature of the data, such as normality or sample size at each level in a multilevel model (Heck 2012).

Another common method is to use standardized data before running an analysis (Heck and Thomas 1999; Hox 1995). Heck and Thomas (1999, 22) suggested several standardizing options:

- standardizing with respect to within-group variance only;
- the between-group variance only;
- within each level of the data hierarchy; or
- with respect to total variance.

These approaches also have some drawbacks. Standardizing data may reduce the variability; it changes the variance components of the random slope and the ρ value of a coefficient would be slightly altered. The size of interactions, the model's variance components, and significant levels of variables could be changed as well (Hox 1995; Heck and Thomas 1999). Yet, this approach helps an audience to compare the magnitude of explanatory variables. Reporting unstandardized and standardized coefficients together mediates the weaknesses of standardizing variables (Heck and Thomas 1999).

In this dissertation, the magnitudes of design components were compared using two suggested approaches. First, explained variances of sets of structural design, ecological design, and other conditions were compared and presented. Second, to reveal the most influential predictor, independent variables were standardized within each level and then multilevel models were run. Only continuous and outcome variables were changed into Z-scores, while dichotomous variables remained in their original types as dummy variables already in the form of a standard deviation metric.

$$z = \frac{X - \overline{X}}{SD} \quad [4.1]$$

where $\bar{X}$ is the mean of X and SD is the standard deviation

4.6.2.2 Multilevel Models Used

Several multilevel models were used to test each hypothesis (Figure 4-6).

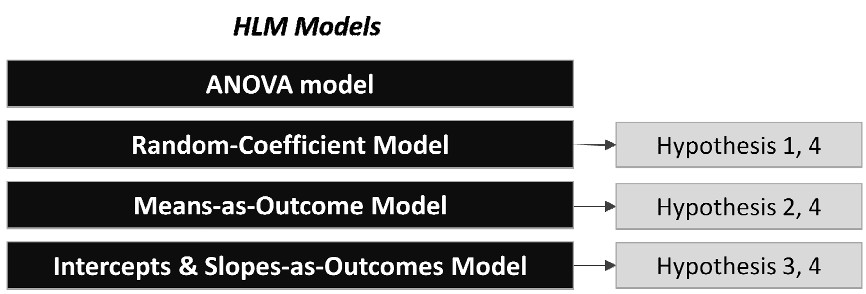


Figure 4-6. Multilevel Models Used to Test Each Hypothesis

First, an ANOVA was performed to confirm the variability of the outcome variable, which only includes neighborhood turnover without including any independent variables. This model informed the necessity of multilevel analysis. Second, to test the independent role of neighborhood condition alone, a random-coefficient model was used, which only included neighborhood level predictor variables in addition to the ANOVA model. As shown in Figure 4-7, independent impacts of neighborhood or context conditions were tested with random-coefficient and means-as-outcomes models. The random-coefficient model was rerun with standardized independent variables to find the most important design factor. The results inform us that we can confirm or reject hypothesis 1 and 4; neighborhood design has an impact on neighborhood turnover; and ecological features are the most influential in neighborhoods, while structural features are the most important in contexts. Third, to identify the influence of neighborhood context only on neighborhood turnover, a means-as-outcomes was employed, which only includes context level predictor variables on top of the ANOVA model. Similar to the random-coefficient model, the model was rerun with standardized independent variables. The results inform us that we can confirm or reject hypothesis 2 and 4; context design alone has impact on neighborhood turnover; and ecological features are the most influential in neighborhoods, while structural features are the most important in contexts.

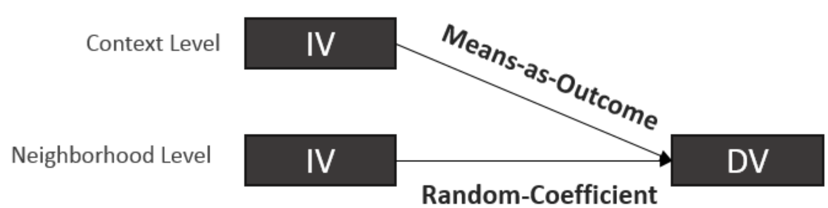


Figure 4-7. Diagrammatic Representation when Considering Neighborhood or Context Only

Finally, the intercepts-and-slopes-as-outcomes model—which includes all independent variables at both the neighborhood and context level—tests the contextual influences on the association between neighborhood and context design on neighborhood turnover (Figure 4-8). The model examines hypotheses 3 and 4; context design influences the relationships between the neighborhood design and its turnover; and ecological features are the most influential in neighborhoods, while structural features are the most important in contexts.

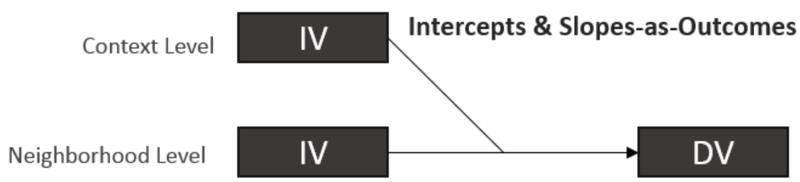


Figure 4-8. Diagrammatic Representation when Considering Neighborhood and Context Together

4.7 Sample Size

The analyses of this study were conducted with 755 neighborhoods and 126 contexts. The sample size was determined by two steps. First, neighborhood and context boundaries were demarcated based on subdivision and census tract geography. Second, a power analysis was done to find a minimum sample size for neighborhoods and contexts to produce enough statistical power.

4.7.1 Creating Neighborhoods and Contexts

To create neighborhoods, residential subdivisions with the same name were combined together. [1] 1,936 subdivisions were collected at first, but 1,121 subdivisions were filtered out since they contained fewer than 30 housing units. The standard of 30 units was set to meet the minimum requirements to form one residential neighborhood, which is greater than several face-blocks; a face-block usually includes approximately ten housing units (American Planning Association 2006; Park and Rogers 2014). After this process, 815 subdivisions, now called neighborhoods herein, remained.

One hundred and sixty-four contexts from census tracts that hosted 815 neighborhoods were collected. However, thirty-eight contexts that contain fewer than three neighborhoods were removed because the criteria of three neighborhoods were set as a minimum number to form one context. This standard fits the theoretical and empirical guidelines of the American Planning Association (2006) and Park and Rogers (2014), which state that an institutional neighborhood—a context herein—includes at least several residential neighborhoods. One hundred and twenty-six contexts remained for the analyses and they included 755 neighborhoods in total.

[1] The specific process to affirm neighborhood boundaries is described in Appendix B.

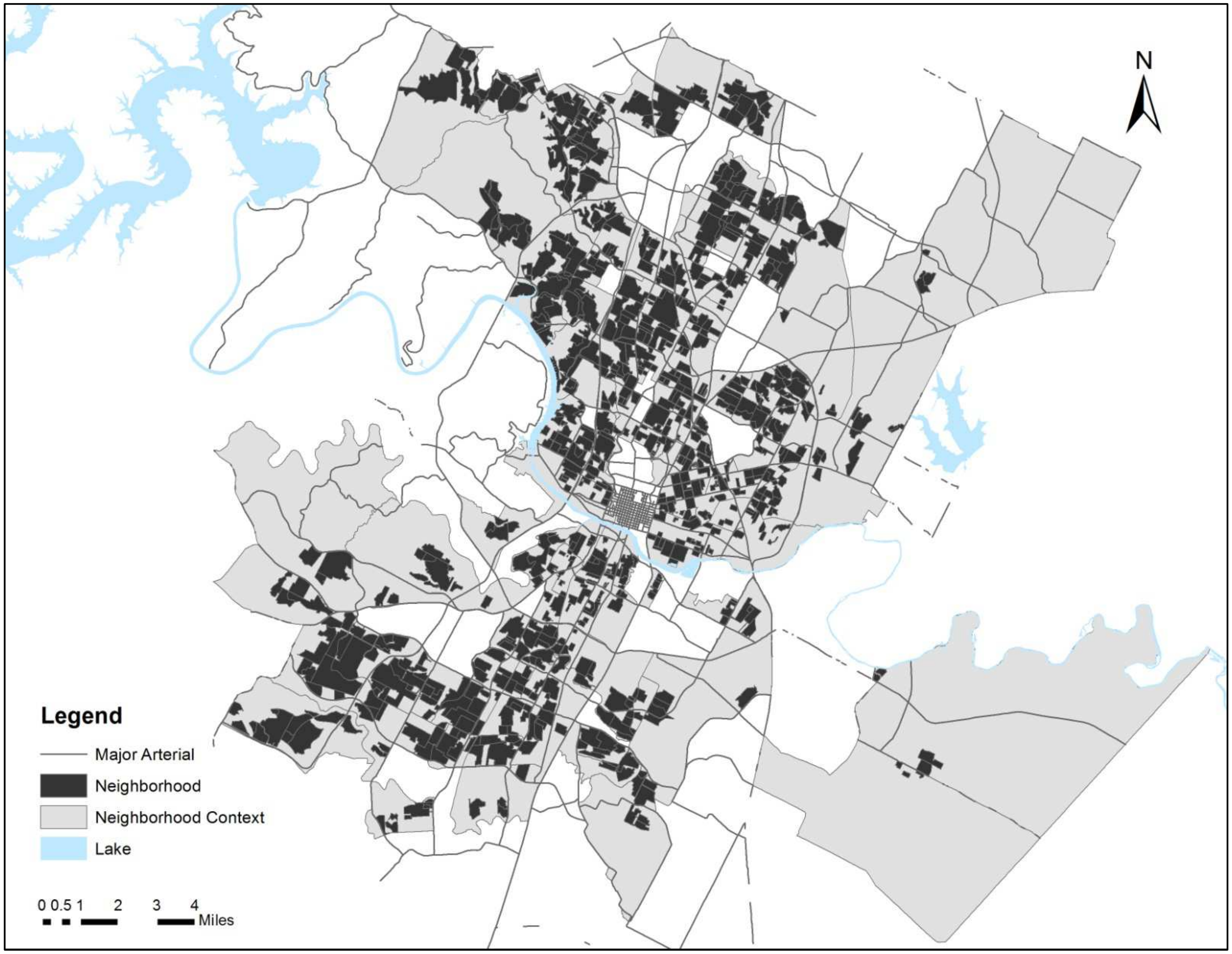


Figure 4-9. Neighborhoods and Contexts for This Study

4.7.2 Power Analysis

To check the minimum number of contexts to run multilevel models with a certain level of statistical power, a power analysis[2] proposed by Spybrook et al. (2011) was also conducted. The outcomes of a power analysis advise that at least 65 contexts to produce a statistical power of 0.9. One hundred and twenty-six contexts are greater than 65. Further, the sample size of contexts also satisfies the minimum criteria of 100 suggested by Hox (1995) and Hox and Maas (2001). They agreed that the sample size of a higher level is more important in detecting interactions between levels than the number of observations of a lower level for more statistical power. One hundred and twenty-six contexts used for this study met the minimum criteria.

4.8 Data

As shown in Table 4-1, data were retrieved from different sources.

4.8.1 Neighborhood Turnover

The owner change date of each property was retrieved from the deed history data[3] since sales data for single-family homes were not open to the public in Texas.[4]

---

[2] Detailed process of the power analysis can be found in Appendix D.

[3] The deed change data used for this study do not contain any refinancing records such as a warranty, special deed, or quitclaim deed from financing companies. This information was retrieved from the correspondence with a staff member in TCAD.

[4] Sec. 552.148 in the Texas Government Code says, "information relating to real property sales prices, descriptions, characteristics, and other related information received from a private entity by the comptroller or the chief appraiser of an appraisal district remains confidential in the possession of the property owner or agent; and may not be disclosed to a person who is not authorized to receive or inspect the information"(Texas Government 2013).

Deed data were considered as alternative records of market transactions. Deed data trace the name of grantees (buyers) and grantors (sellers) of property. Deed history data used for this study only have dates of the changes of grantees, not owner names, which were purchased from Travis Central Appraisal District, Texas in October 2013.

There were found 105 cases missing among 127,867 single-family housing parcel data. The improvement codes of missing data were recorded as single-family, but their year built and deed dates were not recorded. Sixty-nine out of 755 neighborhoods had missing data, but they were evenly distributed across neighborhoods, 1.13 single-family homes on average. At the most, three parcels were missed out of 1,110 single-family housing units in the Crestview Addition Subdivision. A list-wise deletion method was used since the size of the missing data was not substantial and evenly distributed. Another five cases were found in which the properties' year built were miscoded as 194, 205, or 206. After comparing year built of adjacent properties, the values were re-recorded from 194 to 1994, 205 to 2005, and 206 to 2006.

4.8.2 Design Components

GIS data sets including topography (elevation and lakes), streets, roads, rails, land uses, and subdivision boundaries were retrieved from the city of Austin in December 2012. Appraisal roll information and related GIS information such as lot size, value, improvement code, and built year were received from the Travis Central Appraisal District in April 2013. Arc Map 10.1 was used to measure the majority of the independent variables. To measure the landscape patterns, FRAGSTATS 4.2 software developed by McGarigal (2012) was used. Land cover data were created based on one-meter color infrared high-resolution digital ortho quadrangles (DOQs) imagery from 2010 retrieved from the Texas Natural Resources Information System.[5]

4.8.3 Other Conditions

Data and maps regarding ethnic composition, income, crashes, crime, and school quality were retrieved from the 2010 decennial census data, five-year estimate American Community Survey (2006-2010), the Austin Police Department, the Texas Education Agency, and the Austin Independent School District.

[5] The process of creating land cover data is explained in Appendix A. After creating land cover data for the Austin areas, the Watershed Protection Department of the city of Austin released the tree canopy data as of 2010. The publicly released data were preferably used to measure tree landscape patterns at the neighborhood level.

Table 4-1. Data Source and Date

Sources		Year	Related Measures
Travis County Appraisal Data	**Parcels**	2010	· Lost Size · Improvement Code (SF, MF) · Year Built · Appraised Value
	Deed History*	2013	· Turnover
Austin GIS Data	**Arterials**	2009	· Traffic
	Rails	2007	· Traffic
	Elevation	2008	· Elevation
	Facilities	2010	· Grocery · Elementary School
	Land Use	2010	· Mixed Land Use · Parks & Greenway
	Hydro	2010	· Lake
	Project	2009-2011	· On-going project
	Street Centerline	2010	· Street Shape · Network / Airline Distance
	Subdivision*	2013	· Neighborhood Boundary
	Sidewalk	2013	· Existing Sidewalk
	Tree Canopy	2010	· Landscape Patterns
Census		2010	· Population · Race/Ethnicity · Age
American Community Survey		2006-2010	· Income
Texas Natural Resources Information System		2010	· Land cover
Austin Police Department		2010	· Crime · Crashes
Texas Education Agency		2010	· School Quality
Austin Independence School District **		2012	· High School Attendance Zone

*Housing and subdivisions built after 1/1/2011 were not counted.
**Attendance zones were digitized by Dr. Wei Lee in Texas A&M University based on the paper map purchased from Austin Independent School District.

4.9 Measurement

The study employs four major research constructs: neighborhood turnover rate, structural design, ecological design, and other neighborhood quality indicators.

Measures of each research construct were collected slightly differently in neighborhoods and contexts. Variables and measures were guided by the previous literature and were assigned with consideration for the characteristics of units. Variables and measures were also constrained by information available in the secondary data (Table 4-2).

Table 4-2. Research Constructs and Variables

Constructs		Neighborhood Level	Context Level
DEPENDENT VARIABLE			
Neighborhood Turnover		· Single-family Home Owner Change Rate	
INDEPENDENT VARIABLE			
Structural Feature	**Density**	· Lost Size	· Population Density
	Mixed-use	· Housing Mix	· Affordable Housing Mix · Land Use Mix
	Street Pattern	· Dead-end density · Sidewalk Density · Route directness to the Nearest Grocery Store · Route directness to the Nearest Elementary School	· Street Network (α, β, γ)
Ecological Feature	**Nature-in**	· Elevation · Lake nearby	
	Open Space	· Distance to Open Space	· Share of Open Space
	Landscape Pattern	· Share of Tree Patch · Size and Shape of Tree Patch · Shape of Tree Patch · Fragmentation of Tree Patch · Connectivity of Tree Patch	· Share of Green Cover
Control		· School Quality · Traffic · Housing Values · Year Built	· Racial Homogeneity · Median Age · Median Income · Crime · Car Accidents · New Development · Spillover Effect

4.9.1 Neighborhood Turnover

Neighborhood turnover is the rate of change in all residential occupations including owners and renters, but is often operationalized in the number of ownership changes. For this dissertation, neighborhood turnover rate was counted as the average flux of single-family home owners per year, which were observed for five years from 2005 to 2010. Neighborhood turnover, T, was calculated by dividing the total number of new owners by the total number of single-family homes during the five-year period, and was expressed as a percentage.

$$T\,(\%) = \frac{\sum N}{\sum S} \times 100 \qquad [4.2]$$

where N is the number of new owners of each single-family housing and S is single-family housing units, which are summed over in a neighborhood

Two things were carefully deliberated when counting the total owner changes of each property. First, properties flipped within less than one year were not counted as actual owner changes. It was assumed that there was a high possibility that real estate agencies or similar entities might buy and sell properties with no intention of living there. Further, we do not expect neighborhood design to significantly influence residents' lives during such short residencies. Second, the built year and the first deed year of each property were compared. Deed change dates recorded before any construction was likely altered by landowners, not residents.

4.9.2 Design Components

4.9.2.1 Structural Design Components

<u>Density</u>

Density was measured by different methods according to neighborhood scales. At the neighborhood level, the median lot size of single-family homes was employed, as a larger lot indicates a lower density in general (Song and Knaap 2004b, 2003). At the context level, population density was measured. In previous research, household size and dwelling units per unit area are frequently employed (Song and Knaap 2003; Handy 1996; Lee and Moudon 2006; Calthorpe 1993), but density of population the most direct measure for development intensity.

<u>Mixed-use</u>

In residential neighborhoods, the major concern is the mixture of different housing types, and extensive mixed land use of different kinds is rarely achieved. Hence, the ratio of land areas for multi-family houses to single-family homes was calculated at the neighborhood level instead of land use mix (Jones et al. 2007). At the context level, the mixture of housing types was measured by the presence of affordable housing (Jones et al. 2009) and mixed land use by Shannon's diversity index (Van Cao and Cory 1982; Galster et al. 2001; Song and Knaap 2004a). As shown in Figure 4-10, Shannon's diversity index is useful in measuring both the richness (a simple count of the number of land uses) and evenness of land uses (proportional area distribution among different land uses). The distribution and proportion of four different land use classes (single-and multi-family, commercial, and industrial uses) were calculated. Values range from 0 to 5, and a higher value indicates a proportionally and evenly distributed mix of land uses (McGarigal and Marks 1995).

$$H' = -\sum_{i=1}^{c} p_i \ln(p_i) \qquad [4.3]$$

where p_i is the proportion of area in land use class *i* and *c* is the number of land uses.

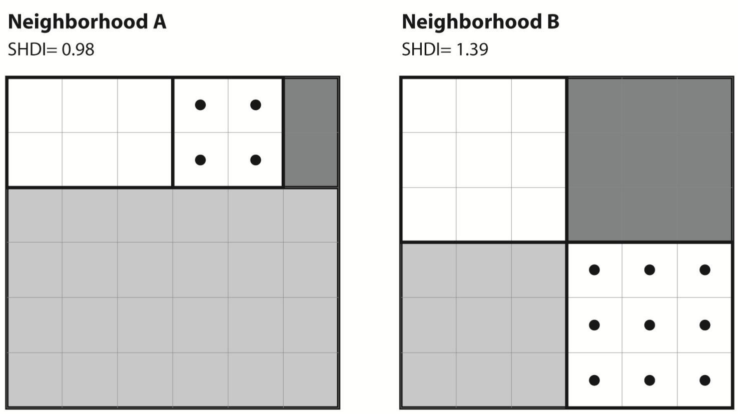


Figure 4-10. Example: Differences in Shannon's Index

Street Pattern

At the neighborhood level, dead-end density, the presence of sidewalks, and the route directness to grocery stores and an elementary school were measured. Dead-end density does not describe the street shape directly, but rather implies it. A higher dead-end density implies that a neighborhood is likely to have longer and winding streets such as cul-de-sacs (lollipops) or looped streets (loops). It also describes the lower connectedness of streets. Dead-end density was calculated dividing the number of dead-ends by the total areas. Sidewalks and the route directness are also closely related to within-neighborhood circulation, particularly for pedestrians or low-speed vehicles. The network distance is a primary concern for residents deciding whether to walk or cycle; a lower value means shorter pedestrian travel routes to some important destinations near neighborhoods (Dill 2004; Randall and Baetz 2001). The route directness—the value of network distance divided by the straight distance from each property—to daily services in terms of grocery stores and elementary schools was observed. Sidewalk ratio was also measured by the linear feet of existing sidewalks divided by the total land areas.

At the context level, the connectivity of streets was measured by calculating a link-node ratio indicated by alpha, beta, and gamma values (Table 4-3). Links are defined as roadway or pathway segments between two nodes, and nodes are intersections or the ends of cul-de-sacs. The alpha index (α) refers to the ratio of the number of actual circuits or loops in the tract to the maximum possible number of circuits and the beta index (β) is the ratio of links to nodes. The gamma index (γ) refers to the ratio of the number of links in the tract to the maximum possible number of links between nodes (Cohen et al. 2006). The range of values is different among the three measures, but a higher value indicates a greater connectivity. Although there was a high possibility of correlation between them, all three were measured as each value shows a slightly different character regarding street connectivity (Figure 4-11). During the analysis process, the best representative was chosen.

Table 4-3. Links and Nodes Measures: α, β, and γ

α	β	γ
$\frac{(L-N+1)}{2N-5}$	$\frac{L}{N}$	$\frac{L}{(3(N-2))}$
$0.0 \le \alpha \le 1.0$	$\beta > 1.0$	$0.0 \le \gamma \le 1.0$

where L refers to the number of links and N nodes.

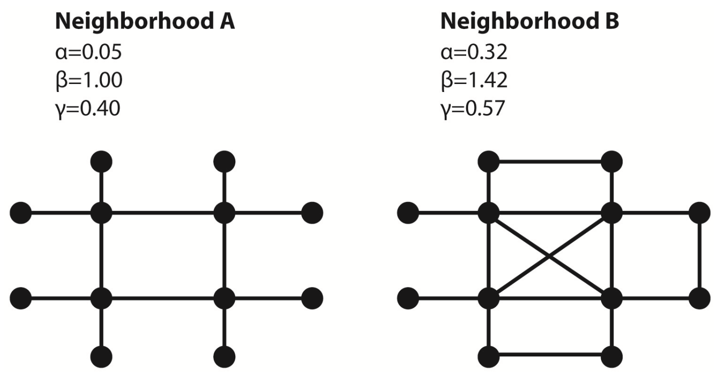


Figure 4-11. Example: The Different Values of Network Index α, β, and γ

4.9.2.2 Ecological Design Components

<u>Natural Features</u>

Typically, direct view to nature is one of the most critical factor in increasing the quality of neighborhoods, but simple proximity to mountains or hills could be an alternative measure because direct scenic views to the mountain from each property was hard to obtain (Jim and Chen 2009). Scenic view data necessarily require a field operation or need to be collected specially. This study used average elevation of a neighborhood to measure the closeness to a mountain or hill Austin is relatively flat, but topographical differences still exist. The west side of Interstate 35 is hilly compared to the east side. Mount Bonnell, the highest point at approximately 780 feet above sea level, is the most distictive highlands in Austin. Closeness to lakes is also perceived as an amenity resulting in a increase in residents' preferences (Lansford Jr and Jones 1995). This variable was coded as a one if there was a lake (s) within a 500-foot buffer from a neighborhood boundary; if not, it was coded as a zero.

<u>Open Space</u>

The closeness, size, and attractiveness of open space are critical to determine the residents' preferences (Cho et al. 2006; McLeod 1984; Giles-Corti et al. 2005). The distance from the center of a neighborhood to the edge of the nearest park or greenway was measured at the neighborhood level because the visibility and closeness to open space are important. The share of land for parks or greenways was measured at the context level. The size of open space matters in a larger scale neighborhood since they typically require various types of facilities and equipment for recreation, leisure, and occasional activities.

<u>Landscape Patterns</u>

At the neighborhood level, patterns of tree patches were observed since the importance of urban trees has been frequently found to be important in previous research. It is said that urban trees improve scenic quality and privacy, reduce stress, and provide shelter residents (Sander et al. 2010; Dwyer et al. 1992; Jim 2006; Mansfield et al. 2005). Several landscape metrics were employed to measure size, shape, fragmentation, and connectivity of tree patches (McGarigal and Marks 1995; Gustafson and Parker 1994; Plotnick et al. 1993). To measure the share of tree patches, a percentage of total tree patches in a certain area, (PLAND) was used. When the value of PLAND reaches 100, it indicates that the entire landscape is comprised of a single tree patch. The edge density (ED) was calculated dividing by total edge segments by area (meters/hectare). ED indicates the complexity of the shape of patches as well as the size. The landscape shape index (LSI) indicates dispersion or aggregation. A greater value of the LSI implies that the patch types are more dispersed. Fragmentation of trees is measured by the patch density (PD). PD expresses the number of patches per unit area, the value of which increases when patches are more fragmented. The patch cohesion index (PCI) was used to observe the connectivity of tree patches, which represents the physical connectedness of the corresponding patch type. The specific formula and description for each measure are presented in Table 4-4 and some examples are demonstrated in Figure 4-12. These landscape metrics measure different aspects of spatial landscape but are often redundant; therefore, a few best representatives were chosen for analysis.

Specific landscape patterns were not calculated at the context level due to the fact that landscape patterns could not be identified by people at the macro-level neighborhood. At the context level, the size of green cover, referring to both tree and grass patches, was measured. The distinction between trees and vegetation is not essential at the macro-level because both of them are perceived as a forest.

Table 4-4. Measures of Landscape Patterns

Characters		Formulas	Values & Conditions	Unit
Share	PLAND	$PLAND = \frac{\sum a_i}{A} \times 100$ a_i is area of patch i A is total landscape area	Increasing values indicate larger size	0 ≤ PLAND ≤ 100
Size & Shape	ED	$ED = \frac{\sum_{k=1}^{m} e_{ik}}{A}$ e_{ik} is length of patch k of type i	Increasing values indicate larger size and more complex shapes	m / ha
Shape	LSI	$LSI = \frac{0.25E'}{\sqrt{A}}$ E' is total length of edge, including boundary	Increasing values indicate more complex shape	LSI ≥ 1
Fragme-ntation	PD	$PD = \frac{\sum n_i}{A}$ n_i is the number of patch i	Increasing values indicate more fragmented patterns	number / ha
Connectivity	PCI	$PCI = \left(1 - \frac{\sum p}{\sum p\sqrt{a}}\right)\left(1 - \frac{1}{\sqrt{N}}\right)^{-1} \times 100$ p is patch perimeter a is patch area N is the number of pixels on the map	Increasing values indicate more connectedness	0 ≤ PCI < 100

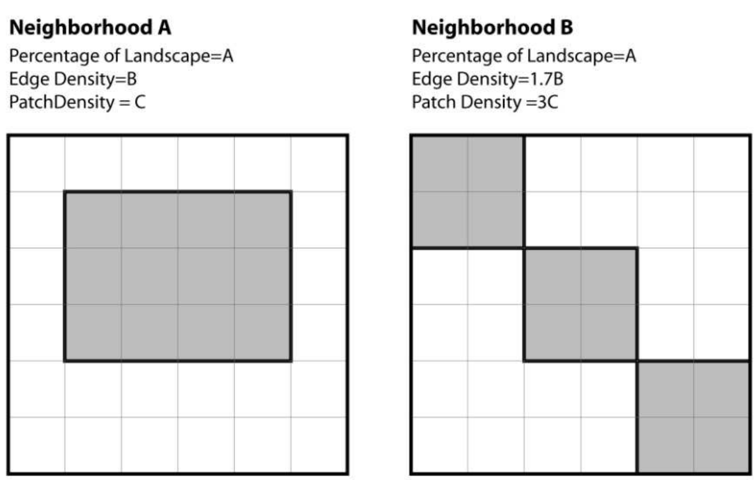


Figure 4-12. Example: PLAND, ED, and PD

4.9.3 Other Neighborhood Conditions

Other conditions that could affect the quality of a neighborhood, such as housing adequacy, school quality, traffic, car crashes, crime, demographic characteristics, socio-economic status, and on-going projects, were regarded as potential correlates of neighborhood turnover (Marans 1979; Bartik et al. 1992; Van Zandt and Rohe 2006; Chen and Jim 2010). Neighboring spillover effects were also taken into account to observe the unbounded impacts from adjacent contexts.

4.9.3.1 Neighborhood Quality Indicators

At the neighborhood level, physical conditions other than design features were measured. These included a presence of disamenities (traffic), school quality (exam passing rate), housing adequacy (housing year built), and socio-economic condition (housing value). The proximity to major traffic was coded as a dummy variable; if a neighborhood was located within a 500 foot buffer from major arterials or metro rails, it was coded as a one; if not, it was coded as a zero. School quality was measured by the exit-level passing rate of students in the 11th grade, retrieved from the Academic Excellence Indicator System Performance Report of 2010, and the value was assigned to neighborhoods based on attendance zones. Socio-economic conditions were also measured by the median appraised value of single-family housing; property value was assumed to be a proxy of income level. The median year built of single-family housing units in a neighborhood was counted to identify the age of the housing structures (or the age of the neighborhood) and housing adequacy.

At the context level, seven possible control variables were measured such as racial composition (the share of non-white population), median income, median age, crashes (only fatal crashes and serious and minor injuries), and crime (the total numbers of murders, rapes, robberies, assaults, burglaries, thefts, motor thefts, arson, and non-indexed crime). New developments including residential, civic, commercial, mixed-use, office, open space, planned unit development (PUD), retail, transportation, utilities, or transit-oriented development (TOD) that occurred from 2009 to early 2011 were mapped, assuming those development projects could affect the fluctuation of neighborhood.

4.9.3.2 Neighboring Spillover Effects

Neighborhoods are fairly exclusive due to boundaries, physical fences and entrances, and identifying names. On the other hand, the internal leverage of contexts might be relatively loose.[6] Relative inclusive character of contexts raises the issue of spatial autocorrelation. Statistically, a multilevel model rarely deals with spatial autocorrelation at an individual level (neighborhood level in this case) because it already assumes individuals in each group are similar to one another. In other words, the multilevel model presumes that the data are spatially correlated within groups (Chaix et al., 2005). Hence, neighboring spillover effects at the neighborhood level was not considered, while it is worth detecting in order to control the potential influence of effects from nearby contexts.

---

[6] The results of the OLS at the neighborhood level showed that neighborhood turnover does not have any spatial autocorrelation, while context does if the impacts from nearby contexts were not taken into account. This is another statistical support for including spillover effects at the context level. The values of spatial autocorrelations at each level are described in Appendix K.

Some previous studies used spatial econometrics in order to estimate spatial spillover effects, but these had some limitations (Anselin and Bera 1998). As spatial econometrics defines contexts arbitrarily, we cannot explicitly explain the estimation process and easily interpret the influence from contexts (Corrado and Fingleton 2012). Further, a single spatial autoregressive model hardly allows the specific conditions of contexts, although it considers the overall effects from contexts. There have been attempts to combine multilevel and spatial econometric thinking, called a hierarchical spatial autoregressive model. A hierarchical spatial autoregressive modeling is a new strategy that attempts to combine multilevel and spatial econometric thinking, but the method is still being developed. Thus, this study follows another method suggested by Goldstein and Drucker (2006) and Donegan et al. (2008). They counted the number of nearby metropolitan statistical areas (MSAs), which were the units of analysis for their study—to take into account spillover effects, assuming that phenomena in nearby MSAs could reach beyond their boundaries. Similarly, the numbers of adjacent census tracts were counted to capture the spillover effects from neighboring contexts.

Table 4-5. Measurements of Neighborhood Conditions

Constructs		Variables	Var. Names	Specific Measures
Structural Feature	**Density**	Lost Size	MEDLOT	The median lot size of single-family homes (sq.ft)
	Mixed-use	Housing Mix	MSFRAT	The ratio of land for multi-family housing to single-family housing
	Street Pattern	Dead-end density	DEADDEN	The number of dead ends per unit area (#/acre)
		Sidewalk Density	SIDEN	The linear feet of sidewalk divided by total length of streets
		Route Directness to Grocery Store	DSGRO	The sum of network distance to straight-line distance to the nearest grocery store from each property
		Route Directness to Elementary School	DSELE	The sum of the ratio of network distance to straight-line distance to the nearest elementary school from each property
Ecological Feature	**Nature-in**	Elevation	AVEELEV	Average elevation (ft)
		Lake Nearby	DISLAKE	Distance from the center of a neighborhood to the nearest edge of lake (ft)
	Open Space	Nearby Park	DISPARK	Distance from the center of a neighborhood to the edge of the nearest park and greenway (ft)
	Landscape Pattern	Share	TRRAT	Total share of tree patches per unit area (%)
		Size & Shape	TREDEN	The sum of edges of tree patches per 100 ha (m/100ha)
		Fragmentation	TRPADEN	The number of tree patches per unit area
		Shape	TRLSI	Landscape Shape Index of tree patches
		Connectivity	TRPCI	Tree Patch Cohesion Index
Other Condition		School Quality	SQUAL	The ratio of 11th grade SAI* to state SAI in 2010 for each assignment zone
		Traffic	TRAF500	The presence of major arterial and metro rail within a 500 ft. buffer from the edge of a neighborhood (if yes=1, no=0)
		Housing Value	MEDVAL	The median appraised value of single-family housing
		Year Built	MBUILT	The median years of single-family housing since built (years)

*SAI: Standard Accountability Indicator of secondary schools (exit-level passing rate)

Table 4-6. Measurements of Context Conditions

Constructs		Variables	Var. Names	Specific Measures
	Density	Population Density	POPDEN	The number of people per unit area (ppl/acre)
	Mixed-use	Social Housing Mix	SMART	The presence of SMART housing (if yes=1, no=0)
		Land Use Mix	MIXLAND	Shannon's Diversity Index
Structural				(single-family housing, multi-family housing, commercial, and industrial land uses)
Feature	**Street Pattern**	Street Network (α)	ALPHA	The ratio of the number of actual circuits
		Street Network (β)	BETA	The ratio of streets to intersections
		Street Network (γ)	GAMMA	The ratio of the number of links in the tract to the maximum possible number of links between nodes
Ecological	**Open Space**	Parks & Greenways	PARKRAT	The share of land for parks and greenways
Feature	**Landscape Pattern**	Green Ratio	GRRAT	The ratio of green cover (trees & grass)
		Racial Homogeneity	MINOR	The share of non-white population
		Median Age	MEDAGE	The median age of households
		Median Income	INCOM	The median income of households
		Crime	CRIME	The number of crime per 1,000 people
Other Condition		Car Accident	CRASH	The number of injury crashes (fatality, serious & minor injury)
		New Development	PROJECT	On-going or planned development from 2009-2011. If yes=1, no=0. Development types: Residential, Civic, Commercial, Mixed-use, Office, Open Space, PUD, Retail, Transportation, Utilities, TOD
		Neighboring Spillover	SPILL	The number of adjacent neighboring census tracts

*SMART Housing (Safe, Mixed-Income, Accessible, Reasonably priced, and Transit oriented Housing): Housing program designed to stimulate creation of reasonably priced homes. It includes housing for homeless services, emergency shelters, transitional housing, public housing and assisted housing in Austin, TX (City of Austin 2008)

4.10 Variables Selection

4.10.1 Consequence of Collinearity

To avoid multicollinearity, bivariate correlations between independent variables were observed (Table 4-7), as including all variables could be redundant [7]; there were found high chances of correlation between variables, since each variable measured different aspects of the same principles. Relatively conservative criteria were used to choose the most representative parameters, because a simpler multilevel model is able to generate more accurate results when the sample size of the context level is not large.[8] The correlation coefficient was chosen to be greater than 0.55 was chosen to indicate a multicollinearity problem; the criteria of perfect collinearity as 0.99, medium as 0.55, and low as 0.19 were used (Nduka and Ijomah 2012).

The correlation coefficients between six structural and six ecological design components were compared at the neighborhood level. Tree patch size ratio, tree patch density, and tree patch cohesion index were highly correlated. Tree patch ratio was chosen because of its simple interpretation. Three control variables, traffic, median built year, and median housing value, remained for the analyses, and while school quality was excluded because median housing value and school quality were highly correlated. Median housing value was chosen instead of the school quality as housing value was more comparable to median income at the context level.

---

[7] Before checking collinearity, some variables were natural log transformed. Details can be found in Appendix C.
[8] Random parameters of neighborhood and context parameters created relatively large interaction terms. If the number of interactions were to be larger than the number of context units, this could be the low degree of freedom for estimating the sigma-squared value.

At the context level, the correlation between four structural and two ecological design variables were compared. Some variables were forced to remain in the analyses, even though a high level of correlation was found, if only the correlation coefficient was not overly high (lower than 0.7). Further, the variables were deemed of importance in each design domain. Population density and green cover ratio were correlated negatively and moderately, but both of the variables were not removed since they represented different design domains and were not exceptionally correlated each other. For such reasons, Shannon's index and median income also remained in the models. Four control variables were chosen out of six initial control variables. Demographics such as racial homogeneity, crime, median age, and median income were highly correlated each other. Since there was no specific criterion for choosing the best representatives among them, a principal component analysis was conducted. The results of the factor analysis indicated that median income was the best representative because it was the most critical factor and median age of residents, racial homogeneity, and crime followed. It is also comparable to median housing value at the neighborhood level. Frey (2011) reported that the economic status of residents would explain more about neighborhood quality than only the racial composition because of current trends of declining racial homogeneity in neighborhoods.

4.10.2 Final Sets of Variables

In total, twenty-five independent variables were used for the analyses. At the neighborhood level, six structural design components (i.e., median lot size, the share of multi-family to single family housing, dead-end density, sidewalk density, and the route directness to the nearest grocery store and elementary school) and six ecological design components (i.e., average elevation, lake nearby, distances to parks, tree cover ratio, the size and shape of tree cover, and the shape of tree cover), and three other neighborhood conditions (i.e., traffic, median housing value, and median built year) were included.

At the context level, ten variables such as four structural design features (i.e., population density, affordable housing, mixed land use, and street connectivity), two ecological design features (i.e., ratio of parks and greenways and green cover ratio), and four other conditions (i.e., median income, crashes, on-going projects, and spillover effect) were remained.

Table 4-7. Correlation Matrix

NEIGHBORHOOD																		
Var. Name	LMEDLOT	LMSFRAT	DEADDEN	LSIDEN	LDSGRO	LDSELE	AVEELEV	LAKE500	DISPARK	TRRAT	TREDEN	TRPADEN	TRLSI	TRPCI	SQUAL	TRAF500	LMEDVAL	MBUILT
LMEDLOT	1.000																	
LMSFRAT	0.080*	1.000																
DEADDEN	-0.020	0.093*	1.000															
LSIDEN	-0.179*	0.215*	0.049	1.000														
LDSGRO	0.071	-0.009	-0.036	0.038	1.000													
LDSELE	0.057	0.115*	0.105*	-0.001	0.062	1.000												
AVEELEV	0.299*	0.253*	0.016	0.073*	0.059	0.161*	1.000											
LAKE500	0.039	-0.133*	0.056	-0.081*	-0.024	-0.014	-0.231*	1.000										
DISPARK	0.073*	0.105*	0.059	0.022	0.000	0.160*	0.148*	-0.133*	1.000									
TRRAT	0.439*	-0.201*	-0.069	-0.268*	0.074*	-0.036	0.084*	0.049	-0.144*	1.000								
TREDEN	-0.082*	-0.265*	-0.076*	-0.200*	0.017	-0.088*	-0.075*	-0.018	-0.248*	0.239*	1.000							
TRPADEN	-0.380*	0.173*	0.111*	0.225*	-0.084*	0.016	-0.154*	-0.029	0.038	-0.820*	0.021	1.000						
TRLSI	0.043	-0.009	-0.027	0.090*	-0.039	0.057	0.276*	0.069	0.110*	-0.314*	-0.004	0.271*	1.000					
TRPCI	0.281*	-0.194*	-0.106*	-0.197*	0.090*	-0.009	0.238*	-0.001	-0.267*	0.658*	0.476*	-0.525*	-0.078*	1.000				
SQUAL	0.295*	0.202*	-0.032	0.002	-0.019	0.148*	0.506*	-0.185*	0.141*	0.313*	-0.145*	-0.368*	0.026	0.134*	1.000			
TRAF500	-0.009	-0.178*	-0.065	-0.111*	-0.057	0.012	-0.112*	0.042	0.062	-0.006	-0.010	-0.038	0.140*	0.044	-0.061	1.000		
LMEDVAL	0.388*	0.045	-0.050	-0.120*	0.035	0.088*	0.234*	-0.022	-0.066	0.480*	-0.023	-0.524*	-0.120*	0.281*	0.584*	-0.036	1.000	
MBUILT	-0.062	-0.476*	-0.194*	-0.315*	0.000	-0.184*	-0.426*	0.082*	-0.213*	0.419*	0.469*	-0.374*	-0.324*	0.373*	-0.183*	0.182*	0.132*	1.000

CONTEXT													
Var. Name	POPDEN	SMRAT	MIXLAND	BETA	GRRAT	PARKRAT	MINOR	MEDAGE	INCOME	CRIME	CRASH	PROJECT	NEIGH
POPDEN	1.000												
SMRAT	-0.049	1.000											
MIXLAND	0.229*	0.017	1.000										
BETA	0.519*	-0.034	0.171	1.000									
GRRAT	-0.582*	0.070	-0.464*	-0.484*	1.000								
PARKRAT	-0.258*	0.050	-0.049	-0.171	0.328*	1.000							
MINOR	0.120*	0.438*	0.224*	0.011	-0.259*	0.127	1.000						
MEDAGE	-0.440*	-0.255*	-0.473*	-0.461*	0.389*	-0.001	0.628*	1.000					
INCOM	-0.440*	-0.255*	-0.596*	-0.461*	0.540*	-0.001	-0.586*	0.759*	1.000				
CRIME	0.355*	0.155	0.462*	0.309*	-0.630*	-0.072	0.464*	-0.532*	-0.579*	1.000			
CRASH	0.237*	0.101	0.322*	0.234*	-0.318*	-0.098	0.244*	-0.318*	-0.350*	0.492*	1.000		
PROJECT	-0.127	-0.053	0.052	-0.044	-0.032	-0.076	-0.090	-0.004	0.038	0.035	-0.001	1.000	
SPILL	-0.045	-0.037	0.103	0.081	-0.128	0.059	0.002	0.065	-0.118	0.238*	0.082	0.084	1.000

* ρ <0.05

CHAPTER V

RESULTS

5.1 Introduction

In this chapter, the **descriptive statistics** of neighborhoods and contexts in the study area and four sets of **results** are presented. The first asks whether there are multi-scale phenomena between neighborhoods and contexts regarding neighborhood turnover. The second questions whether **neighborhood design alone holds the connections** to neighborhood turnover and which element is relatively the most important. The third asks whether **context designs alone have impacts** on neighborhood turnover and which element of neighborhood design is the most important. The fourth seeks to observe **the relationships of neighborhood design and neighborhood turnover considering contexts' conditions simultaneously** and the significant combinations of neighborhood and context design components.

5.2 Descriptive Statistics

5.2.1 Size of Neighborhoods and Contexts

A neighborhood included 143 single-family housing units in about 49 acres of land, on average; the size of the land varied from about 6 to 477 acres. The number of single-family housing units ranged from 30 to 1,385. A typical context had around 1,328 acres of land including 1,063 single-family units; the land ranged from 197.8 to 17,846.0 acres and contained from 226 to 3,714 single-family homes. One context had about

Table 5-1. Size of Neighborhoods and Contexts

Item	Mean	Min	25%	50%	75%	Max
NEIGHBORHOOD						**N=755**
Area (acre)	49.18	5.57	17.70	31.60	62.01	476.65
Single-family Housing	142.52	30	50	89	179	1,385
CONTEXTS						**N=126**
Area (acre)	1,327.93	197.83	429.97	647.35	979.50	17,845.96
Single-family Housing	1,062.84	226	378	962	1,346	3,714
Population	4,603.64	1,469	3,180	4,087	5,535	13,159

twenty- seven times more land acreage and approximately seven times more single-family housing units than one neighborhood (Table 5-1).

5.2.2 Character of Neighborhoods and Contexts

Descriptive statistics of potential interest are presented in Table 5-2.

5.2.2.1 Neighborhood Homogeneity [9]

This study assumes that neighborhoods, subdivisions for data collection, have some level of homogenous characteristics. To identify homogeneous characteristics of neighborhoods, the coefficient of variation (CV) was used, which is a normalized measure of dispersion of data to the mean which is sometimes know as relative standard deviation (Lovie 2005). CV is useful as the variance of data can be observed in the context of the data, normalizing the standard deviation. Thus, low CV indicates relatively little variation within the sample (Faria Filho et al. 2010). Even though there is no global standard, the value of CV greater than one indicates a relatively high variation.

[9] In Appendix O, results of three different multilevel linear models that exclude heterogeneous neighborhoods in terms of lot size, house size, and housing price are presented. The results remain almost the same in revised models.

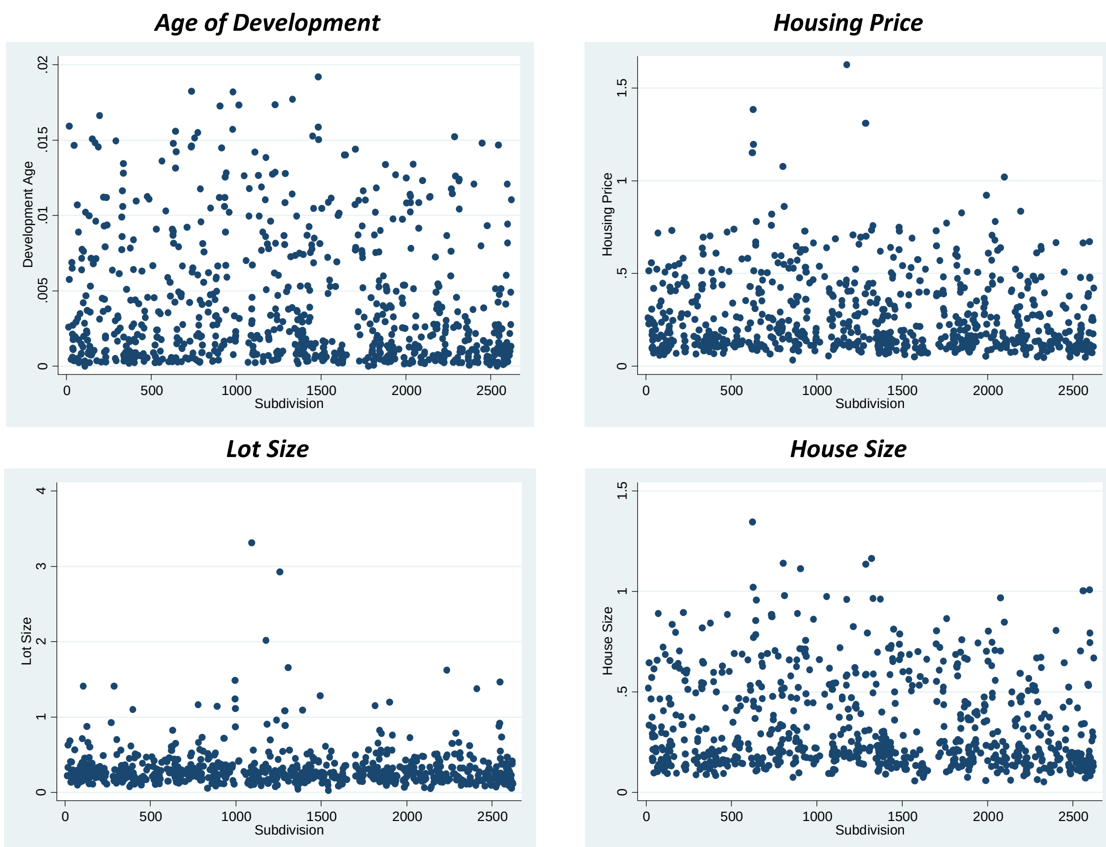


Figure 5-1. The Distributions of CVs: Development Age, Housing Price, Lot Size, and House Size

Twenty out of 755 neighborhoods (about 2.6 percent) had a relatively high variability of lot size of single-family homes. Eight neighborhoods and seven neighborhoods showed a relatively high variation regarding housing sizes and housing price, respectively. Only there was one neighborhood that had CVs of lot size, home size, and housing price were greater than 1.0 (Figure 5-1). As assumed before, residential subdivisions, which were units of data collection that represented neighborhoods, showed relatively high level of homogeneous characteristics in terms of the age of development, lot sizes, house sizes, and housing price.

5.2.2.2 Neighborhood Conditions

Over the past five years, an average of ten percent of single-family homes had new owners each year in a neighborhood. The median lot size of single-family housing was 9,092 square feet (about 0.2 acre). A neighborhood typically used approximately 9 percent of its land for multi-family homes, which indicated that the majority of the land was used to construct single-family homes in neighborhoods. The average dead-end density was 0.04, but there are neighborhoods that did not have any dead-ends, if all streets were grids, or did not have any streets within neighborhoods (Figure 5-2). On average, there were about 66 feet per 100 acres of sidewalks. The mean ratio of network distance to straight distance to the nearest grocery store and to an elementary school were 1.7 and 0.2, respectively. This indicated that the actual travel distance to a nearby grocery store was about 70 percent longer than the straight-line distance, while travel distance to the nearest elementary school was 18 percent shorter. The elevation averaged about 654 feet. Thirty-six percent of neighborhoods were located within 500 feet from lakes and the mean distance from the center of a neighborhood to the edge of nearest park was about 1,556 feet. Tree patches covered 47.4 percent of the land, the mean tree edge density was approximately 1,638 meters per hectare. Tree landscape index was 25.9. Almost 68 percent of neighborhoods were within 500 feet from major arterials or metro rails. The median value of single-family housing was about $254,075 and the median age of single-family homes was about 42 years.

Figure 5-2. Some Circumstances of the Minimum Value of Zero

5.2.2.3 Neighborhood Context Conditions

An average of seven people shared one acre of land in a context. Twenty percent of land was used for affordable housings. The average value of Shannon's index was 0.8 and the link to node ratio was 1.4. Parks consumed six percent of the land and tree and grass patches comprised 57 percent of the land on average. The average median income of a context was about $57,089. Car accidents, injury cases only, occurred 33 times per year on average. Roughly, 25 percent of contexts experienced on-going projects or planned developments. One context shared boundaries with about eight contexts on average.

Table 5-2. Descriptive Statistics of Potential Interest

Variable	N	Mean	SD	Min	Max
NEIGHBORHOOD TURNOVER					
Mean Turnover (%)	755	10.281	4.574	0.741	35.636
NEIGHBORHOOD					
Structural Design Components					
Lot Size (sq.ft)	755	9091.807	3805.394	3017.084	40891.390
Housing Mix (MF/SF)	755	0.094	0.316	0	5.241
Dead-end Density	755	0.042	0.064	0	0.556
Sidewalk Density (ft/acre)	755	0.659	0.680	0	10.120
Route to Grocery	755	1.663	1.362	0.226	27.566
Route to Elementary School	755	0.182	0.259	0.001	2.887
Ecological Design Components					
Average Elevation (ft)	755	653.583	142.490	0	992
Lake (yes=1)	755	0.363	0.481	0	1
Distance to Park (ft)	755	1555.736	1385.536	0	10788.110
Tree Ratio	755	47.441	14.076	0.885	84.864
Tree Edge Density (m/ha)	755	1637.773	274.916	180.807	2239.353
Three Shape Index	755	25.924	11.841	7.222	81.986
Other Conditions					
Traffic (yes=1)	755	0.682	0.466	0	1
Housing Value ($)	755	254074.6	173966.1	16326.5	2563405.0
Built Year (year)	755	41.736	20.673	1.000	96.500
CONTEXT					
Structural Design Components					
Population Density (ppl/acre)	126	6.606	3.473	0.335	16.842
Affordable Housing (yes=1)	126	0.198	0.400	0	1
Land Use Mix	126	0.770	0.242	0.144	1.222
Street Connectivity (β Index)	126	1.401	0.179	0.924	1.805
Ecological Design Components					
Park Ratio	126	0.057	0.071	0.000	0.299
Green Cover Ratio	126	0.573	0.108	0.299	0.868
Other Conditions					
Median Income ($)	126	57,088.6	27,921.3	20,391.0	145,435.0
Crash	126	33.333	23.964	1	117
On-going Project (yes=1)	126	0.246	0.432	0	1
Spillover Effect	126	7.5	1.719	4	14

5.3 The Variance of Neighborhood Turnover Occurred within and across Contexts

5.3.1 The ANOVA Model

To determine the total amount of variability in the turnover rate within and between contexts, a random-effects ANOVA model was run. This model is necessary to determine how much of the variance in neighborhood turnover lies within contexts and between contexts. The formula of a random-effect ANOVA model is:

Neighborhood Level: $$T_{ij} = \beta_{0j} + r_{ij} \quad [5.1]$$

Context Level: $$\beta_{oj} = \gamma_{oo} + u_{oj} \quad [5.2]$$

Combined: $$T_{ij} = \gamma_{oo} + u_{oj} + r_{ij} \quad [5.3]$$

where *i* is the *i*th neighborhood;

j is the *j*th context;

β_{0j} is the mean turnover rate of the *j*th context;

γ_{00} is the mean turnover rate across contexts;

u_{0j} is context effect; and

r_{ij} is the residual variance at the neighborhood level.

5.3.2 Findings of Neighborhood Variance within and between Neighborhoods

The outcomes of the ANOVA model provided some useful preliminary information. First, the grand mean for the yearly turnover rate was 10.2 percent with a standard error of 0.2. Second, the reliability estimate (λ) of 0.6 indicated that sample means were reliable as an indicator of the true means of the turnover rate.

Second, the outcomes of the chi-square test statistics (χ^2), variance components, and the intra-class coefficient (ρ) affirmed whether a single or multilevel analysis was necessary (Table 5-3). First, the χ^2 test of 334.4 with 125 degrees of freedom ($p < 0.001$) indicated that the variation among contexts in their mean rate of turnover was significantly different from zero. The variance of the true context means around the grand mean, referred to as τ_{00}, was 4.6, and true neighborhood mean, referred to as σ^2, was 16.5. These estimates indicated that the variance in the means of the context was significantly different from zero and most of the variation in turnover occurs at the neighborhood level. The value of intra-class coefficient (ρ) also explained the variance of each level.

$$\rho = \frac{\tau_{00}}{(\tau_{00} + \sigma^2)} \qquad [5.4]$$

where τ_{00} is the between contexts variability and σ^2 within contexts variability

The value of ρ indicated that about 22 percent of the variance (ρ=4.595 / (4.595+16.525)= 0.218) in turnover occurred between contexts and 78 percent (100-21.8=78.2) occurred within contexts. Since this implies a difference occurred at the context level, we conducted a multilevel analysis. The necessity of using multilevel modeling was also affirmed by the “design effect” proposed by Muthen and Satorra (1995), [10] which assessed whether a multilevel analysis led to more convincing results than a single-level model. These pieces of evidences confirmed the necessity of using a multilevel model and statistically validated the theoretical assumption.

[10] The specific equation and calculation of the design effect can be found in Appendix E.

Table 5-3. Estimated Random Effects on the Random-effects ANOVA Model

Parameter	Std. Dev.	Variance Component	D.F.	χ2	p-value
Intercept (τ_{00})	2.144	4.595	125	334.376	<0.001
Level-1 (σ^2)	4.065	16.525			

5.4 The Independent Impacts of Neighborhoods on Neighborhood Turnover

5.4.1 The Random-Coefficient Model

To assess whether or not there were significant associations between neighborhood turnover and neighborhood conditions regardless of context conditions, a random-coefficient model was employed. Random-coefficient models allow us to analyze the impact of predictor variables at the neighborhood level on the turnover rate within each context. An incremental approach was taken to identify the influence of each set of neighborhood conditions: structural components, ecological components, and other conditions. Model 1 only included structural design characteristics such as median lot size, the mix of housing types, street shape, sidewalks, and connectedness to the nearest grocery store and the nearest elementary school. Model 2 added ecological design components such as average elevation, being near lakes and parks, and tree size and shape to the characteristics listed in Model 1.[11] Model 3, the full model, invited all predictor variables including control variables such as traffic, median housing value, and median year built. The full model is shown below.

[11] More explanations and results of model 1 and model 2 can be found in Appendix G.

Neighborhood Level:
$$T_{ij} = \beta_{0j} + \beta_{1j}(LMEDLOT) + \beta_{2j}(LMSFRAT) + \beta_{3j}(DEADDEN) + \beta_{4j}(LSIDEN) + \beta_{5j}(LDSGRO) + \beta_{6j}(LDSELE) + \beta_{7j}(AVEELEV) + \beta_{8j}(LAKE500) + \beta_{9j}(DISPARK) + \beta_{10j}(TRRAT) + \beta_{11j}(TREDEN) + \beta_{12j}(TRLSI) + \beta_{13j}(TRAF500) + \beta_{14j}(LMEDVAL) + \beta_{15j}(MBUILT) + r_{ij} \quad [5.5]$$

Context Level:
$$\beta_{qj} = \gamma_{q0} + u_{qj} \quad \text{for } q\text{=0, 1, 2, 6, 8, 14, and 15} \quad [5.6]$$
$$\beta_{qj} = \gamma_{q0} \quad \text{for } q\text{=3, 4, 5, 7, 9, 10, 11, 12, and 13}$$

where all neighborhood level predictor variables are group centered;[12]

r_{q0} is the mean value of neighborhood turnover for each context; and

u_{ij} represents random effect of j^{th} of context for *i*, which is different across contexts.[13]

5.4.2 The Impacts of Neighborhoods without Context Conditions

5.4.2.1 Explained Variance

Similar to the R-squared value in an OLS, total explainable variance was calculated in an multilevel model. Kreft and De Leeuw (1998) suggested a formula to clarify within-unit variance as shown below.

$$Within\ Explained\ Variance\ (R^{2*}) = \frac{\sigma^2(ANOVA) - \sigma^2(Random - Coefficient)}{\sigma^2(ANOVA)} \quad [5.7]$$

When only considering neighborhood conditions, structural design features explained 25.6 percent of neighborhood variance in the mean turnover rate (R^{2*}=(16.525-12.295) /16.525=0.256). When ecological design components were added,

[12] Explanations about centering can be found in See Appendix F.

[13] Descriptions about which independent variables to given random effects or fixed effects can be found in Appendix H.

the explained variance increased to 36.8 percent (R^{2*}=(16.525-10.450) /16.525=0.368). The final model illustrated 60.4 percent of the neighborhood level variance in the mean turnover rate (R^{2*}=(16.525-6.538) /16.525=0.604). This indicated that structural design elements explained 25.6 percent of the neighborhood level variance in the mean owner change and ecological design components alone were responsible for 11.2 percent. The other 23.6 percent was accounted for by other conditions such as traffic, median housing value, and year built. The outcomes suggested that the full model had more explanatory power than the other two models. The chi-square value indicated that there was a residual variance to be explained at the neighborhood level. The variance of the true neighborhood mean around the group mean, referred to as σ^2 is presented in Table 5-4.

Table 5-4. Estimated Random Effects of the Random-Coefficient Models

Models	Parameter	Std. Dev.	Variance Component	D.F.	χ2	p-value
Model 1	Intercept (τ_{00})	2.372	5.625	93	182.426	<0.001
	Level-1 (σ^2)	3.506	12.295			
Model 2	Intercept (τ_{00})	2.454	6.021	56	126.613	<0.001
	Level-1 (σ^2)	3.233	10.450			
Full Model	Intercept (τ_{00})	2.628	6.908	25	105.456	<0.001
	Level-1 (σ^2)	2.557	6.538			

5.4.2.2 The Impact of Neighborhood Design Only[14]

The statistical inference of each predictor variables is presented in Table 5-5. The mean owner change across neighborhoods was 10.2 percent. A higher density tended to promote more frequent owner changes. Holding all other variables constant, a

[14] Only the results of the full model were interpreted since it explained more of the impacts on turnover than do the other two models.

one percent increase in median lot size decreased the mean turnover rate in a neighborhood by 3.2 percent. Owners who lived in a neighborhood with streets with fewer connections were likely to stay longer. A one-unit increase in dead-end density engaged in reducing the mean turnover rate by 6.9 percent. Being located near hills had a positive influence in decreasing the mean turnover rate. Holding all other variables constant, a one hundred foot increase in average elevation was associated with a decline in the mean turnover rate of 0.5 percent. Trees with larger and more complex shapes contributed to a decrease in the mean turnover rate. A one percent improvement in the tree ratio was associated with a 0.05 percent decrease and a one-unit increase in tree edge density a 0.004 percent decreased in the mean turnover rate.

Other than design characteristics, economic status and housing adequacy significantly influenced turnover. Owners who lived in a wealthy neighborhood were more likely to stay a shorter amount of time; a one percent increase in the median value of housing promoted a 2.6 percent increase in the mean turnover rate. On the other hand, residents were more likely to stay longer in older neighborhoods; a one year increase in the median built year of housing structure resulted in a 0.05 percent decrease in the mean neighborhood turnover.

5.4.2.3 Comparing the Magnitude

As shown in explained variance section, a set of structural components was relatively the most influential (25.6 percent) followed by other conditions (23.6 percent) and ecological design factors (11.2 percent). Yet, this information was not enough to reveal the most critical design elements for determining turnover.

The magnitude of each neighborhood was compared by running an HM with standardized data. The standardized results indicated that the level of housing value was relatively the most critical factor in determining the turnover. With regard to design components only, tree edge density was revealed as the strongest predictor of neighborhood turnover.

Table 5-5. The Results of the Final Random-Coefficient Model

Variable	b	B	Std. Err.	t	D.F	P>t	Sig
Mean Turnover	10.229	.	0.254	40.267	125	<0.001	***
Structural Design Components							
Lot Size	-3.241	-1.066	0.620	-5.231	125	<0.001	***
Housing Mix	-0.087	-0.132	0.089	-0.976	125	0.331	
Dead-end Density	-6.863	-0.439	1.947	-3.525	746	<0.001	***
Sidewalk Density	-0.131	-0.195	0.083	-1.567	746	0.118	
Route to Grocery	-0.440	-0.174	0.303	-1.454	746	0.146	
Route to Elementary School	0.035	0.034	0.129	0.269	125	0.788	
Ecological Design Components							
Average Elevation	-0.005	-0.683	0.002	-2.741	746	0.006	***
Lake	0.179	0.086	0.336	0.535	125	0.594	
Distance to Park	0.000	0.320	0.000	1.618	746	0.106	
Tree Ratio	-0.048	-0.671	0.015	-3.174	746	0.002	***
Tree Edge Density	-0.004	-1.115	0.001	-6.532	746	<0.001	***
Three Shape Index	-0.011	-0.126	0.012	-0.892	746	0.373	
Other Conditions							
Traffic	0.134	0.063	0.267	0.503	746	0.615	
Housing Value	2.554	1.448	0.834	3.061	125	0.003	***
Built Year	-0.048	-0.988	0.025	-1.944	125	0.054	*

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

5.5 The Independent Impacts of Contexts on Neighborhood Turnover

5.5.1 The Means-as-Outcomes Model

To identify the influence of context conditions, independent from neighborhood conditions, a means-as-outcome model was employed. Similar to a random-coefficient model, three models were run incrementally. Model 1 explained the impacts of structural design features such as population density, the presence of affordable housing, mixed land use, and street connectivity. Model 2 expanded Model 1 with ecological design components such as the ratio of parks and green cover to total land. The full model examined the impacts of all predictor variables including socio-economic status, on-going development projects, crime, and spillover effects. The full model is shown below.[15]

Neighborhood Level: $$T_{ij} = \beta_{0j} + r_{ij} \qquad [5.8]$$

Context Level: $$\beta_{0j} = \gamma_{00} + \gamma_{01}(POPDEN) + \gamma_{02}(SMART) + \gamma_{03}(MIXLAND) + \gamma_{04}(BETA) + \gamma_{05}(GRRAT) + \gamma_{06}(PARKRAT) + \gamma_{07}(LINCOME) + \gamma_{08}(CRASH) + \gamma_{09}(PROJECT) + \gamma_{10}(NEIGH) + u_{oj} \qquad [5.9]$$

where all context level variables are grand-mean centered.

5.5.2 The Impacts of Contexts without Considering Neighborhood Conditions

5.5.2.1 Explained Variance

Kreft and De Leeuw (1998) and Arnold (1992) suggested the formula to calculate the proportion of variance between contexts after controlling context predictor

[15] More explanations and results of model 1 and model 2 can be found in Appendix H.

variables. This refers to between explained variance.

$$Between\ Explained\ Variance\ (R^{2*}) = \frac{\tau_{00}(ANOVA) - \tau_{00}(Means-as-Outcomes)}{\tau_{00}(ANOVA)} \qquad [5.10]$$

When considering the context conditions only, structural components explained 23.7 percent (R^{2*}=(4.595-3.506) /4.595=0.237) of the variance in the mean turnover rates between contexts. All design elements explained 20.7 percent of between contexts variance in mean neighborhood turnover (R^{2*}=(4.595-3.642) /4.595=0.207). This indicated that ecological design components do not explain the variance of mean turnover.[16] The set of ecological features introduced here were not useful in explaining the mean turnover rates at the context level. Adding other control variables helped to increase the explained variance of the mean of the turnover rate by about 24.8 percent (R^{2*}=(4.595-3.454) / 4.595=0.248). The explained variance indicated that the full model was more useful in explaining turnover rate than the other two models. The variance of the true context mean around the grand mean, referred to τ_{00}, is presented in Table 5-6.

The explained variance between contexts showed that neighborhood turnover was explained more with neighborhood characteristics than contexts, recalling the 60.4 percent explained variance of within contexts. This information assured us that contexts

[16] Reducing variance when new variables were added never happens in an OLS, but in multilevel modeling. Recchia (2010, 3) explained that "the addition of an explanatory variable to a multilevel model can simultaneously increase some of the variance components and decrease others. This means that examining the individual components of variance separately by way of a traditional R^2 can lead to surprising outcomes like negative values or values that decrease when a new regressor is added to the model." The negative value means that an added regressor does not explain the variance.

were significant to neighborhood turnover, but neighborhoods had more impacts.

Table 5-6. Estimated Random Effects on the Regression with Means-as-Outcomes

Models	Parameter	Std. Dev.	Variance Component	D.F.	χ2	p-value
Model 1	Intercept (τ_{00})	1.872	3.506	121	281.884	<0.001
	Level-1 (σ^2)	4.063	16.507			
Model 2	Intercept (τ_{00})	1.908	3.642	119	283.429	<0.001
	Level-1 (σ^2)	4.060	16.481			
Full Model	Intercept (τ_{00})	1.858	3.454	115	267.389	<0.001
	Level-1 (σ^2)	4.053	16.424			

5.5.2.2 The Impacts of Context Design Only[17]

Table 5-7 presents the specific statistical inference of each predictor variable. The results of the full model indicated that a higher population density, mixed land use, and spillover effects of contexts contributed to a reduced rate of neighborhood turnover. A one-unit increase in population density was associated with a 0.3 percent decrease in the average turnover, holding other variables constant. A one-unit increase in Shannon's index resulted in a decrease in the mean owner change by 2.2 percent. Neighborhood spillover effects also decreased the mean turnover rate. When one additional context shared boundaries with, the mean turnover rate was reduced by 0.4 percent.

5.5.2.3 Comparing the Magnitude

The explained variance partially implied that a set of structural components (23.7

[17] Only the results of the full model were interpreted since it explained more of the impacts on turnover than do the other two models.

percent) was more influential than other characteristics. Population density of contexts was relatively the most influential factor in deciding whether residents would stay or move.

Table 5-7. The Results of Final Regression with Means-as-Outcomes Model

Variable	b	B	Std. Err.	t	D.F	P>t	Sig
Structural Design Components							
Population Density	-0.332	-0.252	0.097	-3.425	115	<0.001	***
Affordable Housing	0.935	0.082	0.698	1.340	115	0.183	
Land Use Mix	-2.185	-0.114	1.267	-1.725	115	0.087	*
Street Connectivity	2.455	0.096	1.583	1.551	115	0.124	
Ecological Design Components							
Park Ratio	-2.348	-0.037	3.522	-0.667	115	0.506	
Green Cover Ratio	1.708	0.040	3.214	0.532	115	0.596	
Other Conditions							
Median Income	-1.153	-0.112	0.887	-1.300	115	0.196	
Crash	0.001	-0.001	0.010	0.083	115	0.934	
On-going Project	0.782	0.074	0.534	1.466	115	0.145	
Spillover Effect	-0.369	-0.137	0.138	-2.676	115	0.009	***

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

5.6 The Spontaneous Impacts of Neighborhoods and Contexts on Neighborhood Turnover

To observe the impacts of neighborhoods on neighborhood turnover considering contextual conditions spontaneously, an intercepts-and-slopes-as-outcomes model was run, which included both neighborhood and context predictors at both levels.

5.6.1 The Intercepts-and-slopes-as-outcomes Model

5.6.1.1 Model Description[18]

The intercepts-and-slopes-as-outcomes model, also known as the mixed model, describes how the variance in the slope across contexts was related to the predictor variables of neighborhoods. This is a direct test of the joint effects of contexts. The formula of intercepts-and-slopes-as-outcomes model is shown below. The equation of the neighborhood level remains the same as the random-coefficient model, but the context level was expanded.

Neighborhood Level:

$$\begin{aligned} T_{ij} = {} & \beta_{0j} + \beta_{1j}(LMEDLOT) + \beta_{2j}(LMSFRAT) + \beta_{3j}(DEADDEN) + \\ & \beta_{4j}(LSIDEN) + \beta_{5j}(LDSGRO) + \beta_{6j}(LDSELE) + \beta_{7j}(AVEELEV) + \\ & \beta_{8j}(LAKE500) + \beta_{9j}(DISPARK) + \beta_{10j}(TRRAT) + \beta_{11j}(TREDEN) + \\ & \beta_{12j}(TRLSI) + \beta_{13j}(TRAF500) + \beta_{14j}(LMEDVAL) + \beta_{15j}(MBUILT) + r_{ij} \end{aligned} \quad [5.11]$$

Context Level:

$$\begin{aligned} \beta_{qj} = {} & \gamma_{q0} + \gamma_{q1}(POPDEN) + \gamma_{q2}(SMART) + \gamma_{q3}(MIXLAND) + \\ & \gamma_{q4}(BETA) + \gamma_{q5}(GRRAT) + \gamma_{q6}(PARKRAT) + \gamma_{q7}(LINCOME) + \\ & \gamma_{q8}(CRASH) + \gamma_{q9}(PROJECT) + \gamma_{q10}(NEIGH) + u_{qj} \end{aligned} \quad [5.12]$$

for q=0, 1, 2, 6, 8, 14, and 15

$$\beta_{qj} = \gamma_{q0} \qquad \text{for } q=3, 4, 5, 7, 9, 10, 11, 12, \text{ and } 13$$

where predictor variables at the neighborhood level are group-mean centered and those in context level are grand-mean centered.

[18] There is a concern of the location of neighborhoods within contexts. If a neighborhood is located farther from the center of a context, the impacts of a given context maybe less likely to influence the neighborhood. In Appendix N, results of a revised model that includes the centrality of neighborhoods in contexts are presented. The outcomes of the revised model indicates that the centrality of neighborhoods do not impact the original model.

5.6.1.2 Explained Variance

The degree to which the independent variables of the context level accounted for the between contexts variances in neighborhood turnover was compared with the random-coefficient model, which only included explanatory variables at the neighborhood level. The proportion of variance at the context level was estimated as follows.

$$\text{Between Explained Variance } (R^{2*}) = \frac{\tau_{00}(Random-Coefficient) - \tau_{00}(Fitted)}{\tau_{00}(Random-Coefficient)} \qquad [5.13]$$

Adding predictors of contexts reduced variation in mean owner changes by 20.9 percent (=[(6.908-5.462) /6.908]=0.209). The values of τ_{00} are presented in Table 5-12. As reported in the random-coefficient model, neighborhood conditions alone explained 60.4 percent of the variance in the mean neighborhood turnover.

5.6.2 The Impacts of Contexts on the Association between Neighborhoods and Turnover

5.6.2.1 The Impacts of Neighborhood and Context Design[19]

The statistical inference of each predictor variables is presented in Table 5-8. Neighborhood with larger lots, streets with fewer connections and more sidewalks, nearby hills or mountains and parks or greenways, and tree patterns with larger and

[19] Only the results of the full model were interpreted since it explained more of the impacts on turnover than do the other two models.

complicated shapes were less likely to experience frequent owner shifts. Contexts with high population density, more mixed land use, and more spillover effects contributed to decreasing neighborhood turnover. In addition, some combinational influences between neighborhoods and contexts mediated or augmented the mean turnover rate when they were combined with certain neighborhood characteristics. Only statistically meaningful results were interpreted.

Structural Design Component

The median lot size was negatively related to neighborhood turnover, which was statistically significant. For a one percent increase in median lot size, the mean turnover rate decreased by about 3.7 percent, holding all other variables constant.

The share of multi-family housing had no impact on neighborhood turnover, but the interactions with income, the presence of affordable housing, and the number of car crashes in contexts showed some statistically significant influences. In a context with affordable housing, the slope of the housing mix over the turnover rate was increased by 0.6 percent on average. For a one percent increase in median income, the slope increased by 1.0 percent, and for having one additional car crash, the slope increased by 0.01 percent. For ease of understanding, the interaction term was explained in terms of low (the mean minus one standard deviation) and high (the mean plus one standard deviation) conditions (Table 5-9). If there was affordable housing with high median income and high car crashes in a context, an additional one percent increased in the multi-and single-family housing ratio, the mean turnover rate increased by 5.8 percent (=-0.095+(0.614×1)

+(0.979×log (85009.920))+(0.008×57.297)=5.803). If a context lacked affordable housing and had a low median income and low car crashes in contexts, the mean turnover rate increased by about 4.4 percent (=-0.095+(0.614×0)+(0.979× log (29167.300)) +(0.008×8.58)=4.351). These indicate that if a neighborhood was nested in a context that has affordable housing, a higher median income, and more car crashes, the neighborhood was usually less able to convert a higher housing mix ratio into decreasing turnover.

Table 5-8. The Low and High Value of Affordable Housing, Median Income, and Crash

Variable	Low	High
Affordable Housing $_{(yes=1)}$	0	1
Median Income $_{(\$)}$	29,167.300	85,009.920
Crash	9.370	57.297

The increased number of dead ends per acre tended to decrease the shift of owners. A one-unit increase in dead-end density decreased mean turnover rate by 5.9 percent, which was statistically significant at the 0.01 level. That was, residents in a neighborhood having streets with fewer connections were more likely to remain in that neighborhood. **Sidewalk density** had a negative impact on the mean turnover rate. A one percent increase in sidewalks decreased the mean turnover rate by about 0.2 percent, which was statistically significant at the 0.1 level. Hence, sidewalks were perceived as an appealing factor in helping residents decide to stay in their neighborhoods.

The increased route directness to the nearest elementary school alone had no influence on neighborhood turnover. Yet, the influences of park and green cover ratio of the contexts showed interactional relationships with the condition of route directness to the nearest elementary school. The impact of park ratio reduced the slope of the route directness to an elementary school over the mean turnover rate by 5.0 percent. For a one-unit increase in green ratio in a context, the slope of route directness to the closest elementary school over the mean turnover rate was increased, on average, by 4.6 percent. The low and high values of park ratio and green cover ration are in Table 5-9. For a one-unit increase in route directness to the nearest elementary school, if a neighborhood was nested in a context with a high park ratio and a high green ratio, the mean turnover rate of a neighborhood increased by 2.6 percent (=0.054+(-4.995×0.128) + (4.610×0.681))=2.554); with a low park ratio and a high green ratio, the owner change ratio of a neighborhood was increased by 3.2 percent (=0.054+(- 4.995×0.000) +(4.610×0.681) =3.193); with a high park ratio and a low green ratio, the owner change ratio of a neighborhood was increased by 1.6 percent (=0.054+(- 4.995×0.0128) +(4.610×0.465) =1.558). The results indicated that shorter travel paths to the nearest elementary school became meaningful in reducing neighborhood turnover when surrounded by parks, not green areas.

Table 5-9. The Low and High Value of Green Cover Ratio and Park Ratio

Variable	Low	High
Park Ratio	0.000	0.128
Green Cover Ratio	0.465	0.681

Ecological Design Component

Average elevation was negatively related to the mean turnover rate. A one hundred foot increase in average elevation converted to a decrease in the turnover rate by about 0.5 percent, which was statistically significant at the 0.05 level. This informed that residents who lived in neighborhoods closer to hills or mountains were more likely to stay. **Being within 500 feet of lakes** alone did not show any statistically significant impact, but the interactional relationships with the green ratio and spillover effects in contexts made the impacts of living near lakes significant. For a one-unit increase in the green ratio, the slope of being near a lake decreased by 9.2 percent. For one additional surrounding context, the slope of being near a lake decreased by 0.5 percent. The low and high value of spillover effect in Table 5-10. Within 500 feet of lakes, if the hosting context has a high green ratio and high spillover effects, the mean turnover rate declined by 10.2 percent (=0.376+(-9.154×0.681)+(-0.467×9.219)=-10.163). With a low green ratio and low spillover effects, the mean rate of owner change decreased by 6.6 percent (=0.376+(-9.154××0.465)+(-0.467×5.781)=-6.580). Green areas and surrounding contexts reduced neighborhood turnover of neighborhoods near lakes.

Table 5-10. The Low and High Value of Spillover Effect

Variable	Low	High
Spillover Effect	5.781	9.219

The distance to the edge of the nearest park from the neighborhood center had a positive association with turnover. A neighborhood located one thousand foot farther away from the nearest park, the mean turnover rate increased by 0.3 percent. This was statistically significant at the 0.05 level. This showed that residents were more likely to stay longer in a place where parks were nearby.

The increased tree patches ratio tended to decrease the mean turnover. A one percent increase in the tree patch ratio lowered the mean turnover rate by an average of 0.04 percent, holding all other variables constant. This was statistically significant at the 0.05 level. This indicated that residents might prefer to stay in neighborhoods that had proportionally larger tree areas. **The total tree edge per unit area** was negatively associated with the mean turnover rate; a one-unit point increase in tree edge density decreased the mean turnover rate by 0.004 percent, which was statistically significant at the 0.01 level. This informed that relatively large and complicated tree covers contributed to the reduction of repeated owner changes.

Other Conditions

Median housing value showed a positive relationship to mean neighborhood turnover; neighborhoods with more expensive houses might experience higher turnover. A one percent increase in the median housing value of a neighborhood raised the average turnover rate by 2.7 percent. The interaction with the green ratio of the context lowered the impacts of the median housing value on increased turnover. For a one-unit increase in the green ratio, the slope of the median housing value over turnover rate decreased, on average, by 27.4 percent. For a one percent increase in the median housing value, the turnover rate for neighborhoods nested in a context with a high green ratio decreased by 79.7 percent (=2.699+(-27.393×0.681)= -15.956). With a lower green ratio, the turnover rate lowered by 10.0 percent (=2.699+ (-27.393×0.465)= -10.039). These results indicated that the median housing value of neighborhood alone could not account for neighborhood turnover, but green areas in contexts help reduced neighborhood turnover of the wealthy neighborhoods. **The age of neighborhoods**, measured by the average year built of housing structures, did not show a statistically significant impact. However, the interaction with the population density of a context showed positive impacts. This meant that having a higher population density in a context increased the slope of the age of the neighborhood over the mean turnover rate by about 0.03 percent. The low and high value of population density is in Table 5-9. For a one percent increase in age of a neighborhood, if a neighborhood was nested in a context with a high population density, the turnover rate of a neighborhood increased by 0.3 percent (=-0.041+(0.030×10.079)=0.261); with a lower population density, the turnover rate increased by about 0.1 percent (=-0.041+(0.030×3.133) =0.053). This showed that more frequent neighborhood turnover was likely to occur where older neighborhoods were nested in a populous context.

Table 5-11. The Low and High Value of Population Density

Variables	Low	High
Population Density	3.133	10.079

Population Density, Land Use Mix, and Spillover Effects of Contexts

The outcomes were not different from the results of the means-as-outcomes model. Residents in contexts with high population density and more mixed land uses (high Shannon's index) were likely to remain in their neighborhoods. A one-unit increase in population density and Shannon's index resulted in a 0.4 and 2.2 percent decrease in the mean turnover, respectively. Sharing boundaries with more contexts contributed to the reduction of neighborhood turnover. Having one additional adjacent context decreased the mean turnover rate by 0.4 percent.

5.6.2.2 Comparing the Effects

Comparing Explained Variance

To compare the relative contribution of each set of variables, the explained variances were observed. The values of variance components of each model are shown in Table 5-10.

Model 1-1 only included structural components at the neighborhood level, with full sets of parameters at the context level. Model 1-2 added ecological design components of neighborhoods on top of Model 1-1. The full model had structural and ecological design components and other control variables at the neighborhood and context levels. Explained variance was calculated by matching a means-as-outcomes model with Model 1-1, Model 1-2, and the full model. The results from Model 1-1 indicated that structural components in neighborhoods explained 25.3 percent of the neighborhood level variance in the turnover rate (=(16.424-12.276)/ 16.424=0.253), when factoring in conditions of contexts. The outcome of Model 1-2 suggested that neighborhood designs approximately 36.8 percent of neighborhood level variance (=(16.424-10.388)/ 16.424=0.368). That was, a set of ecological elements described 11.5 percent of neighborhood turnover variance. The conditions other than design elements explained about 24.3 percent of the variance within neighborhoods. Therefore, we can say that a group of structural design components show more influence than other neighborhood characteristics.

Similarly, to identify the explained variances of each group of design elements and other conditions of contexts influencing the turnover rate, three models were compared. Model 2-1 expanded a random-coefficient model, adding structural design features at the context level with a full set of neighborhood level variables; Model 2-2 added ecological design components of contexts based on model 2-1. The variance of the mean turnover rate was reduced by 18.2 percent when introducing structural design components (=(6.908-5.654)/ 6.908=0.182). Model 2-2 suggested that context designs explain 16.4 percent of variation in the mean turnover rate (=(6.908-5.773)/ 6.908=0.164). This indicated that ecological design components did not explain the variance of neighborhood turnover between contexts; the explained variance was even reduced by 1.8 percent when ecological design features were added. In Model 2-3, 20.9 percent (=(6.908-5.462)/ 6.908=0.209) of variation in the mean turnover rate was explained. Contextual conditions other than designs of the context only explained 2.7 percent. Overall, structural designs were relatively more influential than ecological designs in contexts.

Table 5-12. Estimated Random Effects on the Intercepts-and-Slopes-as-Outcomes Model

Model Specifications			Intercept	Level-1	D.F	R^{*2}	R^{*2} of
Model	N level	C Level	(τ_{00})	(σ^2)		of Total (%)	Each Domain (%)
ANOVA	-	-	4.595	16.525	125		
Radom-Coefficient	S +E + C	-	6.908	6.538	25		
Means-as-Outcome	-	S +E + C	3.454	16.424	115		
NEIGHBORHOOD							
Model 1-1	**S**	S +E + C	4.270	12.276	83	25.3	**25.3**
Model 1-2	S+ **E**	S +E + C	4.609	10.388	46	36.8	**11.5**
Full Model	S +G + **C**	S +E + C	5.462	6.387	15	61.1	**24.3**
CONTEXT							
Model 2-1	S +E + C	**S**	5.654	6.603	21	18.2	**18.2**
Model 2-2	S +E + C	S+ **E**	5.773	6.500	19	16.4	**0.0**
Full Model	S +E + C	S +E + **C**	5.462	6.387	15	20.9	**2.7**

S: Structural Design Components
E: Ecological Design Components
C: Controls

Comparing Magnitude

The statistical significance changed between standardized and unstandardized models, while the signs remained consistent. Therefore, we may compare the relative magnitude of each variable with standardized coefficient. The interactional relationship between the age of neighborhoods and the population density of contexts was the most influential factor in turnover. Considering only design elements, the lot size was the most important factor at the neighborhood level, while population density was the most important design factor at the context level.

Table 5-13. Results of The Intercepts-and-Slopes-as-Outcomes Model

Variable	b	B	Std. Err.	t	D.F	P>t	Sig
NEIGHBORHOOD							
Structural Components							
Lot Size	-3.702	-1.231	0.715	-5.178	115	<0.001	***
Housing Mix	-0.095	-0.138	0.098	-0.966	115	0.336	
** Affordable Housing*	0.614	0.359	0.304	2.022	115	0.045	**
**Median Income*	0.979	0.644	0.410	2.386	115	0.019	**
** Crash*	0.008	0.272	0.004	2.026	115	0.045	**
Dead-end Density	-5.915	-0.377	2.051	-2.884	746	0.004	***
Sidewalk Density	-0.157	-0.232	0.085	-1.838	746	0.067	*
Route to the Grocery Store	-0.395	-0.155	0.319	-1.240	746	0.216	
Route to the Elementary School	0.054	0.061	0.139	0.386	115	0.700	
**Park Ratio*	-4.995	-0.346	2.386	-2.093	115	0.039	**
**Green Cover Ratio*	4.610	0.499	2.034	2.266	115	0.025	**
Ecological Components							
Average Elevation	-0.005	-0.614	0.002	-2.563	746	0.011	**
Lake	0.376	0.189	0.366	1.027	115	0.307	
**Green Cover Ratio*	-9.154	-0.466	4.567	-2.004	115	0.047	**
**Spillover Effect*	-0.467	-0.386	0.212	-2.204	115	0.030	**
Distance to Park $^{\Phi}$	0.033	0.469	0.015	2.185	746	0.029	**
Tree Ratio	-0.037	-0.516	0.016	-2.335	746	0.020	**
Tree Edge Density	-0.004	-1.102	0.001	-5.889	746	<0.001	***
Three Shape Index	-0.008	-0.095	0.012	-0.677	746	0.499	
Other Conditions							
Traffic	0.151	0.073	0.278	0.543	746	0.588	
Housing Value	2.699	1.531	1.006	2.683	115	0.008	***
**Green Cover Ratio*	-27.393	-1.705	14.125	-1.939	115	0.055	*
Built Year	-0.041	-0.831	0.027	-1.534	115	0.128	
**Population Density*	0.030	2.151	0.012	2.526	115	0.013	**
CONTEXT							
Structural Components							
Population Density	-0.350	-1.217	0.096	-3.638	115	<0.001	***
Affordable Housing	0.824	0.329	0.702	1.173	115	0.243	
Land Use Mix	-2.248	-0.538	1.284	-1.751	115	0.083	*
Street Connectivity	2.405	0.432	1.610	1.494	115	0.138	
Ecological Components							
Park Ratio	-3.539	-0.254	3.583	-0.988	115	0.325	
Green Cover Ratio	2.313	0.246	3.240	0.714	115	0.477	
Other Conditions							
Median Income	-1.347	-0.598	0.896	-1.504	115	0.135	
Crash	0.002	0.009	0.011	0.154	115	0.878	
On-going Project	0.863	0.373	0.545	1.583	115	0.116	
Spillover Effect	-0.383	-0.653	0.140	-2.736	115	0.007	***

* $\rho < 0.1$ ** $\rho < 0.05$ *** $\rho < 0.01$

Φ Coefficients and standard errors are multiplied by 100

CHAPTER VI

CONCLUSION

6.1 Introduction

This chapter summarizes and presents the **findings of each hypothesis**. The impacts of independent and spontaneous conditions of neighborhoods and contexts on neighborhood turnover are compared. Possible **supporting explanations** for findings are then **discussed**. Further, the results driven by single- and multilevel approaches are compared. This demonstrates the motive for using multilevel approaches, when the unit of analysis has a hierarchical structure. Recommendations about how findings of this dissertation can be **employed in planning policy and practice** follow. The **limitations** and **suggestions** for future study are also mentioned.

6.2 Summary of Findings

This paper examined the independent and spontaneous impacts of neighborhood and context designs on neighborhood turnover in Austin, Texas, using multilevel linear modeling. Neighborhoods and contexts were theoretically defined by two different hierarchical sizes of neighborhoods—residential and institutional neighborhoods. For the operation and data collection, subdivisions (n=755) and census tracts (n=126) were chosen since both fit the theoretical concept of residential and institutional neighborhoods. The influences of design elements were observed with two domains, structural (i.e., density, land use, housing mix, and street patterns) and ecological design components (i.e., natural feature, open space, and landscape patterns). Neighborhood turnover was employed as a reflection of neighborhood satisfaction and stability. It was measured by average owner shifts of single-family homes per year revealed in deed history data. Findings of this study confirm hypotheses 1, 2, and 3, while rejecting hypothesis 4 (Table 6-1).

6.2.1 Findings for Hypothesis 1

Hypothesis 1 asks whether neighborhood design has an influence on neighborhood turnover. The results of the random-coefficient model—which does not consider the interactional influence from contexts—confirm hypothesis 1. Owners are willing to stay longer in neighborhoods with large lots and streets with fewer connections, which are possibly cul-de-sac or loop style. Living near a mountain or hill and having trees with larger and more complex shapes are also considered attractive determinants prompting residents to stay in their neighborhoods. Among design factors, the size and shape of trees are the most prominent factor for recurrent owner changes in neighborhoods when traffic, median value, and year built of neighborhoods are taken into account.

6.2.2 Findings for Hypothesis 2

The outcome of the means-as-outcome model—which only considers the impacts of context design on neighborhood turnover—confirms hypothesis 2. Context design has an influence on neighborhood turnover. When considering the impacts of context only, density and mixed land uses within contexts are significant determinants of neighborhood turnover when income, crashes, on-going projects, and spillover effects from adjacent contexts are taken into account. Ecological design components such as the size of open spaces and green areas do not show any significant influence on neighborhood turnover. Higher population density is the most critical condition that encourages people to stay longer in their contexts. Context and neighborhood conditions effect neighborhood turnover, but neighborhood conditions explain more about it.

6.2.3 Findings for Hypothesis 3

The findings from the intercepts-and-slopes-as-outcomes model confirm hypothesis 3. For the model, design characteristics of contexts are simultaneously evaluated in the relationship between neighborhood design and turnover. The model finds that contexts influence the relationships between neighborhoods and turnover. The outcomes of intercepts-and-slopes-as-outcomes model specify that the variance in mean neighborhood turnover is reduced when introducing contextual characteristics. Further, the results do not remain the same in cases when neighborhood and context conditions are independently considered. The desirable design conditions for the reduction of neighborhood turnover at the neighborhood level include larger lots, streets with fewer connections, sidewalks, nearby parks, and trees with larger and more complex shapes. At the context level, high population density and mixed land uses reduce neighborhood turnover. In comparison with outcomes from models that consider neighborhood and context conditions individually, the existence of sidewalks and shorter distances to parks or greenways become significant factors. We also found combinational impacts between neighborhood and context characteristics. Some associations between neighborhood and context conditions mediate repeated owner changes, while others augment them. For example, the presence of multi-family housing has no influence on neighborhood turnover, but, if a neighborhood is nested in a context with affordable housing, high-income class, or car crashes, multi-family homes play roles in inducing frequent neighborhood turnover. A shorter route distance to elementary schools tends to decrease turnover only when larger parks exist in a context, while larger green areas do the opposite. Locating near a lake does not show any significant impact on neighborhood turnover, but the turnover does tend to decrease when a lake neighborhood is surrounded by more adjacent contexts or larger green areas.

6.2.4 Findings for Hypothesis 4

When considering the characteristics of neighborhoods and contexts spontaneously, the results reject hypothesis 4. Hypothesis 4 suggests that ecological design components are the most influential in neighborhoods, while structural design features are the most influential in contexts. Density is the most powerful design factor in both neighborhoods and contexts, but contrasts each other. A larger lot size decreases turnover the most, yet a lower population density increases it. Further, comparisons of the explained variance of a set of structural design components, ecological design components, and other conditions indicate that structural design components explain more about neighborhood turnover than other factors in both neighborhoods and

Table 6-1. Comparing Results of Separate Multilevel Model vs. Combined Model

Construct		Neighborhood & Context Condition	Separate Model: Neighborhood	Separate Model: Context	Combined Model: Neighborhood	Combined Model: Context
Structural Feature	**Density**	Higher Development Intensity	↑		↑	
		Higher Population Density		↓		↓
	Mixed-use	Having More Multi-family Housing				
		Having Affordable Housing				
		More Mixed Land Use		↓		↓
	Street Pattern	Better Street Connectivity	↑		↑	
		More Sidewalk			↓	
		Better Connection to Grocery				
		Better Connection to Elementary School				
Ecological Feature	**Nature-in**	Closer to Mount/Hills	↓		↓	
		Closer to Lakes				
	Open Space	Closer to Parks			↓	
		Larger Parks and Greenways				
	Landscape Pattern	Relatively Larger Trees	↓		↓	
		Larger & More Complex Trees	↓		↓	
		More Complex Tree Patterns				
		Larger Green Area				
	Control	Better Economic Status	↑		↑	
		Living Closer to Traffic				
		More Car Crashes				
		Older the Neighborhood	↓			
		On-going Projects within				
		More Spillover Effects		↓		↓

↑ : Increasing Neighborhood Turnover ↓: Decreasing Neighborhood Turnover contexts. At the neighborhood level, other than design factors such as traffic, median housing value, and the age of housing structure are as important as structural design features.

Given the impacts of neighborhood and context design independently, however, tree patch density is the most influential in neighborhoods, while population density is the most important in context among the design elements.

6.3 Discussion

6.3.1 The Impacts of Neighborhood and Context Design

Several interesting points are drawn from findings of this study.

First, neighborhood and context design have their unique and interactional roles in neighborhood turnover.

Neighborhood design has more impact than context design because residents may have much more frequent contacts with their immediate surroundings. The influences of contexts, however, are not negligible. Almost one-fourth of neighborhood turnover are explained by contextual conditions.

Second, the same design principles are often perceived differently depending on neighborhood scales.

High density is the most critical design element determining neighborhood turnover, but it has been perceived as a good condition in contexts, but bad condition in neighborhoods. Namely, residents prefer a lower level of development intensity in neighborhoods, while a higher density in their contexts. These findings support the ideas of two different ends. There is no supporting argument that explains this discrepancy, but possibly high density may be perceived as crowdedness causing stress and psychological overload in immediate neighborhoods (Frank and Engelke 2001; Kearney 2006). People may keep their personal anonymity, or interactions may exceed residents' contact capacity in residential neighborhoods. High density in contexts, on the other hand, can be considered as a necessary condition to support services and facilities that make the residents' lives easier and more comfortable (Buys and Miller 2012). These opposing findings indicate that people prefer to live in secluded neighborhoods, while they do not want to live far from services and amenities.

High density in contexts is not always good for all circumstances. The combination of old neighborhoods and populous contexts tends to increase neighborhood dissatisfaction. There is no scholarly support for the negative impact of this mixture, but this may be because neighborhoods with older housing structure surrounded by high-density areas are likely to be around an urban core. Usually, an urban core is not a good place to provide a pleasant living environment often requiring redevelopment or remodeling. [20] Further, other social and economic issues are typically concentrated in a city center (Yang 2008). In this case, the concentration of social ills may outweigh the benefits of having a higher density.

Sometimes **mixed land use** is mentioned as a bad condition because of negative overflows from non-residential uses such as traffic, noise, odor, safety, unsightly

[20] The overlapped distribution of neighborhood age and context density in Austin is mapped in Appendix J.

structures, or crowding (Buys and Miller 2012; Kweon et al. 2010). The findings of this study, however, support the opposite. People are willing to have various functions and services in their contexts (Jacobs 1961; Grant 2002). One possible reason is that the benefits of having various functions could outweigh the negative spillovers from non-residential land uses. Or this can only be true in the case where mixed land use does not affect the pleasant lives in neighborhoods. Probably, non-residential uses may not be placed too close to neighborhoods or not in the neighborhoods at all. Or negative spillover of non-residential uses could be screened with a well-defined edge or physical barriers of residential neighborhoods.

Street patterns matter in neighborhoods, but not in contexts. People prefer to have streets with fewer connection such as cul-de-sacs or loop streets and this is consistent with findings from previous studies. Cul-de-sacs or loops are desirable conditions because they are capable of maximizing privacy and protecting residents from negative externalities and random access from strangers (Asabere 1990; Southworth and Owens 1993). Moreover, as Matthews and Turnbull (2007) mentioned well-defined neighborhoods with inward streets could promote a social cohesion. This is against the notion of new urbanism, which argues that a grid pattern—which has a higher connectivity than cul-de-sacs or loops—is better because it provides possible alternatives to turn corners, encourages repetitive encounters of residents (Duany et al. 2001; Matthews and Turnbull 2007; Southworth 1997), and increases the permeability and safety of places (Montgomery 1998; Jacobs 1961).

There are possible reasons why lower street connectivity is perceived as good in neighborhoods and does not show any influence in contexts. Better street connectivity is less important in contexts because people hardly walk or bike around large areas (Dill 2004) and the automobile is the most frequently used mode of travel in the U.S. cities. Better street connectivity may only have positive impacts where pedestrian-oriented development patterns are observed (Matthews and Turnbull 2007). Also, walking and biking occurred at the neighborhood may be greatly associated with the leisure purpose. Recreational walking does not necessarily require the shortest paths to specific destinations (Lee and Moudon 2006). In accordance with a preference to sidewalks, residents may be willing to walk, stroll, jog, or walk the dog. Transportation walking may happen less in automobile-oriented neighborhoods.

The findings report that **ecological design components** in neighborhoods are positive and attractive conditions that cause residents to stay longer. This is consistent across previous research, which reported positive impacts of close proximity to mountains or hills (Kaplan 2001; Kearney 2006; Luttik 2000; Hui et al. 2007), shorter distances to parks (Morrow-Jones et al. 2004; Sugiyama et al. 2009; Geoghegan et al. 1997), and larger and complex shaped landscapes (Kweon et al. 2010; Lee et al. 2008; Geoghegan et al. 1997; Dombrow et al. 2000). This may be because greening features affect the level of relaxation, pleasantness, and tranquility of residents (Ulrich 1993; Matsuoka and Kaplan 2008). Meanwhile, the size of parks and green areas in contexts do not show significant impact with neighborhood turnover. One possible explanation is that ecological design features play decisive roles only when people are in contact with them visually, immediately, and daily basis.

Third, there are interdependent influences between neighborhoods and contexts.

Housing mix in neighborhoods—a mixture of single- and multi-family housing—and contexts—do not alone effect neighborhood turnover. However, multi-family housing is not welcomed when it appears with other affordable housing or in wealthy contexts. There is not enough scholarly evidence to explain the combination of multi-family homes in neighborhoods and affordable housing in contexts. Yet, a review by Nguyen (2005) that synthesizes previous studies about the associations between affordable housing and property values provides some supporting clues. If public housing is clustered with multi-family housing, which often represents lower income residents, this may be seen as a concentration of low-income families and results in neighborhood dissatisfaction. Multi-family homes located in wealthy neighborhoods would be also seen as more negative than those in low-income neighborhoods would. Different from the thought of de Souza Briggs et al. (1999), the huge contrast between multi-family housing and high income single-family owners cannot dissuade the negative perception from multi-family housing. These two outcomes imply that contexts full of middle class residents would be the most tolerable to the mixture of the housing types.

The connectedness to elementary schools becomes important, if parks or greenways are nearby. Some of previous research also correspond this idea that well-maintained trails along with parks and greenways encourage walking or bicycling (Saelens and Handy 2008). Choguill (2008) provides an explanation that parks in combination with elementary schools can serve as meeting spots for mothers and their children. On the other hand, the simply high level of greening seems an unfavorable condition. Dense forest may block sight lines and be perceived as a threat to personal safety. (Kim 2011)

One interesting point is that turnover of **lake neighborhoods** is likely to be reduced if larger green areas appear in the neighborhoods, although simply living nearby lake does not have any influence on neighborhood turnover. Maybe, having both water and green spaces around makes the neighborhoods more attractive to residents.

Fourth, Structural components are the most important factors at the neighborhood and context level.

As mentioned above, when considering both neighborhood and context conditions at the same time, density is the most critical element in explaining neighborhood turnover, but the trends contrast. Low-density is preferable in neighborhoods, but not is not desirable factor in contexts. If considering design components as a different set in terms of structural components (i.e., density, land use, housing mix, and street patterns) and ecological features (i.e., nature, open space, and landscape patterns), structural components are the most significant in neighborhoods and contexts, while a set of ecological features (i.e., nature, open space, and landscape patterns) shows a significant role only in neighborhoods. Probably, structural components cannot be changed easily once built, and their impacts last relatively longer.

6.3.2 The Impacts of Neighborhood and Context Conditions Other Than Design

The **socio-economic status** of neighborhoods effects neighborhood turnover; it was the most significant factor beyond and above other conditions, while the overall income level of contexts does not have any influence. Residents in wealthy neighborhoods are likely to shift often to other neighborhoods. One potential reason is that socio-economic status affects the affordability of moving to other places; less prosperous people are more likely to become trapped in their neighborhoods, even though they may not be satisfied with their residential conditions. Or they may rely more on reciprocal and informal help formed through long-term social relationships unlike wealthy people (Wu 2012). The collective efficacy works better in disadvantaged neighborhoods as it can mediate social ills (Sampson et al. 1997).

Spillover effects from nearby contexts are also noteworthy. More surrounding contexts help decrease neighborhood turnover. Simply stated, even though residents cannot have all functions in their hosting contexts, nearby contexts can become providers of necessary services. This would suggest that the perception and activities of residents could reach over institutional neighborhoods to a community level as large as sub-districts of a city.

6.3.3 The Size of Neighborhood and Context

The outcomes of this study reveal that neighborhood and context design simultaneously influence neighborhood satisfaction. In addition, the same design principles are perceived differently depending on neighborhood scales. This partially explains the dissimilar results from previous studies that reported different directions or inconclusive results for the same design principle on neighborhood satisfaction. Simply stated, the different outcomes could be explained by the differences in the circumstances of study areas such as planning policy, acknowledgement and attitude of people toward planning projects and policies, geography, culture, and history. Yet, the findings of this study bring up another issue of dissimilar theoretical and analytical definition of neighborhood. The work done by Geoghegan et al. (1997) partially supports this argument . They found that larger open space was perceived as positive factor in immediate neighborhoods (0.1 km buffer, 7.8 acres), but negative in macro neighborhoods (1.0 km buffer, 775.9 acres). Lee et al. (2008) found that the significance of tree patch density changed by the size of neighborhoods.

Census units and radius buffers from individual parcels were the most frequently adopted units of analysis to represent neighborhoods; other researchers occasionally used already defined geographic units such as subdivisions, planning districts, named neighborhoods, or zip code areas. Since the sizes of neighborhoods vary, neighborhoods in other studies may be as large as "contexts" or smaller than "neighborhoods" in this study. Taking into account the average size of a neighborhood about 50 acres with 150 single-family housing units (about 500 people) and a context about 1,350 acres with 4,600 people, a “neighborhood” is smaller than a neighborhood defined by a quarter-mile buffer (125 acres). A "neighborhood" is bigger than a block or a census block and almost same size of one census block group that has around 600 to 3,000 people on average. A “context” is smaller than a neighborhood defined by one-mile radius buffer

(2,000 acres) and is similar to that of three a half-mile radius buffer neighborhoods combined (1,500 acres).

6.3.4 Statistical Approach: Using Multilevel, not Single-level

Previous studies defined a neighborhood as a single-level phenomenon and the impacts on residents' preferences were often tested with OLS models. Sometimes different sizes of neighborhoods were compared, but the cross-level impacts were rarely examined. This study supports the fact that the results of single-level models reveal the different outcomes from multilevel models.

6.3.4.1 Neighborhood as a Single-level Phenomenon[21]

If treating neighborhood and context conditions independently with two OLS and two multilevel models, the results are different across models. The impact of median lot size, the tree ratio, and median housing value at the neighborhood level and population density at the context level remain the same in OLS and multilevel linear models. Different results may occur as OLS assumes neighborhood conditions are not considerably different across contexts.

6.3.4.2 Considering Context Conditions with OLS Models[22]

We can simultaneously consider neighborhood and context conditions in several

---

[21] Detailed outcomes of OLS regressions at the neighborhood and the context levels can be found in Appendix K.

[22] Detailed outcomes of disaggregated and aggregated OLS regressions can be found in Appendix L.

statistical ways: the disaggregated OLS, the aggregated OLS, and the intercepts-and-slopes-as-outcomes model of multilevel models. As discussed in Chapter III, both OLS models have several weaknesses. The disaggregation of context features into neighborhoods violates the primary assumption of OLS, independency, and the aggregation of neighborhoods conditions into contexts causes the loss of important information. The results by OLS models show considerably different results. There are coincidently significant elements (i.e., median lot size, tree ratio, and housing value of a neighborhood and the population density and street connectivity of contexts) in both OLS models. The single-level and multilevel models are inconsistent. The single-level and multilevel models mutually report that median lot size, tree ratio, and the median housing value of neighborhoods and the population density of contexts are significant factors to determine neighborhood turnover.

Multilevel linear modeling permits us to test these relationships statistically and theoretically correct ways. More so than would have been possible with OLS regressions that were frequently used in previous studies (Poston 2002). Using OLS may possibly over simplify the research question, or not be an appropriate statistical approach, if the tested variables have a hierarchical structure. Even though we can consider the condition of neighborhoods and contexts with methods of disaggregation or aggregation, we cannot confidently ensure which method is correct. Further, the interactional relationship between neighborhoods and contexts is hard to show in OLS because current theory does not articulate the specific interactions of them, even though creating specific interaction terms based on theory is a possibility.

Table 6-2. Comparing the Results of Single-level and Multilevel Model

Variable	Separate Model		Combined Model		
	OLS	HLM	Disaggregated OLS	Aggregated OLS	HLM
NEIGHBORHOOD					
Structural Design Component					
Lot Size	-	-	-	-	-
Housing Mix			-		
Dead-end Density	-	-	-		-
Sidewalk Density	-		-		-
Route to the Grocery Store	-		-		
Route to the Elementary School					
Ecological Design Component					
Average Elevation	-	-			-
Lake				+	
Distance to Park	+		+		+
Tree Ratio	-	-	-	-	-
Tree Edge Density	-	-	-		-
Three Shape Index					
Other Condition					
Traffic					
Housing Value	+	+	+	+	+
Built Year	-	-	-		
CONTEXT					
Structural Design Component					
Population Density	-	-	-	-	-
Affordable Housing	+				
Land Use Mix		-			-
Street Connectivity (β Index)	+		+	+	
Ecological Design Component					
Park Ratio					
Green Cover Ratio				+	
Other Condition					
Median Income					
Crash					
On-going Project					
Spillover Effect		-			-

6.4 Planning Implications

Planning professionals are fascinated with the role of so called "sustainable developments" based on the belief that certain design directions can promote a quality of life (Berke 2002; Talen 1999; Talen and Ellis 2002). The notion of sustainable development does not solely remain in planning theory. No matter what the circumstances of cities, the public and even the private sector consider implementing unproved and over-arching design principles. For example, high-density, mixed land use, a mixture of a variety of housing types, well-connected and pedestrian-friendly streets, well-preserved natural features, closer or larger open spaces, and good landscapes. The findings of this dissertation, however, conditionally disagree with the current normative planning theory and policy. Not all recommended designs contribute to promoting neighborhood satisfaction and neighborhood stability. Rather, people perceive the same design principles in different ways depending on the spatial level of neighborhoods. People are less likely to sacrifice their typical suburban designs in their residential neighborhoods, but they are willing to buy homes that are within contexts that employ the current planning guidelines.

If this difference occurs simply because we are presently in a transition period between the old and the new design paradigm. We experienced a design paradigm shift in the 20th century, from an urban to suburban life-style. Now planners attempt to avoid suburban designs. People need time to be aware the benefits and necessity of current visionary ideas and act on those thoughts. If this is the case, planning theorists and researchers should support for why our neighborhoods, communities, and cities need to change in the direction of current development trends. Educating the public would be one way to expedite the change. If this planning theory recommendation is correct, helping people understand the positive consequences of suggested design principles would be beneficial. Planning theorists can suggest model districts, like showrooms, for new or redevelopment areas. This would encourage people to recognize the physical, social, economic, and environmental benefits of living in more compact, more diverse, more connected, and greener neighborhoods.

Yet, if these preferences are an unchangeable nature of people, it means that a normative planning theory failed to contribute to improving the quality of life and needs to develop more scale sensitive details; form-based code does this to a degree, but is more similar to planning guidelines, rather than theory. Theory has to find reasons why people take two different stands with different sizes of neighborhoods. Further, they need to reconcile two opposite demands in various scales of neighborhoods. With planning practice perspectives, the findings suggest evidence-based design guidelines for planning projects and policies. Recommendations for neighborhood design driven from the findings of this study can be distinguished for new neighborhood developments and redevelopments or remodeling of existing neighborhoods. For new development sites, structural design components are relatively important factor to consider. A mix of suburban style could be implemented to keep privacy and promote pleasant living environments. Extremely high density or a grid pattern for streets ought not to be forced. Residents should also have some flexibility and options of smaller to larger lots. Sidewalks for a pleasant walking environment and good landscapes could be recommended by a design review or site plan. Further, the harmonious implementation of ecological design components is also recommended.

For remodeling or redevelopment at existing or fully developed neighborhoods, which cannot alter the fundamental urban structure, ecological design components can give more help. Ordinances are an effective tool for reinforcing desirable ecological designs. A tree ordinance, for example, would encourage new tree planting on public and private property to cultivate a flourishing urban forest (street tree ordinance) [23] and protect the indiscriminate removal of native, historically important, or large trees (tree protection ordinances).[24] Residents can also manage landscaping in their yards through covenants or deed documents. Other elements such as low fences, low garden walls, or buffer strips could be recommended that allow privacy and good landscapes as well. Park plans can highlight small pocket parks, mini-parks, or playgrounds close to neighborhoods or with paths to elementary schools. These paths can provide greenery and a place to sit outdoors, and sometimes serve as children's playgrounds and parents' gathering spots. In addition, minor reconfigurations of structural components can be put into practice. Renovation projects to improve neighborhood retention can resemble middle-class suburban styles by blocking vehicular traffic at some parts of grid-pattern streets to give enclosed feelings, combining small lots to provide the flexibility to have various sizes of homes, installing sidewalks to promote safe pedestrian travel, or creating courtyards to increase social cohesion with inward streets (Figure 6-1).

[23] From San Luis Obispo, CA: City Code Section 12.24.010
[24] From Austin, TX: City Code Section 25.8.621

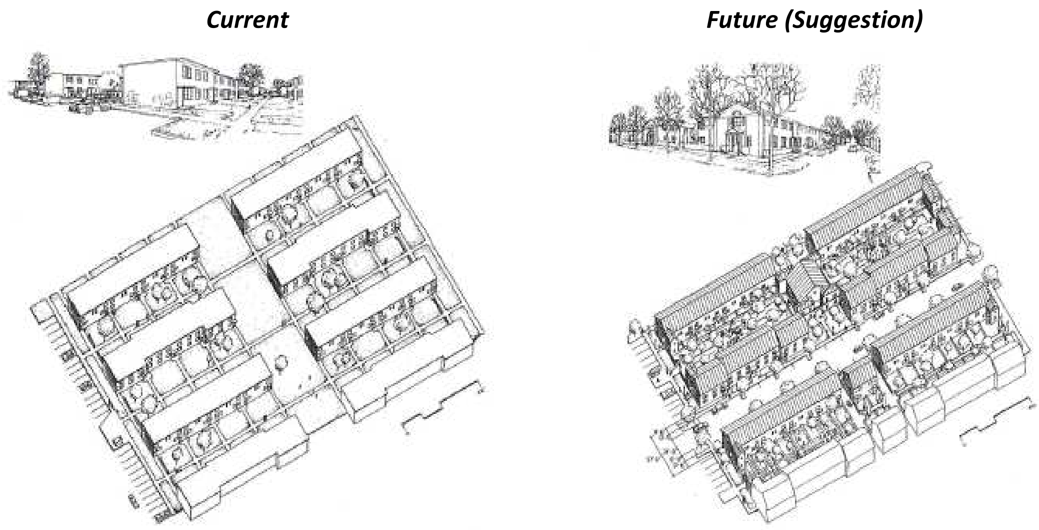


Figure 6-1. An Example: How to Enhance Ecological Design Features in Developed Neighborhoods

Source from: Barnett (2003, 124 & 125)

To manage neighborhood contexts, zoning plans could be revised. Up-zoning or zoning revision is required for under used land such as gray and brown fields, or vacant areas. Filling-in neighborhoods between unoccupied areas will help increase the overall compactness and diversity of land uses, while not damaging existing residential neighborhoods. To reduce negative spillover from these redevelopments, gradual zoning transition or buffer zones could be placed between existing neighborhoods by specific activities, functions, and site characteristics. A form-based code could be one possible tool in this situation as well. More detailed zoning or design guidelines can be provided through neighborhood plans. Neighborhood plans should translate the local contexts and combine them with neighborhood characteristics to selectively specify design details suggested by this dissertation. Design guidebooks or brochures could help increase the awareness of residents or developers (Figure 6-2).

Current ***Future (Suggestion)***

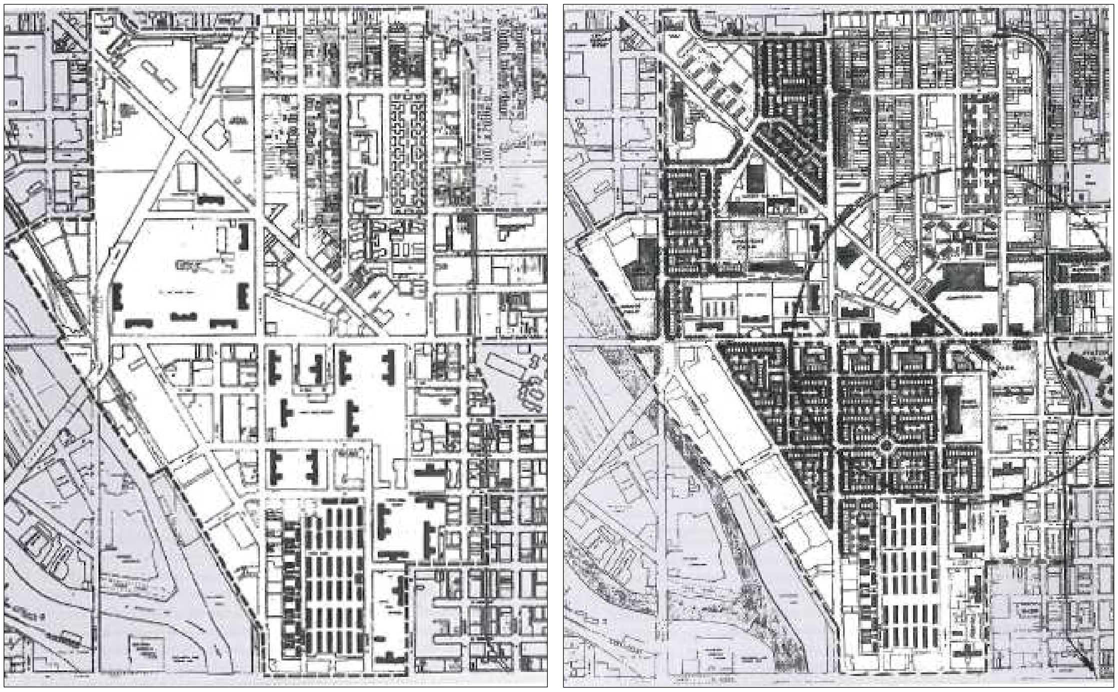


Figure 6-2. An Example: How to Enhance Overall Density in Contexts

Source from: Barnett (2003, 142 & 143)

The size of a neighborhood is another issue that developers and planners need to consider. A neighborhood developed at a large-scale can be a context as well. If the development is solely oriented to residential purposes with suburban style, the development is less likely to be attractive. In this case, developers and planners can consider splitting one huge neighborhood into several neighborhoods, and integrating them as an institutional neighborhood that share common facilities, annual events, or forums (Figure 6-3).

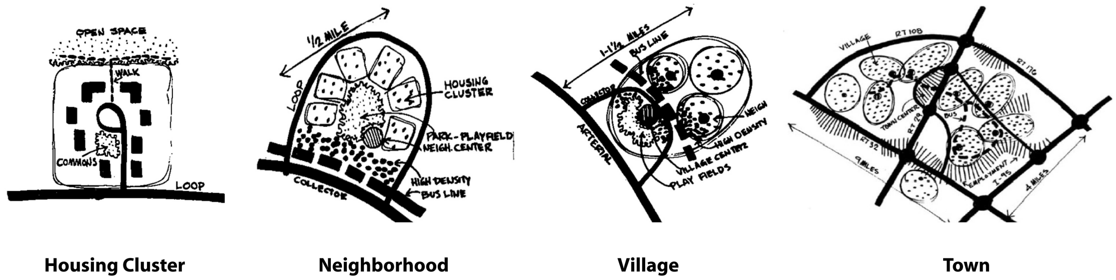


Figure 6-3. Example from Columbia New Town, MD: The Conceptual Diagram to Show How to Aggregate Neighborhoods to the Next Larger Units, from a Housing Cluster to a Town

Source from: Hoppenfeld (1967, 406 & 407)

6.5 Conclusion

When homebuyers decide to relocate, what do they usually consider? You may think that the characteristics of a house with respect to size, year, style, and price might be the first conditions buyers explore, and then they examine the surrounding areas. In contrast to this notion, according to a report from the National Association of Realtors, 65 percent of homebuyers ranked the quality of the neighborhood as the first condition (Yun, Bishop, & Smith, 2012). The term 'neighborhood condition' herein denotes several circumstances such as neighborhood design, green community features, parks, and school quality.

This study explores whether this neighborhood conditions, particularly neighborhood design, are important factors in influencing people's neighborhood choice and which designs can increase neighborhood satisfaction. Even though preferences are determined by multiple conditions of neighborhoods and contexts, the results of this study ascertain that independent and simultaneous neighborhood and context designs definitely influences on residents' preferences. As expected, neighborhood designs have more impact than context designs since residents have much more frequent contacts with their immediate surroundings. Meanwhile, the influences of contexts are not negligible. Context designs have their unique and interactional roles in neighborhood turnover. Further, residents' sometimes perceived the same design principle in different directions depending on spatial scale. Residents seek design elements that help create neighborhoods as residential havens, which are more suburban style. Yet, sufficient seek services and facilities from contexts, which are more like the new urbanism style. This indicates that developing ways of managing the conflicting needs is one of the important tasks for planners. Further, the importance of structural design is highlighted in this study. Once formed, structural design components are a major constituent of the characteristics of places and shape the flows and activities of people. Thus, a careful approach is necessary when working on neighborhood structure.

6.6 Limitation and Further Study

This study has limitations and future studies should take into consideration the remaining issues. First, this study examined the neighborhood design and turnover in one city over a short period. Austin is a southern city in the U.S. and the life-styles and preferences for certain designs may not be the same for cities in other regions that have different cultural, historical, and geographical acceptance, and even planning policy. At worst, this study merely presents little more than a case study of one southern city in the U.S. At best, it gives a general explanation about cities that have begun pushing the new neighborhood design paradigm. To generalize these findings, different cities of various regions need to be compared in a future studies.

Second, this study is limited in the geographical unit of analysis. Subdivisions and census tracts were used as the best representatives of neighborhoods and contexts. Even though this study tries to find the most relevant units corresponding to the theoretical basis, the modifiable areal unit problem (MAUP) [25] is a fundamental conflict issue across neighborhood studies. There are two methods of setting up experiments for possible in future studies. One way is choosing different scales of neighborhoods in a neighborhood hierarchy; for example, face-block vs. residential neighborhoods, institutional neighborhood vs. community, or residential neighborhood vs. community. Another way is to find different analytical units representing residential and institutional neighborhoods. Master planned communities, named neighborhoods, or fee-based communities can be alternatives for residential neighborhoods, and planning districts, communities, a group of census tracts, or zip code tabulation areas for institutional neighborhoods.

Third, this study only considers two levels of neighborhoods. This is useful in taking into account neighborhoods and contexts simultaneously, but this association can be classified into more than two levels. Contexts can reach over the community or the city level. Future research should consider three-level modeling for a more specific

[25] MAUP arises in neighborhood studies as the areal units are “modifiable.” The scale (aggregating) and zone (grouping) of an areal unit are two distinctive types of MAUP. The scale effect refers to the variation in results when different scales of units of analysis are used, or progressively aggregated into fewer and larger units (e.g., by state, county, city, or block). The zoning effect refers to the problem of combining small areas into larger units, which are grouped by some threshold, target, shape or homogeneity of small areas (Jelinski and Wu, 1996).

conceptualization of research on neighborhood and contexts effects. This would allow a combination of the features within residential and institutional neighborhoods and communities to be examined.

Fourth, neighborhood turnover reflects neighborhood satisfaction in indirect ways. Neighborhood turnover is beneficial for showing actual behavior or decisions about where to live, and the findings can convert to planning policy for decision making to promote neighborhood stability. Yet, it is not a direct measure of the concept of interest. If data are available, comparing the impacts of neighborhood design on stated preferences is meaningful. This will determine whether self-reported perceptions and decisions in actions match each other. Further, examining the influences of another revealed preference measure like housing values would be interesting.

Finally, even though the analyses included neighborhood design elements and neighborhood quality indicators, there can still be other factors significantly related to neighborhood turnover. Variables used herein are limited to GIS-based and publicly published data. Even though GIS-based data are useful in creating spatial reference data and public data have a certain level of reliability and validity, those measures are not enough to evaluate the quality of neighborhood design. Some objective and subjective measures can help. Auditing enables a researcher to gather qualitative and quantitative data that are not shown by GIS maps, aerial photos, or satellite images. Data such as the aesthetics of buildings, maintenance, cleanness, the condition of sidewalks, and the surfaces of streets could be considered. Even the imageability, visual enclosure, or human scale can be evaluated through an audit. In addition, surveys through telephone, mail, and in person interviews, have the strength to quantify the actual residents' perceptions of the quality of neighborhood conditions.

REFERENCES

Alberti, Marina, and Paul Waddell. 2000. "An integrated urban development and ecological simulation model." *Integrated Assessment* no. 1 (3):215-227.

Alexander, David E., and Rhodes Whitmore Fairbridge. 2006. *Encyclopedia of Environmental Science*. 1 ed. Vol. 20. The Netherlands: Springer.

American Planning Association. 2006. *Planning and urban design standards*. Hoboken, NJ: Wiley.

American Society of Planning Officials. 1965. Standards for Outdoor Recreational Areas. Commission for Accreditation of Park and Recreation Agencies.

Anderson, William P., Pavlos S. Kanaroglou, and Eric J. Miller. 1996. "Urban form, energy and the environment: A review of issues, evidence and policy." *Urban Studies* no. 33 (1):7-35. doi: 10.1080/00420989650012095

Aneshensel, Carol S., and Clea A. Sucoff. 1996. "The neighborhood context of adolescent mental health." *Journal of Health and Social Behavior* no. 37 (4):293-310. doi: 10.2307/2137258.

Anselin, Luc, and Anil K Bera. 1998. "Spatial dependence in linear regression models with an introduction to spatial econometrics." In *Handbook of applied economic statistics*, edited by Aman Ullah and David E.A. Giles. New York, NY: Marcel Dekker, Inc.

Arnold, Carolyn L. 1992. "An introduction to hierarchical linear models." *Measurement and Evaluation in Counseling and Development* no. 25 (2):58-90.

Asabere, Paul K. 1990. "The value of a neighborhood street with reference to the cul-de-sac." *The Journal of Real Estate Finance and Economics* no. 3 (2):185-193.

Bailly, Paul Charles. 1959. *An urban elementary school for Boston*, Massachusetts Institute of Technology, Cambridge, MA.

Barbosa, Olga, Jamie A. Tratalos, Paul R. Armsworth, Richard G. Davies, Richard A. Fuller, Pat Johnson, and Kevin J. Gaston. 2007. "Who benefits from access to green space? A case study from Sheffield, UK." *Landscape and Urban Planning* no. 83 (2-3):187-195.

Barnett, Jonathan. 1982. *An Introduction to Urban Design*. New York, NY: HarperCollins Publishers.

———. 2003. *Redesigning Cities. Principles, Practice, Implementation*.

Bartik, Timothy J., John Scott Butler, and Jin-Tan Liu. 1992. "Maximum score estimates of the determinants of residential mobility: Implications for the value of residential attachment and neighborhood amenities." *Journal of Urban Economics* no. 32 (2):233-256.

Behee, Chris. 2012. Vegetation modeling with NAIP color IR imagery. In *Washington GIS Conference*. Tacoma WA.

Berke, Philip R. 2002. "Does sustainable development offer a new direction for planning? Challenges for the twenty-first century." *Journal of Planning Literature* no. 17 (1):21-36.

———. 2008. "The evolution of green community planning, scholarship, and practice: An introduction to the special issue." *Journal of the American Planning Association* no. 74 (4):393-407.

Berke, Philip R., and Maria Manta Conroy. 2000. "Are we planning for sustainable development?" *Journal of the American Planning Association* no. 66 (1):21-33.

Blake, Kevin S., and Daniel D. Arreola. 1996. "Residential subdivision identity in metropolitan Phoenix." *Landscape Journal* no. 15 (1):23-35.

Bloom, Howard S., Carolyn J. Hill, Alison Rebeck. Black, and Mark W. Lipsey. 2008. "Performance trajectories and performance gaps as achievement effect-size benchmarks for educational interventions." *Journal of Research on Educational Effectiveness* no. 1 (4):289-328.

Boehm, Thomas P. 1982. "A hierarchical model of housing choice." *Urban Studies* no. 19 (1):17-31.

Botequilha Leitão, Ahren, and Jack Ahern. 2002. "Applying landscape ecological concepts and metrics in sustainable landscape planning." *Landscape and Urban Planning* no. 59 (2):65-93.

Bowden, Leonard W. 1972. "How to define neighborhood." *The Professional Geographer* no. 24 (3):227-228.

Bradford, Susan 1993. "Are TNDs selling?" *Builder* no. 16 (8):76-79.

Bramley, Glen, and Sinead Power. 2009. "Urban form and social sustainability: The role of density and housing type." *Environment and Planning B* no. 36 (1):30.

Brown, Barbara B, and Vivian L Cropper. 2001. "New urban and standard suburban subdivisions: Evaluating psychological and social goals." *Journal of the American Planning Association* no. 67 (4):402-419.

Brown, Barbara, Douglas D Perkins, and Graham Brown. 2003. "Place attachment in a revitalizing neighborhood: Individual and block levels of analysis." *Journal of Environmental Psychology* no. 23 (3):259-271.

Brownstone, David, and Thomas F. Golob. 2009. "The impact of residential density on vehicle usage and energy consumption." *Journal of Urban Economics* no. 65 (1):91-98.

Butler, E.W., F.S. Chapin, G.C. Hemmens, E.J. Kaiser, M.A. Stegman, and S.F. Weiss. 1969. Moving behavior and residential choice-A national survey. In *Highway Research Board* National Cooperative Highway Research Program.

Buys, Laurie, and Evonne Miller. 2012. "Residential satisfaction in inner urban higher-density Brisbane, Australia: Role of dwelling design, neighbourhood and neighbours." *Journal of Environmental Planning and Management* no. 55 (3):319-338.

Calthorpe, Peter. 1993. *The next American metropolis: Ecology, community, and the American dream*. New York, NY: Princeton Architectural Press.

Cervero, Robert, and Kara Kockelman. 1997. "Travel demand and the 3Ds: Density, diversity, and design." *Transportation Research Part D: Transport and Environment* no. 2 (3):199-219. doi: 10.1016/s1361-9209(97)00009-6

Chaix, Basile, Juan Merlo, and Pierre Chauvin. 2005. "Comparison of a spatial approach with the multilevel approach for investigating place effects on health: The example of healthcare utilisation in France." *Journal of Epidemiology and Community Health* no. 59 (6):517-526.

Chasan, Daniel J. 1993. *Mountains to Sound: the creation of a greenway across the Cascades*. Seattle, WA: Sasquatch Books.

Chaskin, Robert J. 1997. "Perspectives on neighborhood and community: A review of the literature." *The Social Service Review*:521-547.

———. 1998. "Neighborhood as a unit of planning and action: A heuristic approach." *Journal of Planning Literature* no. 13 (1):11-30.

Chen, Wendy Y., and C. Y. Jim. 2010. "Amenities and disamenities: A hedonic analysis of the heterogeneous urban landscape in Shenzhen (China)." *Geographical Journal* no. 176 (3):227-240. doi: 10.1111/j.1475-4959.2010.00358.x.

Cho, Seong-Hoon, J Michael Bowker, and William M Park. 2006. "Measuring the contribution of water and green space amenities to housing values: An application and comparison of spatially weighted hedonic models." *Journal of Agricultural and Resource Economics* no. 31 (3):485-507.

Choguill, Charles L. 2008. "Developing sustainable neighbourhoods." *Habitat International* no. 32 (1):41-48.

Christie, Les 2007. The fastest growing U.S. cities. *CNNMoney*.

Churchman, Arza, and Yona Ginsberg. 1984. "The image and experience of high rise housing in Israel." *Journal of Environmental Psychology* no. 4 (1):27-41.

City of Austin. 2008. S.M.A.R.T. Housing Policy Resource Guide. Austin, TX: City of Austin.

Cohen, Deborah A., Thomas L. McKenzie, Amber Sehgal, Stephanie Williamson, Daniela Golinelli, and Nicole Lurie. 2007. "Contribution of public parks to physical activity." *American Journal of Public Health* no. 97 (3):509-514.

Cohen, Deborah, J Scott Ashwood, Molly M. Scott, Adrian Overton, Kelly R. Evenson, Carolyn C. Voorhees, Ariane L. Bedimo-Rung, and Thomas L. McKenzie. 2006. "Proximity to school and physical activity among middle school girls." *Journal of Physical Activity and Health* no. 3 (1):129-138.

Coles, R.W., and S.C. Bussey. 2000. "Urban forest landscapes in the UK—progressing the social agenda." *Landscape and Urban Planning* no. 52 (2):181-188.

Connerly, Charles E., and Robert W. Marans. 1985. "Comparing two global measures of perceived neighborhood quality." *Social Indicators Research* no. 17 (1):29-47.

Corbusier, L. 1967. *The radiant city: Elements of a doctrine of urbanism to be used as the basis of our machine-age civilization* Orion Press.

Corrado, Luisa, and Bernard Fingleton. 2012. "Where is the economics in spatial econometrics? ." *Journal of Regional Science* no. 52 (2):210-239.

Coulton, Claudia J., Jill Korbin, Tsui Chan, and Marilyn Su. 2001. "Mapping residents' perceptions of neighborhood boundaries: a methodological note." *American Journal of Community Psychology* no. 29 (2):371-383.

Craig, Gary, and Marjorie Mayo. 1995. *Community empowerment: A reader in participation and development*. London, UK: Zed Books.

De Jong, Kim, Maria Albin, Erik Skärbäck, Patrik Grahn, and Jonas Björk. 2012. "Perceived green qualities were associated with neighborhood satisfaction, physical activity, and general health: Results from a cross-sectional study in suburban and rural Scania, southern Sweden." *Health & Place* no. 18 (6):1374-1380.

de Souza Briggs, Xavier, Joe T. Darden, and Angela Aidala. 1999. "In the wake of desegregation: Early impacts of scattered-site public housing on neighborhoods in Yonkers, New York." *Journal of the American Planning Association* no. 65 (1):27-49.

Dehring, Carolyn, and Neil Dunse. 2006. "Housing density and the effect of proximity to public open space in Aberdeen, Scotland." *Real Estate Economics* no. 34 (4):553-566.

Diamond, Jared M. 1975. "The island dilemma: lessons of modern biogeographic studies for the design of natural reserves." *Biological conservation* no. 7 (2):129-146.

Dill, Jennifer. 2004. Measuring network connectivity for bicycling and walking. Paper read at 83rd Annual Meeting of the Transportation Research Board, at Washington, DC.

Dombrow, Jonathan, Mauricio Rodriguez, and C.F. Sirmans. 2000. "The market value of mature trees in single-family housing markets." *Appraisal Journal* no. 68 (1):39-43.

Donegan, Mary, Joshua Drucker, Harvey Goldstein, Nichola Lowe, and Emil Malizia. 2008. "Which indicators explain metropolitan economic performance best?

Traditional or creative class." *Journal of the American Planning Association* no. 74 (2):180-195.

Donovan, Nick, David Halpern, and Richard Sargeant. 2002. Life Satisfaction: the state of knowledge and implications for government. Cabinet Office, Strategy Unit.

Drukker, Marjan, Charles Kaplan, and Jim van Os. 2005. "Residential instability in socioeconomically deprived neighbourhoods, good or bad?" *Health & Place* no. 11 (2):121-129.

Duany, Andres, Elizabeth Plater-Zyberk, Alex Krieger, and William R. Lennertz. 1991. *Towns and town-making principles*: Rizzoli International Publications.

Duany, Andres, Elizabeth Plater-Zyberk, and Jeff Speck. 2001. *Suburban nation: The rise of sprawl and the decline of the American dream*: North Point Press.

Duany, Anres, and Elizabeth Plater-Zyberk. 1992. "The second coming of the American small town." *Wilson Quarterly* no. 16 (1):3-51.

Dwyer, John F., E. Gregory McPherson, Herbert W. Schroeder, and Rowan A. Rowntree. 1992. "Assessing the benefits and costs of the urban forest." *Journal of Arboriculture* no. 18 (5):227-227.

Echenique, Marcial H., Anthony J. Hargreaves, Gordon Mitchell, and Anil Namdeo. 2012. "Growing cities sustainably: Does urban form really matter?" *Journal of the American Planning Association* no. 78 (2):121-137.

Ellen, Ingrid Gould, and Margery Austin Turner. 1997. "Does neighborhood matter? Assessing recent evidence." *Housing Policy Debate* no. 8 (4):833-866.

Ellis, Cliff. 2010. History of cities and city planning.

Evans, Gary W., Catherine Smith, and Kathy Pezdek. 1982. "Cognitive maps and urban form." *Journal of the American Planning Association* no. 48 (2):232-244.

Ewing, Reid. 1997. "Is Los Angeles-style sprawl desirable?" *Journal of the American Planning Association* no. 63 (1):107-126.

Ewing, Reid, Rolf Pendall, and Don Chen. 2003. "Measuring sprawl and its transportation impacts." *Transportation Research Record: Journal of the Transportation Research Board* no. 1831 (1):175-183.

Ewing, Reid, and Fang Rong. 2008. "The impact of urban form on US residential energy use." *Housing Policy Debate* no. 19 (1):1-30.

Fainstein, Susan S. 2000. "New directions in planning theory." *Urban Affairs Review* no. 35 (4):451-478.

Faria Filho, DE, AN Dias, ALC Veloso, CFD Bueno, FAP Couto, JB Matos Júnior, KZO Barreto, PA Rodrigues, and WA Carneiro. 2010. "Classification of coefficients of variation in experiments with commercial layers." *Revista Brasileira de Ciência Avícola* no. 12 (4):255-257.

Fisher, Daniel *America's fastest-growing cities*. Forbes 2012 [cited December, 2014. Available from http://www.forbes.com/sites/danielfisher/2012/04/18/americas-fastest-growing-cities/.

Fitchen, Janet M. 1994. "Residential mobility among the rural poor." *Rural Sociology* no. 59 (3):416-436.

Fleury-Bahi, Ghozlane, Marie-Line Félonneau, and Dorothée Marchand. 2008. "Processes of place identification and residential satisfaction." *Environment and Behavior* no. 40 (5):669.

Forman, Richard T.T. 1995. *Land mosaics: The ecology of landscapes and regions*: Cambridge University Press.

Forman, Richard T.T., and Michel Godron. 1986. *Landscape Ecology* Hoboken, NJ: Wiley.

Forsyth, Ann, J. Michael Oakes, Kathryn H. Schmitz, and Mary Hearst. 2007. "Does residential density increase walking and other physical activity?" *Urban Studies* no. 44 (4):679-697.

Frank, Lawrence D., and Peter O. Engelke. 2001. "The built environment and human activity patterns: Exploring the impacts of urban form on public health." *Journal of Planning Literature* no. 16 (2):202-218.

French, Sarah, Lisa Wood, Sarah Alexandra Foster, Billie Giles-Corti, Lawrence Frank, and Vincent Learnihan. 2013. "Sense of community and its association with the neighborhood built environment." *Environment and Behavior* no. 46 (6):677-697.

Frey, William H. 2011. *Melting pot cities and suburbs: Racial and ethnic change in metro America in the 2000s*: Brookings Institution, Metropolitan Policy Program.

Friedman, Avi. 2007. *Sustainable residential development: Planning and design for green neighborhoods*: McGraw-Hill Professional.

Frumkin, Howard. 2002. "Urban sprawl and public health." *Public Health Reports* no. 117 (3):201-217.

Galster, George. 1987. "Identifying the correlates of dwelling satisfaction an empirical critique." *Environment and Behavior* no. 19 (5):539-568.

Galster, George C., and Garry W. Hesser. 1981. "Residential satisfaction compositional and contextual correlates." *Environment and Behavior* no. 13 (6):735-758.

Galster, George, Royce Hanson, Michael R. Ratcliffe, Harold Wolman, Stephen Coleman, and Jason Freihage. 2001. "Wrestling sprawl to the ground: defining and measuring an elusive concept." *Housing Policy Debate* no. 12 (4):681-717.

Gehl, Jan. 2011. *Life between buildings*: Island Press. Original edition, **1987**. Reprint, 3.

Geoghegan, Jacqueline, Lisa A. Wainger, and Nancy E. Bockstael. 1997. "Spatial landscape indices in a hedonic framework: An ecological economics analysis using GIS." *Ecological Economics* no. 23 (3):251-264.

Giles-Corti, Billie, Melissa H Broomhall, Matthew Knuiman, Catherine Collins, Kate Douglas, Kevin Ng, Andrea Lange, and Robert J Donovan. 2005. "Increasing walking: How important is distance to, attractiveness, and size of public open space?" *American Journal of Preventive Medicine* no. 28 (2):169-176.

Girling, Cynthia, and Ronald Kellett. 2005. *Skinny streets and green neighborhoods: Design for environment and community*: Island Press.

Gittell, Ross, and Avis Vidal. 1998. *Community organizing: Building social capital as a development strategy*: Sage.

Goldstein, Harvey, and Joshua Drucker. 2006. "The economic development impacts of universities on regions: do size and distance matter?" *Economic development quarterly* no. 20 (1):22-43.

Goodman, Allen C. 1977. "A comparison of block group and census tract data in a hedonic housing price model." *Land Economics* no. 53 (4):483-487.

Gootman, Jennifer Appleton, and Jacquelynne Eccles. 2002. *Community programs to promote youth development*: National Academies Press.

Grant, Jill. 2002. "Mixed use in theory and practice: Canadian experience with implementing a planning principle." *Journal of the American Planning Association* no. 68 (1):71-84.

Greenberg, Michael R. 1999. "Improving neighborhood quality: A hierarchy of needs." *Housing Policy Debate* no. 10 (3):601-624.

Grether, David M., and Peter Mieszkowski. 1974. "Determinants of real estate values." *Journal of Urban Economics* no. 1 (2):127-145.

Grinde, Bjørn, and Grete Grindal Patil. 2009. "Biophilia: Does visual contact with nature impact on health and well-being?" *International Journal of Environmental Research and Public Health* no. 6 (9):2332-2343. doi: 10.3390/ijerph6092332

Gustafson, Eric J., and George R. Parker. 1994. "Using an index of habitat patch proximity for landscape design." *Landscape and Urban Planning* no. 29 (2-3):117-130. doi: 10.1016/0169-2046(94)90022-1.

Hallman, Howard W. 1984. *Neighborhoods: Their place in urban life*. Thousand Oaks, CA: Sage.

Handy, Susan L. 1996. "Understanding the link between urban form and nonwork travel behavior." *Journal of Planning Education and Research* no. 15 (3):183-198. doi: 10.1177/0739456x9601500303

Harries, Karsten. 1998. *The ethical function of architecture*. Cambiridge, MA: The MIT Press.

Haurin, Donald R, Robert Dietz, and Bruce Weinberg. 2005. "The impact of neighborhood homeownership rates: A review of the theoretical and empirical literature." *Economics of Innovation and New Technology* no. 14 (5):1-40.

Hayes, Kathy J., and Lori L. Taylor. 1996. Neighborhood school characteristics: What signals quality to homebuyers? In *Economic Review*: Federal Reserve Bank of Dallas.

Heck, Ron. 2012. Some concerns to consider in standardizing variables in multilevel analyses. Portland, OR: Portland State University.

Heck, Ronald H, and Scott L Thomas. 1999. *An introduction to multilevel modeling techniques*: Psychology Press.

Hite, Diane, Wen Chern, Fred Hitzhusen, and Alan Randall. 2001. "Property-value impacts of an environmental disamenity: The case of landfills." *The Journal of Real Estate Finance and Economics* no. 22 (2):185-202.

Hofmann, David A, and Mark B Gavin. 1998. "Centering decisions in hierarchical linear models: Implications for research in organizations." *Journal of Management* no. 24 (5):623-641.

Hoppenfeld, Morton. 1967. "A sketch of the planning-building process for Columbia, Maryland." *Journal of the American Institute of Planners* no. 33 (6):398-409.

Howley, Peter, Mark Scott, and Declan Redmond. 2009. "Sustainability versus liveability: An investigation of neighbourhood satisfaction." *Journal of Environmental Planning and Management* no. 52 (6):847-864.

Hox, Joop J. 1995. *Applied multilevel analysis*. Amsterdam, Netherland: TT-publikaties.

Hox, Joop J, and Cora JM Maas. 2001. "The accuracy of multilevel structural equation modeling with pseudobalanced groups and small samples." *Structural equation modeling* no. 8 (2):157-174.

Hui, Eddie , C. K. Chau, Lilian Pun, and M. Y. Law. 2007. "Measuring the neighboring and environmental effects on residential property value: Using spatial weighting matrix." *Building and Environment* no. 42 (6):2333-2343.

Hur, Misun, and H. Morrow-Jones. 2008. "Factors that influence residents' satisfaction with neighborhoods." *Environment and Behavior* no. 40 (5):619-635.

Hur, Misun, Jack L. Nasar, and Bumseok Chun. 2010. "Neighborhood satisfaction, physical and perceived naturalness and openness." *Journal of Environmental Psychology* no. 30 (1):52-59.

Jabareen, Yosef Rafeq. 2006. "Sustainable urban forms: Their typologies, models, and concepts." *Journal of Planning Education and Research* no. 26 (1):38-52. doi: 10.1177/0739456x05285119

Jacobs, Jane. 1961. *The death and life of great American cities*. New York, NY: Vintage Books.

Jim, C.Y. 2006. "Formulaic expert method to integrate evaluation and valuation of heritage trees in compact city." *Environmental monitoring and assessment* no. 116 (3):53-80.

Jim, C.Y., and Wendy Y Chen. 2009. "Value of scenic views: Hedonic assessment of private housing in Hong Kong." *Landscape and Urban Planning* no. 91 (4):226-234.

Jim, C.Y., and Wendy Y. Chen. 2010. "External effects of neighbourhood parks and landscape elements on high-rise residential value." *Land Use Policy* no. 27 (2):662-670.

Jones, Colin, Chris Leishman, and Charlotte MacDonald. 2005. Local housing markets and urban form. In *Annual European Real Estate Society Conference*. Dublin, Ireland.

———. 2007. Sustainable urban form and residential development viability. In *Housing Studies Association Conference*. York, England.

———. 2009. "Sustainable urban form and residential development viability." *Environment and Planning A* no. 41 (7):1667-1690.

Kaplan, Rachel. 2001. "The nature of the view from home psychological benefits." *Environment and Behavior* no. 33 (4):507-542.

Katz, Peter. 1994. *The new urbanism: Toward an architecture of community*. New York, NY: McGraw-Hill Professional.

Kearney, Anne R. 2006. "Residential development patterns and neighborhood satisfaction impacts of density and nearby nature." *Environment and Behavior* no. 38 (1):112-139.

Keller, Suzanne. 1968. *The urban neighborhood: A sociological perspective*. Vol. 33. New York, NY: Random House

Kim, Junhyun. 2011. *The Role of Landscape Spatial Patterns on Childhood Obesity and Quality of Life: A Study of Hispanic Children in Inner-city Neighborhoods*, Landscape Architecture and Urban Planning, Texas A&M University, College Station, TX.

Kline, Rex B. 2008. *Becoming a behavioral science researcher: A guide to producing research that matters*: Guilford Press.

Kreft, Ita GG, and Jan De Leeuw. 1998. *Introducing multilevel modeling*. Thousand Oaks, CA: Sage.

Kweon, Byoung Suk, Christopher D Ellis, Pedro I Leiva, and George O Rogers. 2010. "Landscape components, land use, and neighborhood satisfaction." *Environment and Planning B* no. 37 (3):500-517.

Lam, Julie. 1985. "Type of structure, satisfaction, and propensity to move." *Housing and Society* no. 12 (1):32-44.

Lansford Jr, Node H, and Lonnie L Jones. 1995. "Recreational and aesthetic value of water using hedonic price analysis." *Journal of Agricultural and Resource Economics* no. 20 (2):341-355.

Lansing, John B., and Robert W. Marans. 1969. "Evaluation of neighborhood quality." *Journal of the American Institute of Planners* no. 35 (3):195-199.

Lee, Chanam, and Anne V. Moudon. 2004. "Physical activity and environment research in the health field: implications for urban and transportation planning practice and research." *Journal of Planning Literature* no. 19 (2):147-181.

———. 2006. "Correlates of walking for transportation or recreation purposes." *Journal of Physical Activity & Health* no. 3 (1):77-98.

———. 2008. "Neighbourhood design and physical activity." *Building Research & Information* no. 36 (5):395-411.

Lee, Sang Woo, Christopher D. Ellis, Byoung Suk Kweon, and Sung Kwon Hong. 2008. "Relationship between landscape structure and neighborhood satisfaction in urbanized areas." *Landscape and Urban Planning* no. 85 (1):60-70.

Lee, Suzanna M. 2010. *The association between neighborhood environment and neighborhood satisfaction: Moderating effects of demographics*, San Diego State University, San Diego, CA.

Lin, Ge, and Tonglin Zhang. 2007. "Loglinear residual tests of Moran's I autocorrelation and their applications to Kentucky breast cancer data." *Geographical Analysis* no. 39 (3):293-310.

Lovie, Pat. 2005. "Coefficient of variation." *Encyclopedia of statistics in behavioral science* no. 1 (1):317-318.

Luttik, Joke. 2000. "The value of trees, water and open space as reflected by house prices in the Netherlands." *Landscape and Urban Planning* no. 48 (4):161-167.

Lynch, Kevin. 1984. *Good city form*. Cambridege, MA: The MIT Press.

Maco, Scott E, and E Gregory McPherson. 2003. "A practical approach to assessing structure, function, and value of street tree populations in small communities." *Journal of Arboriculture* no. 29 (2):84-97.

Madanipour, Ali. 1997. "Ambiguities of urban design." *Town Planning Review* no. 68 (3):363-383.

Malpezzi, Stephen, and Wen-Kai Guo. 2001. Measuring “sprawl”: Alternative measures of urban form in US metropolitan areas. Madison, WI: Center for Urban Land Economics Research, University of Madison-Wisconsin.

Mansfield, Carol, Subhrendu K Pattanayak, William McDow, Robert McDonald, and Patrick Halpin. 2005. "Shades of green: Measuring the value of urban forests in the housing market." *Journal of Forest Economics* no. 11 (3):177-199.

Marans, Robert W. 1979. The determinants of neighborhood quality. In *Annual Housing Survey Studies* U.S. Department of Housing and Urban Development.

Martin, Deborah G. 2003. "Enacting neighborhood." *Urban Geography* no. 24 (5):361-385.

Maruani, Tseira, and Irit Amit-Cohen. 2007. "Open space planning models: A review of approaches and methods." *Landscape and Urban Planning* no. 81 (1):1-13.

Matsuoka, Rodney H., and Rachel Kaplan. 2008. "People needs in the urban landscape: Analysis of landscape snd urban planning contributions." *Landscape and Urban Planning* no. 84 (1):7-19. doi: 10.1016/j.landurbplan.2007.09.009.

Matthews, John W., and Geoffrey K. Turnbull. 2007. "Neighborhood street layout and property value: The interaction of accessibility and land use mix." *The Journal of Real Estate Finance and Economics* no. 35 (2):111-141.

McConnell, Virginia, and Margaret A Walls. 2005. *The value of open space: Evidence from studies of nonmarket benefits*. Washington, D.C.: Resources for the Future

FRAGSTATS: Spatial pattern analysis program for categorical and continuous maps 4.0. University of Massachusetts, Amherst, Amherst, MA.

McGarigal, Kevin, and Barbara J. Marks. 1995. Spatial pattern analysis program for quantifying landscape structure. edited by Oregon State University. Corvallis, OR.

McLeod, Paul B. 1984. "The demand for local amenity: An hedonic price analysis." *Environment and Planning A* no. 16 (3):389-400.

Mertes, James David, and James R Hall. 1995. *Park, Recreation, Open Space and Greenway Guidelines*. Ashburn, VA: National Recreation and Park Association.

Miller, Robert W. 1988. *Urban forestry: Planning and managing urban greenspaces*. Upper Saddle River, NJ: Prentice Hall.

Molotch, Harvey. 1969. "Racial change in a stable community." *American Journal of Sociology* no. 75 (2):226-238. doi: 10.1086/224768.

Montgomery, John. 1998. "Making a city: Urbanity, vitality and urban design." *Journal of Urban Design* no. 3 (1):93-116. doi: 10.1080/13574809808724418

Morrow-Jones, Hazel A.., Elena G. Irwin, and Brian Roe. 2004. "Consumer preference for neotraditional neighborhood characteristics." *Housing Policy Debate* no. 15 (1):171-202.

Moudon, Anne Vernez, Paul M. Hess, Mary Catherine Snyder, and Kiril Stanilov. 1997. "Effects of site design on pedestrian travel in mixed-use, medium-density environments." *Transportation Research Record: Journal of the Transportation Research Board* no. 1578 (1):48-55.

Mowbray, Martin. 2005. "Community capacity building or state opportunism?" *Community Development Journal* no. 40 (3):255-264.

Mumford, Lewis. 1954. "The neighborhood and the neighborhood unit." *Town Planning Review* no. 24 (4):256-270.

Muthen, Bengt O., and Albert Satorra. 1995. "Complex sample data in structural equation modeling." *Sociological Methodology* no. 25 (1):267-316.

Nasar, Jack L. 2003. "Does neotraditional development build community?" *Journal of Planning Education and Research* no. 23 (1):58-68.

Ndubisi, Forster. 2002. *Ecological planning: A historical and comparative synthesis*. Baltimore, MD: Johns Hopkins University Press.

Nduka, Ethelbert Chinaka, and Maxwell Azubuike Ijomah. 2012. "The Effects of Perturbing Eigenvalues In The Presence of Multicollinearity." *Electronic Journal of Applied Statistical Analysis* no. 5 (2):304-311.

Newman, Peter. 1999. "Sustainability and cities: Extending the metabolism model." *Landscape and Urban Planning* no. 44 (4):219-226.

Newman, Sandra J., and Ann B. Schnare. 1997. "“… And a suitable living environment”: The failure of housing programs to deliver on neighborhood quality." *Housing Policy Debate* no. 8 (4):703-741.

Nguyen, Mai Thi. 2005. "Does affordable housing detrimentally affect property values? A review of the literature." *Journal of Planning Literature* no. 20 (1):15-26.

Nisbet, Elizabeth K, John M Zelenski, and Steven A Murphy. 2011. "Happiness is in our nature: Exploring nature relatedness as a contributor to subjective well-being." *Journal of Happiness Studies* no. 12 (2):303-322. doi: 10.1007/s10902-010-9197-7.

Orr, John M, Paul R Sackett, and CATHY LZ DUBOIS. 1991. "Outlier detection and treatment in I/O psychology: A survey of researcher beliefs and an empirical illustration." *Personnel Psychology* no. 44 (3):473-486.

Osborne, Jason W, and Amy Overbay. 2004. "The power of outliers (and why researchers should always check for them)." *Practical assessment, research & evaluation* no. 9 (6):1-12.

Paquin, J Walter. 2007. *When city renters buy homes? Do they buy in better neighborhoods?*, Washington University St. Louis, MO.

Park, Robert Ezra. 1952. *Human communities: The city and human ecology*. Vol. 2: Free Press.

Park, Yunmi, and Goerge O. Rogers. 2014. "Neighborhood planning theory, guidelines, and research: Can area, population, and boundary guide conceptual framing?" *Journal of Planning Literature*. doi: 10.1177/0885412214549422.

Parks, Carolyn P, and Howard O Straker. 1996. "Community assets mapping: Community health assessment with a different twist." *Journal of Health Education* no. 27 (5):321-323.

Patterson, Patricia. 2004. "Urban form and older residents' service use, walking, driving, quality of life, and neighborhood satisfaction." *American Journal of Health Promotion* no. 19 (1):45-52.

Pattillo, Mary E. 1998. "Sweet mothers and gangbangers: Managing crime in a black middle-class neighborhood." *Social Forces* no. 76 (3):747-774.

Peet, Richard. 1985. "The social origins of environmental determinism." *Annals of the Association of American Geographers* no. 75 (3):309-333.

Plotnick, Roy E., Robert H. Gardner, and Robert V. O'Neill. 1993. "Lacunarity indices as measures of landscape texture." *Landscape Ecology* no. 8 (3):201-211.

Porter, Douglas R. 1998. "Transit-focused development: A progress report." *Journal of the American Planning Association* no. 64 (4):475-488. doi: 10.1080/01944369808976006.

Poston, Dudley L. 2002. "Human capital, cultural capital and economic attainment patterns of Asian-born immigrants to the United States: Multi-level analyses." *Asian and Pacific Migration Journal* no. 11 (2):197-220.

Putnam, Robert D. 2001. *Bowling alone: The collapse and revival of American community*. New York, NY: Simon & Schuster.

Randall, T.A., and B.W. Baetz. 2001. "Evaluating pedestrian connectivity for suburban sustainability." *Journal of Urban Planning and Development* no. 127 (1):1-15.

Optimal Design Software for Multi-level and Longitudinal Research (Version 3.01) [Software]. Available from www.wtgrantfoundation.org.

HLM for Windows 7.0. Scientific Software International Inc., Lincolnwood, IL.

Ricketts, Erol R, and Isabel V Sawhill. 1988. "Defining and measuring the underclass." *Journal of Policy Analysis and Management* no. 7 (2):316-325.

Rogers, George O., and Sineenart Sukolratanametee. 2009. "Neighborhood design and sense of community: Comparing suburban neighborhoods in Houston Texas." *Landscape and Urban Planning* no. 92 (3):325-334.

Rohe, William M., and Michael A. Stegman. 1994. "The effects of homeownership: on the self-esteem, perceived control and life satisfaction of low-income people." *Journal of the American Planning Association* no. 60 (2):173-184.

Rohe, William M., and Leslie S. Stewart. 1996. "Homeownership and neighborhood stability." *Housing Policy Debate* no. 7 (1):37-81.

Rohe, William M., Shannon Van Zandt, and George McCarthy. 2002. "Social benefits and costs of homeownership." In *Low-income homeownership: Examining the unexamined goal*, edited by Nicolas Paul Retsinas and Eric S. Belsky, 381-406. Washington, D.C.: Brookings Institution Press.

Ross, Catherine E, John R Reynolds, and Karlyn J Geis. 2000. "The contingent meaning of neighborhood stability for residents' psychological well-being." *American Sociological Review* no. 65 (4):581-597. doi: 10.2307/2657384.

Rowley, Alan. 1996. "Mixed-use development: ambiguous concept, simplistic analysis and wishful thinking?" *Planning Practice and Research* no. 11 (1):85-98. doi: 10.1080/02697459650036477.

Saelens, Brian E., and Susan L. Handy. 2008. "Built environment correlates of walking: a review." *Medicine and Science in Sports and Exercise* no. 40 (7):550-566.

Saelens, Brian E., James F. Sallis, and Lawrence D. Frank. 2003. "Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures." *Annals of Behavioral Medicine* no. 25 (2):80-91.

Sampson, Robert J, Stephen W Raudenbush, and Felton Earls. 1997. "Neighborhoods and violent crime: A multilevel study of collective efficacy." *Science* no. 277 (5328):918-924.

Sampson, Robert J., Jeffrey D. Morenoff, and Thomas Gannon-Rowley. 2002. "Assessing" neighborhood effects": Social processes and new directions in research." *Annual Review of Sociology* no. 28 (1):443-478.

Sander, Heather, Stephen Polasky, and Robert G. Haight. 2010. "The value of urban tree cover: A hedonic property price model in Ramsey and Dakota Counties, Minnesota, USA." *Ecological Economics* no. 69 (8):1646-1656.

Sawicki, David S., and Patrice Flynn. 1996. "Neighborhood indicators: A review of the literature and an assessment of conceptual and methodological issues." *Journal of the American Planning Association* no. 62 (2):165-183.

Schieman, Scott. 2005. "Residential stability and the social impact of neighborhood disadvantage: A study of-gender and race-contingent effects." *Social Forces* no. 83 (3):1031-1064. doi: 10.2307/3598268.

Schweitzer, Lisa, and Jiangping Zhou. 2010. "Neighborhood air quality, respiratory health, and vulnerable populations in compact and sprawled regions." *Journal of the American Planning Association* no. 76 (3):363-371.

Shafer, Craig. 1994. "Beyond park boundaries." In *Landscape planning and ecological networks*, edited by Edward Cook and H. N. van Lier, 201-223. Elsevier Science.

Shin, Woo Jin. 2013. *Evaluation of value creation concepts in single family residential subdivisions*, Texas A&M University, College Station, TX.

Shin, Woo Jin, Jesse Saginor, and Shannon Van Zandt. 2011. "Evaluating subdivision characteristics on single-family housing value using hierarchical linear modeling." *Journal of Real Estate Research* no. 33 (3):317-348.

Sirgy, M Joseph, and Terri Cornwell. 2002. "How neighborhood features affect quality of life." *Social Indicators Research* no. 59 (1):79-114.

Smith, Barbara. 2000. *Home girls: A black feminist anthology*. Piscataway Township, NY: Rutgers University Press.

Smith, Michael E. 2010. "The archaeological study of neighborhoods and districts in ancient cities." *Journal of Anthropological Archaeology* no. 29 (2):137-154.

Song, Yan, and Gerrit-Jan Knaap. 2003. "New urbanism and housing values: A disaggregate assessment." *Journal of Urban Economics* no. 54 (2):218-238.

———. 2004a. "Measuring the effects of mixed land uses on housing values." *Regional Science and Urban Economics* no. 34 (6):663-680.

———. 2004b. "Measuring urban form: Is Portland winning the war on sprawl?" *Journal of the American Planning Association* no. 70 (2):210-225.

Southworth, Michael. 1997. "Walkable suburbs?: An evaluation of neotraditional communities at the urban edge." *Journal of the American Planning Association* no. 63 (1):28-44.

Southworth, Michael, and Peter M. Owens. 1993. "The evolving metropolis: Studies of community, neighborhood, and street form at the urban edge." *Journal of the American Planning Association* no. 59 (3):271-287. doi: 10.1080/01944369308975880.

Spybrook, Jessaca, Stephen. W. Raudenbush, Xiao-feng Liu, Richard Congdon, and Andrés Martínez. 2011. Optimal design for longitudinal and multilevel research: Documentation for the optimal design doftware version 3.0. Available from www.wtgrantfoundation.org.

Sternberg, Ernest. 2000. "An integrative theory of urban design." *Journal of the American Planning Association* no. 66 (3):265-278. doi: 10.1080/01944360008976106.

Sugiyama, Takemi, Catharine Ward Thompson, and Susana Alves. 2009. "Associations between neighborhood open space attributes and quality of life for older people in Britain." *Environment and Behavior* no. 41 (1):3-21.

Talen, Emily. 1999. "Sense of community and neighbourhood form: An assessment of the social doctrine of new urbanism." *Urban Studies* no. 36 (8):1361-1379.

Talen, Emily, and Cliff Ellis. 2002. "Beyond relativism reclaiming the search for good city form." *Journal of Planning Education and Research* no. 22 (1):36-49. doi: 10.1177/0739456X0202200104.

Texas A&M Real Estate Center. 2013. MLS housing activity in Austin. http://recenter.tamu.edu/data/hs/hs140.asp.

Texas Government. *Subchapter C: Information excerpted from required disclosure* 2013 [cited Sep. 8th, 2014. Available from http://www.statutes.legis.state.tx.us/SOTWDocs/GV/htm/GV.552.htm.

Thompson, Catharine Ward. 2002. "Urban open space in the 21st century." *Landscape and Urban Planning* no. 60 (2):59-72. doi: 10.1016/s0169-2046(02)00059-2.

Tu, Charles C., and Mark J. Eppli. 1999. "Valuing new urbanism: The case of Kentlands." *Real Estate Economics* no. 27 (3):425-451.

Turner, Monica Goigel. 1989. "Landscape ecology: The effect of pattern on process." *Annual Review of Ecology and Systematics* no. 20 (1):171-197.

U.S. Bureau of the Census. 1994. Geographic areas reference manual. U.S. Bureau of the Census.

Ulrich, Roger S. 1979. "Visual landscapes and psychological well-being." *Landscape Research* no. 4 (1):17-23.

———. 1993. "Biophilia, Biophobia, and Natural Landscapes." In *The Biophilia Hypothesis*, edited by Stephen R. Kellert and Edward O. Wilson, 73-137. Washington DC: Island Press.

Ulrich, Roger S., Robert F. Simons, Barbara D. Losito, Evelyn Fiorito, Mark A. Miles, and Michael Zelson. 1991. "Stress recovery during exposure to natural and urban environments." *Journal of Environmental Psychology* no. 11 (3):201-230. doi: 10.1016/s0272-4944(05)80184-7

Van Cao, Than, and Dennis C. Cory. 1982. "Mixed land uses, land-use externalities, and residential property values: A reevaluation." *The Annals of Regional Science* no. 16 (1):1-24.

Van Zandt, Shannon, and William M. Rohe. 2006. "Do first time home buyers improve their neighborhood quality?" *Journal of Urban Affairs* no. 28 (5):491-510.

Walmsley, Anthony. 1995. "Greenways and the making of urban form." *Landscape and Urban Planning* no. 33 (1-3):81-127.

Wassmer, Robert W. 2000. Urban sprawl in a U.S. metropolitan area: Ways to measure and a comparison of the Sacramento area to similar metropolitan areas in California and the U.S.: Lincoln Institute of Land Policy.

Wech, Barbara A, and Anita L Heck. 2004. "An introduction to hierarchical linear modeling for marketing researchers." *Marketing Bulletin* no. 15 (1):1-8.

Weiss, Christopher C., Marnie Purciel, Michael Bader, James W. Quinn, Gina Lovasi, Kathryn M. Neckerman, and Andrew G. Rundle. 2011. "Reconsidering access:

Park facilities and neighborhood disamenities in New York City." *Journal of Urban Health* no. 88 (2):297-310.

Williams, Katie, Elizabeth Burton, and Mike Jenks. 2005. "Achieving the compact city through intensification: An acceptable option." In *The compact city: A sustainable urban form?*, edited by Katie Williams, Elizabeth Burton and Mike Jenks, 71-83. Taylor & Francis.

Williams, Katie, Elizabeth Burton, Mike Jenks, K Williams, E Burton, and M Jenks. 2000. *Achieving sustainable urban form*. New York, NY: Routeledge.

Wilson, Edward O. 1984. *Biophilia*. Boston, MA: Harvard University Press.

Wilson, Georjeanna, and Mark Baldassare. 1996. "Overall sense of community" in a suburban region: The effects of localism, privacy, and urbanization." *Environment and Behavior* no. 28 (1):27-43.

Wu, Fulong. 2012. "Neighborhood attachment, social participation, and willingness to stay in China's low-income communities." *Urban Affairs Review* no. 48 (4):547-570.

Yang, Yizhao. 2008. "A tale of two cities: Physical form and neighborhood satisfaction in metropolitan Portland and Charlotte." *Journal of the American Planning Association* no. 74 (3):307-323.

Yun, Lawrence , Paul C. Bishop, and Jed Smith. 2012. Profile of homebuyers and sellers. Chicago, IL: National Association of Realtors.

Zhang, Yun. 2001. "Texture-integrated classification of urban treed areas in high-resolution color-infrared imagery." *Photogrammetric Engineering and Remote Sensing* no. 67 (12):1359-1366.

APPENDIX A

CREATING LAND COVER

Land cover data are necessary to measure landscape patterns of neighborhoods and contexts. Publicly released land cover data like the National Land Cover Database (NLCD) which is one of the most frequently used land cover that introduces sixteen land cover classifications would not be useful for this study because of its coarse resolution, 30 meters, and created date, 2006. Hence, land cover maps were produced by following the steps suggested by Behee (2012).

One-meter color infrared high-resolution digital ortho quadrangles (DOQs) imageries as of 2010 from the Texas Natural Resources Information System were retrived. For accurate classification, normalized difference vegetation index (NDVI) layers and texture analysis were added on top of the four bands provided (near infrared, red, green, and blue) of the DOQs imagery. A texture analysis was integrated to distinguish the texture and shapes between trees and grass. A texture analysis helps increase the accuracy in separating forested areas and evenly illuminated low grass areas (Zhang 2001). A seven by seven pixel was chosen to identify a mature tree crown; a radius of seven pixels is generally treated as one mature tree crown in one-meter resolution imagery. The NDVI index, which is one of the most commonly used indices to identify vegetation is supplemented to clarify the vegetation areas, and is calculated based on the differences in reflectivity. Usually, visible light is likely to be absorbed by

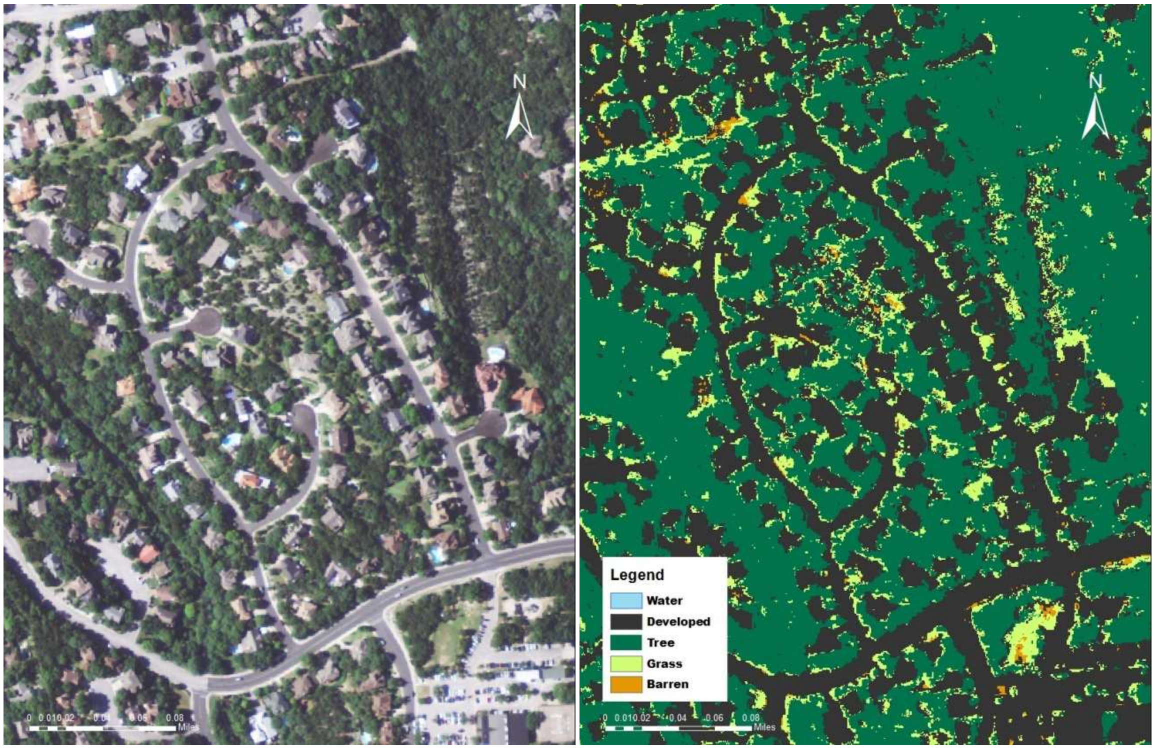


Figure A-1. Land Cover Data with Five Classifications: Water, Developed, Tree, Grass, and Barren

photosynthetic pigments (green leaves), while near infrared light passes through live leaves. It means that healthy vegetation is likely to absorb more visible light, while sparse or unhealthy vegetation reflects visible light. The value of the NDVI ranges between -1.0 to 1.0. Healthy vegetation areas usually have the value about 0.9 and bare soil 0.1 (Forman 1995; Ulrich 1993). The NDVI values were obtained by the formula below.

$$NDVI = \frac{NIR - VIS}{NIR + VIS}$$

where NIR is the sum of the near infrared pixels and VIS is the sum of visible (red) pixels.

An ISO cluster unsupervised classification was conducted with six layers: band 1 (blue), band 2 (green), band 3 (red), band 4 (Near-IR), texture, and NDVI. Seventy classes of layers were created and then reclassified into four classes: water, developed area, tree, grass, and dry grass/barren. The tree layer was used to measure different types of landscape patterns in neighborhoods, while tree and grass layers are combined as "green cover" to identify greening patterns in contexts. The Arc GIS 10.1 software program was used to create land cover data.

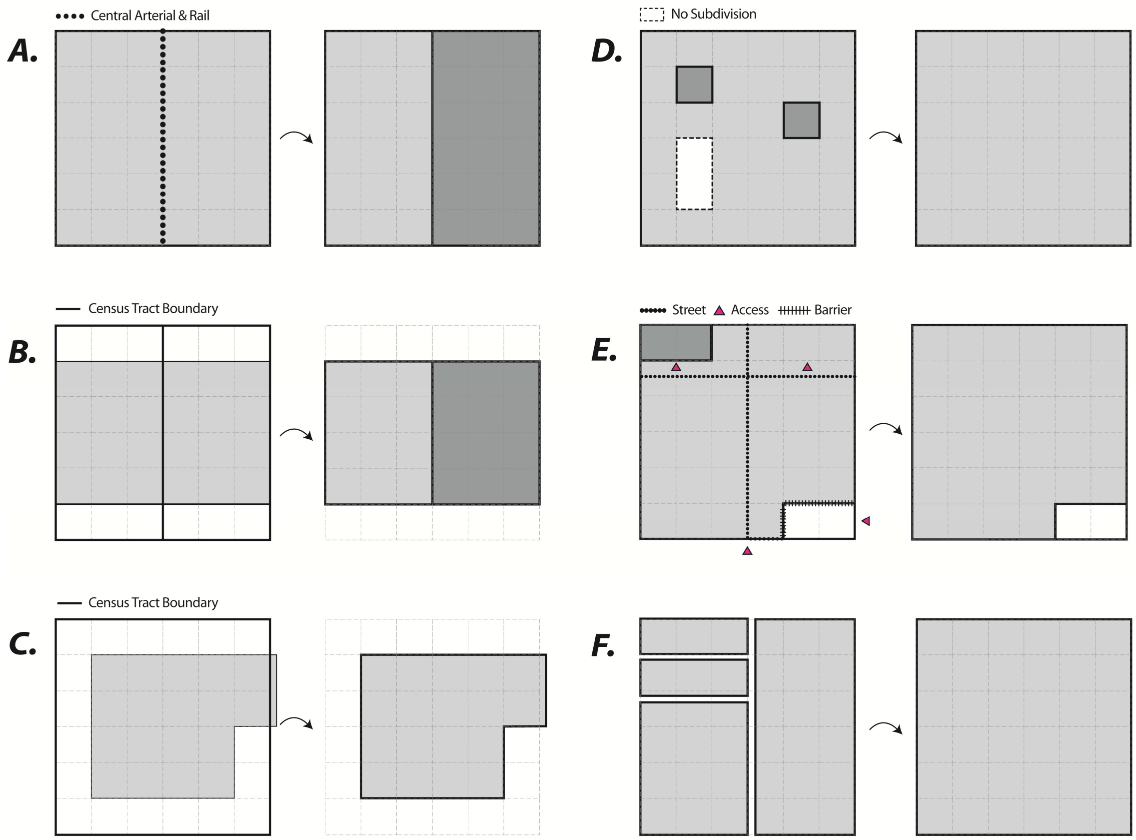
APPENDIX B

HOW TO AFFIRM A NEIGHBORHOOD BOUNDARY

The boundaries of neighborhoods were created by combining subdivisions through few steps. First, information on subdivisions with the same name was gathered, including re-subdivided subdivisions within an existing subdivision.

Second, the boundaries of combined subdivisions were carefully observed. When the shape of a combined subdivision was regular, in other words enclosed by streets or drive ways, it was confirmed as one neighborhood. There were several cases of neighborhoods with irregular shapes. When a combined subdivision was separated by major or minor arterials, it was considered as a separate neighborhoods (example A) since high speeds and high vehicular traffic volume usually kept people from crossing from one side to the other. On top of that, there were a few cases found where one subdivision was divided by a census tract boundary. Census tract boundaries are identifiable barriers across neighborhoods that are normally delineated by visible obstacles (U.S. Bureau of the Census 1994). Hence, if one subdivision was separated by a census tract boundary, the separated parts were considered different neighborhoods (example B). Yet, if there were no housing units in an extended part of a neighborhood like example C, the existing boundary of a neighborhood was not adjusted. Examples D, E, and F show how to confirm the final boundary of neighborhoods when subdivisions have irregular or not enclosed shapes. When subdivisions of different names or lots with no name were located completely within one subdivision boundary, they were combined as one neighborhood (Example D). Portions of subdivisions or buildings were joined in the neighborhood boundary, if they were not separated by physical barriers such as walls, fences, or green corridors (Example F). When subdivisions with the same name were separated by inner streets and close enough together, they were grouped as one neighborhood (Example E). Field observation was done to confirm the boundary of a neighborhood that does not meet the suggested criteria. Field observations were done in twelve subdivisions: Duval Heights 230, Georgian Acres, Reservoir Heights, Rosewood Village Sec 11, Fairview Park, Theodore Low Heights, Swisher Addition, G.K. Beckett Estate, Walling Place, Houston Heights, Hofheinz re-subdivision, and Lot 46 Division. Among 6,062 residential subdivisions in the study area, 1,936 neighborhoods were created through the second step.

Third, neighborhoods under the minimum requirement of 30 housing units were filtered out as they were too small to be considered "residential neighborhoods"



A. Crossed by central arterials and railroad: a subdivision divided by major arterials or railroad is separated.
B. Crossed by a census tract: if there are houses within a census tract, the subdivision boundary is separated along with the census tract boundary.
C. Extended out of census tract: if a subdivision extends out of a census tract boundary and there is no housing, the existing subdivision boundary will be kept.
D. Holes: if no subdivisions or subdivisions with different names are nested within a bigger subdivision, they are adjoined into an inclusive subdivision.
E. Access and barrier: if different subdivisions share the same access, they are adjoined. If subdivisions do not share the same access or are separated by barriers, they are detached.
F. Patchwork: if subdivisions with the same name are close enough, but separated by inner streets, they are adjoined.
G. Ways of Confirming Irregular Shaped Residential Neighborhood Boundaries

Figure A-2. Examples of Irregular Shaped Neighborhood Boundaries

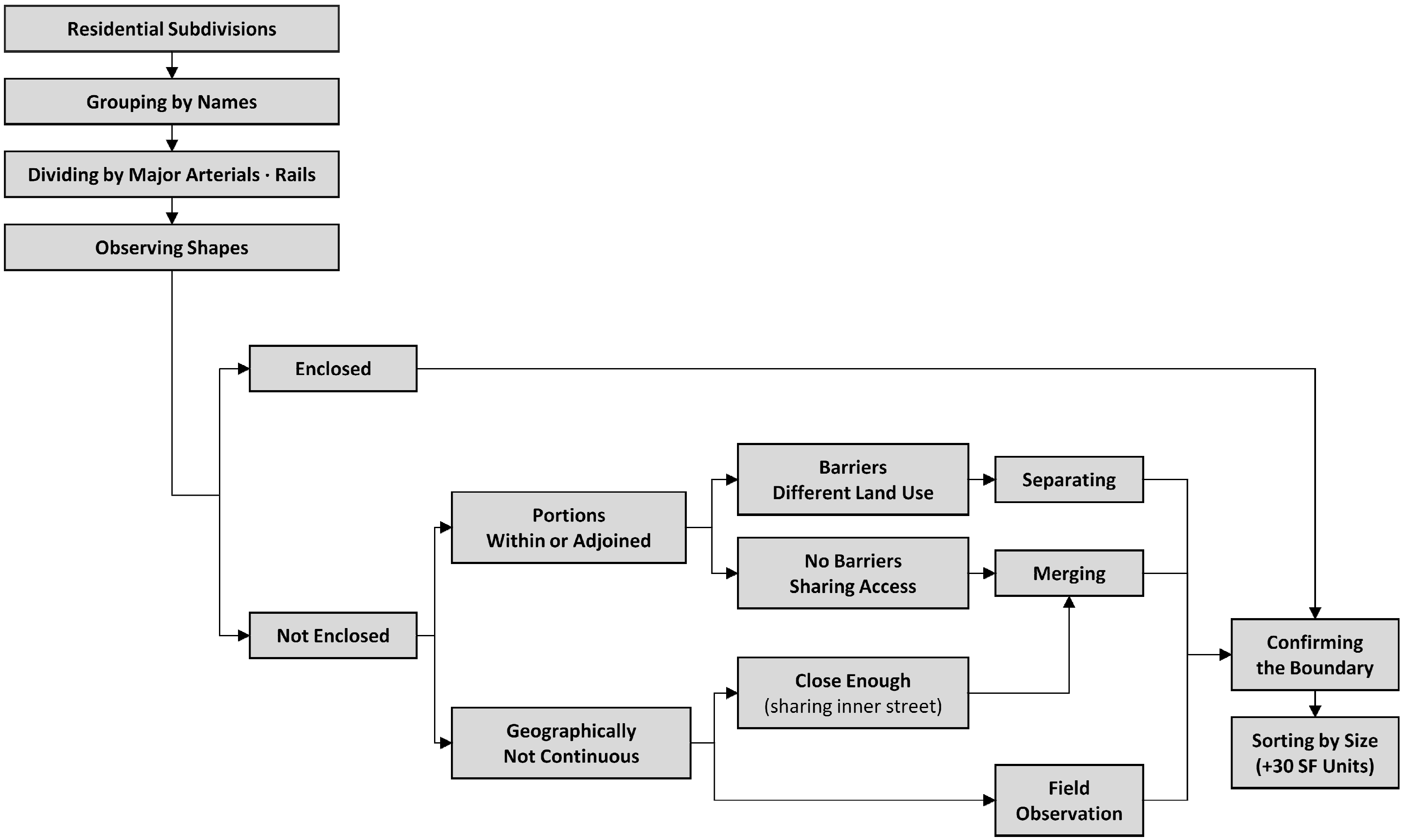


Figure A-3. Process of Affirming Neighborhoods for the Study

APPENDIX C

TRANSFORMATION

The regression, a part of multilevel linear modeling, assumes the error term has a normal distribution. Usually, non-normality is examined after running a regression with an error term, but badly skewed independent variables have a high possibility of producing non-normally distributed error terms. Thus, the skewness and kurtosis of independent variables were checked before conducting analyses. This study employs a rule of thumb for indicating problems of values greater than 3.0 of skewness and 10.0 of kurtosis (Kline 2008).

Six independent variables from both the neighborhood and context levels seemed to require transformations to reduce the outliners and non-normality problem. Logarithm and square transformation were considered, but log transformation was preferably used. Logarithmic form is the most commonly used transformation due to its convenient interpretation, which is possibly explained by elasticity (Song and Knaap 2003). Squared root transformation itself, on the other hand, has no such clear interpretation, even though it helps alter the Poisson distribution to Gaussian. Dummy variables were left in their original form since there was no way to interpret a transformed dummy variable. The median income at the contexts was transformed to logarithmic form as well, although it did not show any problem in skewness and kurtosis. The extreme scale difference—median income is expressed by dollars from ten thousand up to a hundred thousand, but neighborhood turnover by percentages—could generate less sensitivity to differences in orders of magnitude.

Transformation cannot be a panacea for all non-normal cases. Even transformation cannot ease the problem of a non-normal case; if the case, raw data were used. This could not be a critical problem as there is also a consensus that violation of normality does not critically affect the statistical decision when the sample size is large enough (Kline 2008).

Table A-1. Transformed Variables

Raw Variable	Skewness	Kurtosis	Transformation	New Var. Name
NEIGHBORHOOD				
Lot Size	3.171	19.017	Log	LMEDLOT
Housing Mix	12.373	188.335	Log	LMSFRAT
Route to the Grocery Store	12.115	203.412	Log	LDSGRO
Route to the Elementary School	5.328	42.433	Log	LDSELE
Housing Value	4.312	45.803	Log	LMEDVAL
CONTEXTS				
Affordable Housing	3.246	14.207	No	SMART
Median Income	0.444	2.576	Log	LINCOME

APPENDIX D

POWER ANALYSIS

Statistical power refers to the probability of rejecting the null hypothesis that there is no difference in the population mean between groups. The statistical power is decided by four statistical inferences: significance criterion (α), standardized effect size (δ), intra-correlation (ρ), and number of clusters (j).

Since the value of a statistical power smaller than 0.9 cause a risk of a Type II error (Shin et al. 2011), this study adopted the value of 0.9. Standardized effect size (δ) refers to the difference of the two groups divided by the standard error of the outcome. Diamond (1975) suggests a rule of thumb for the value of δ; 0.2 is small, 0.5 medium, and 0.8 large. The standard effect size (δ) of 0.5 was taken as bigger than 0.5 could be problematic (Shin 2013). The intra-class correlation (ρ) refers to the variability between clusters, which is captured by a ratio of the variability between clusters to the total variability. School achievement research that often uses multilevel linear modeling has typically reported that the value of ρ ranges between 0.05 and 0.15, but neighborhood related studies rarely report the ρ value. From the subdivision study of Shin (2013), the minimum ρ value of 0.05 was employed. Similar to other quantitative studies, the significance criterion (α) of 0.05 was taken. To sum up, the calculation was done with the value of $\alpha=0.05$, $\rho=0.05$, and $\delta=0.5$. The Optimal Design software developed by Raudenbush, Spybrook, et al. (2011) was used for the calculation and graphing. The result indicates that the total number of contexts needs to be more than 65 to get an expected statistical power with the minimum required number of three neighborhoods for a context.

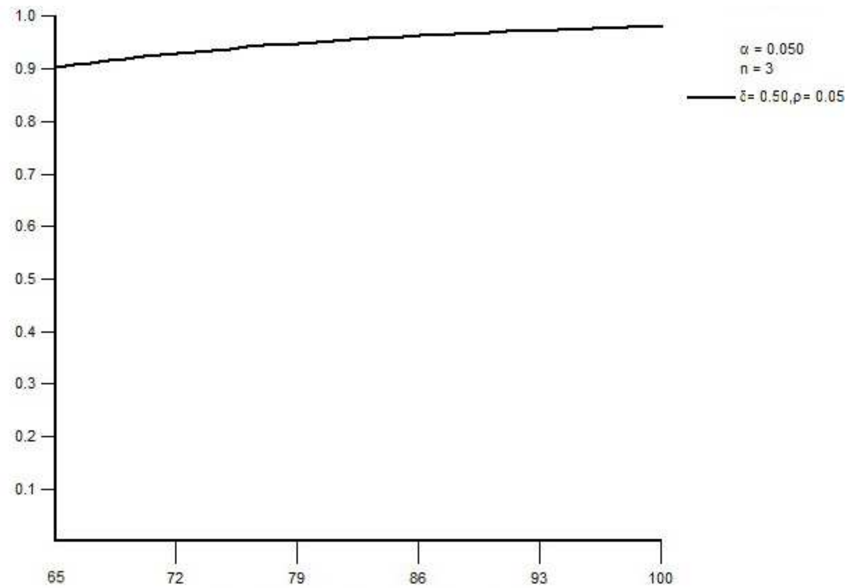


Figure A-4. Total Number of Contexts when n=3, α=0.05, ρ=0.05, and δ=0.5

APPENDIX E

DESIGN EFFECT

The equation of design effect suggested by Muthen and Satorra (1995) is as below.

$$Design\ Effect = 1 + (c - 1) \times \rho$$

where *c* refers to average cluster size and *ρ* represents intra-class correlation coefficient.

The average cluster size (*c*) of this study is about 6.0 (755/126=5.992) as there are 755 neighborhoods and 126 contexts. The intra-class correlation coefficient (ρ) is 0.2. The design effect is 2.1. The value greater than 2.0 indicates that a multilevel analysis more appropriate statistical approach than a single-level.

$$1 + (5.992 - 1) \times 0.218 = 2.088$$

APPENDIX F

CENTERING

Centering refers to shifting the location of a predictor to another value such as zero by adding/subtracting a constant. This rescaling procedure only affects the intercept, while slope remains unchanged in a linear model (Raudenbush, Bryk, et al. 2011). Group mean and grand mean centering are the most frequently used procedures. Group mean centering is used to center each independent variable, centering within each context, by subtracting each observation from the mean of a nested context.

$$X_{ij} - \overline{X_{.j}}$$

where X_{ij} refers to i^{th} neighborhood level in j^{th} context level

$\overline{X}_{.j}$ represents the mean of context j

The grand mean centering is used to center around the grand mean; each observation is subtracted from the overall mean of the contexts.

$$X_{ij} - \overline{X_{..}}$$

where $\overline{X}_{..}$ represents the grand mean of contexts

The main purpose of centering is to allow a meaningful interpretation of the intercept. On top of that, centering is a possible solution to improve parameter estimation in multilevel linear modeling (Kreft and De Leeuw 1998). “Grand mean centering reduces the covariance between the intercepts and slopes, thereby reducing potential problems associated with multicollinearity” (Hofmann and Gavin 1998, 638).

APPENDIX G

DETERMINING RANDOM AND FIXED EFFECTS

To run multilevel models, we need to determine whether the coefficients of contexts have random or fixed effects. We already knew that we could not treat all coefficients as fixed since the ANOVA model tells us that there are variances between contexts; if all the coefficients are treated as fixed effects, the outcome will be the same with the OLS regression. Two things need to be checked to determine random or fixed effects; 1) whether or not there is a guiding theory indicating that the slope of each variable varies between contexts; or 2) if there is a significant amount of variance among data. There is no guiding theory saying that the impacts of certain neighborhood design features on the turnover rate dramatically differ across contexts. Therefore, data were checked to observe whether there was a variation of the slope for each independent variable.

Neighborhood Level: $T_{ij} = \beta_{oj} + \beta_i \times X_{ij} + r_{ij}$

Context Level: $\beta_{oj} = \gamma_{00} + u_{oj}$

$\beta_{ij} = \gamma_{i0} + u_{ij}$

The estimated variances of slopes, referred to as τ_{11}, infers that the relationships between the X variables and the turnover rate vary significantly across the contexts. If we could reject the null, H_0: $\tau_{11}=0$, at the 0.05 significance level, the coefficients were treated as random; if not, the coefficients were treated as fixed effects. Table A-3 shows which explanatory variables were treated as random or fixed effects.

Table A-2. Determining Random and Fixed Effects across Context

Var. Name	Effect	Var. Name	Effect	Var. Name	Effect
LMEDLOT	Random	**LDSELE**	Random	**TREDEN**	Fixed
LMSFRAT	Random	**AVEELEV**	Fixed	**TRLSI**	Fixed
DEADDEN	Fixed	**LAKE500**	Random	**TRAF500**	Fixed
LSIDEN	Fixed	**DISPARK**	Fixed	**LMEDVAL**	Random
LDSGRO	Fixed	**TRRAT**	Fixed	**MBUILT**	Random

APPENDIX H

RANDOM-COEFFICIENT MODELS

1. Model 1: Structural Design Features Only

Only structural design components at the neighborhood level were included in this model. All explanatory variables were statistically significant except sidewalk density. Having larger median lot size, more dead-ends, and better connectivity to the nearest elementary school help decrease the mean neighborhood turnover. The mixture with multi-family housing and shorter travel distance to the grocery store is a factor for residents to leave.

Neighborhood Level:

$$T_{ij} = \beta_{0j} + \beta_{1j}(LMEDLOT) + \beta_{2j}(LMSFRAT) + \beta_{3j}(DEADDEN) + \beta_{4j}(LSIDEN) + \beta_{5j}(LDSGRO) + \beta_{6j}(LDSELE) + r_{ij}$$

Context Level:

$$\beta_{qj} = \gamma_{q0} + u_{qj} \quad \text{for } q\text{=0, 1, 2, and 6}$$

$$\beta_{qj} = \gamma_{q0} \quad \text{for } q\text{=3, 4, and 5}$$

Table A-3. The Results of a Random-coefficient Model: Structural Design Feature Only

Variable	b	Std. Err.	t	D.F	P>t	Sig
Mean Turnover	10.241	0.249	41.147	125	<0.001	***
Lot Size	-4.246	0.949	-4.472	125	<0.001	***
Housing Mix	0.169	0.094	1.802	125	0.074	*
Dead-end Density	-11.823	2.787	-4.242	248	<0.001	***
Sidewalk Density	-0.066	0.071	-0.922	248	0.357	
Route to the Grocery Store	-0.709	0.385	-1.843	248	0.067	*
Route to the Elementary School	0.297	0.166	1.785	125	0.077	*

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

2. Model 2: Structural and Ecological Design Components Only

All design components of neighborhoods were included in model 2. The mixture of multi-family housing and connectivity to the nearest elementary school and grocery store becomes insignificant. Residents are more likely to stay in neighborhoods close to hills and larger and more complex tree patches.

Neighborhood Level:

$$T_{ij} = \beta_{0j} + \beta_{1j}(LMEDLOT) + \beta_{2j}(LMSFRAT) + \beta_{3j}(DEADDEN) + \beta_{4j}(LSIDEN) + \beta_{5j}(LDSGRO) + \beta_{6j}(LDSELE) + \beta_{7j}(AVEELEV) + \beta_{8j}(LAKE500) + \beta_{9j}(DISPARK) + \beta_{10j}(TRRAT) + \beta_{11j}(TREDEN) + \beta_{12j}(TRLSI) + r_{ij}$$

Context Level:

$$\beta_{qj} = \gamma_{q0} + u_{qj} \quad \text{for } q\text{=0, 1, 2, 6, and 8}$$

$$\beta_{qj} = \gamma_{q0} \quad \text{for } q\text{=3, 4, 5, 7, 9, 10, 11, 12, and 13}$$

Table A-4. The Results of a Random-coefficient Model: Structural and Ecological Designs Only

Variable	b	Std. Err.	t	D.F	P>t	Sig
Mean Turnover	10.244	0.250	40.977	125	<0.001	***
Structural Design Component						
Lot Size	-2.581	0.656	-3.936	125	<0.001	***
Housing Mix	-0.026	0.081	-0.323	125	0.747	
Dead-end Density	-8.893	2.333	-3.812	117	<0.001	***
Sidewalk Density	-0.205	0.071	-2.886	117	0.005	***
Route to the Grocery Store	-0.621	0.408	-1.522	117	0.131	
Route to the Elementary School	0.680	0.769	0.884	125	0.378	
Ecological Design Component						
Average Elevation	-0.006	0.002	-2.527	117	0.013	**
Lake	0.138	0.401	0.344	125	0.732	
Distance to Park	0.000	0.000	1.245	117	0.216	
Tree Ratio	-0.108	0.023	-4.681	117	<0.001	***
Tree Edge Density	-0.007	0.001	-6.863	117	<0.001	***
Three Shape Index	-0.015	0.019	-0.793	117	0.429	

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

3. Comparing Models

The signs are consistent across Model 1, Model 2, and Model3, also called full model, but the significance of each explanatory variable changes across models. Sign and significance of median lot size, dead-end density, average elevation, tree patch ratio, and tree edge density remain the same through all models.

Table A-5. The Results of Random-Coefficient Models

Variable	Model 1		Model 2		Model 3	
	b	Sig.	b	Sig.	b	Sig.
Mean Turnover	10.241	***	10.244	***	10.229	***
Structural Design Component						
Lot Size	-4.246	***	-2.581	***	-3.241	***
Housing Mix	0.169	*	-0.026		-0.087	
Dead-end Density	-11.823	***	-8.893	***	-6.863	***
Sidewalk Density	-0.066		-0.205	***	-0.131	
Route to the Grocery Store	-0.709	*	-0.621		-0.440	
Route to the Elementary School	0.297	*	0.680		0.035	
Ecological Design Component						
Average Elevation			-0.006	**	-0.005	***
Lake			0.138		0.179	
Distance to Park			0.000		0.000	
Tree Ratio			-0.108	***	-0.048	***
Tree Edge Density			-0.007	***	-0.004	***
Three Shape Index			-0.015		-0.011	
Other Condition						
Traffic					0.134	
Housing Value					2.554	***
Built Year					-0.048	*

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

APPENDIX I

MEANS-AS-OUTCOMES MODELS

1. Model 1: Structural Design Features Only

Only structural design components of contexts were included in model 1. A higher population density of contexts decreases neighborhood turnover, while having affordable houses and more connected streets increase it.

Neighborhood Level: $T_{ij} = \beta_{0j} + r_{ij}$

Context Level: $\beta_{0j} = \gamma_{00} + \gamma_{01}(POPDEN) + \gamma_{02}(SMART) + \gamma_{03}(MIXLAND) + \gamma_{04}(BETA) + u_{oj}$

Table A-6. Results of Means-as-Outcomes Model: Structural Design Feature Only

Variable	b	Std. Err.	t	D.F	P>t	Sig
Mean Turnover	10.203	0.228	44.833	121	<0.001	***
Population Density	-0.289	0.083	-3.489	121	<0.001	***
Affordable Housing	1.265	0.581	2.178	121	0.031	**
Land Use Mix	-1.589	0.969	-1.640	121	0.104	
Street Connectivity	2.571	1.488	1.727	121	0.087	*

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

2. Model 2: Structural and Ecological Design Components Only

All design elements of contexts were included in model 2. The signs and significance of structural design components remained the same, but ecological design components did not compared to model 1.

Neighborhood Level: $T_{ij} = \beta_{0j} + r_{ij}$

Context Level: $\beta_{0j} = \gamma_{00} + \gamma_{01}(POPDEN) + \gamma_{02}(SMART) + \gamma_{03}(MIXLAND) + \gamma_{04}(BETA) + \gamma_{05}(GRRAT) + \gamma_{06}(PARKRAT) + u_{oj}$

Table A-7. Results of Means-as-Outcomes Model: Structural and Ecological Designs

Variable	b	Std. Err.	t	D.F	P>t	Sig
Mean Turnover	10.206	0.230	44.387	119	<0.001	***
Structural Design Component						
Population Density	-0.282	0.091	-3.090	119	0.002	***
Affordable Housing	1.328	0.594	2.237	119	0.027	**
Land Use Mix	-1.363	1.086	-1.255	119	0.212	
Street Connectivity	2.675	1.556	1.719	119	0.088	*
Ecological Design Component						
Park Ratio	-2.515	3.509	-0.717	119	0.475	
Green Cover Ratio	1.463	3.126	0.468	119	0.641	

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

3. Comparing Models

The signs remain the same across Model 1, Model 2, and Model 3, also called full model, but the statistical significance changes. Population density is the only statistically significant model through models. Ecological designs are never statistically significant at the 0.1 level.

Table A-8. Results of Means-as-Outcomes Models

Variable	Model 1		Model 2		Model 3	
	b	Sig.	b	Sig.	b	Sig.
Mean Turnover	10.203	***	10.206	***	10.234	***
Structural Design Component						
Population Density	-0.289	***	-0.282	***	-0.332	****
Affordable Housing	1.265	**	1.328	**	0.935	
Land Use Mix	-1.589		-1.363		-2.185	*
Street Connectivity	2.571	*	2.675	*	2.455	
Ecological Design Component						
Park Ratio			-2.515		-2.348	
Green Cover Ratio			1.463		1.708	
Other Condition						
Median Income					-1.153	
Crash					0.001	
On-going Project					0.782	
Spillover Effect					-0.369	***

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

APPENDIX J

NEIGHBORHOOD AGE AND POPULATION DENSITY

The age of neighborhoods (median year built) and density of contexts (population density) were classified by quartiles and mapped. The map shows that old neighborhoods are located around the urban core and contexts with high-density neighborhoods are along with Interstate 35.

Age of Neighborhoods **Population Density of Contexts**

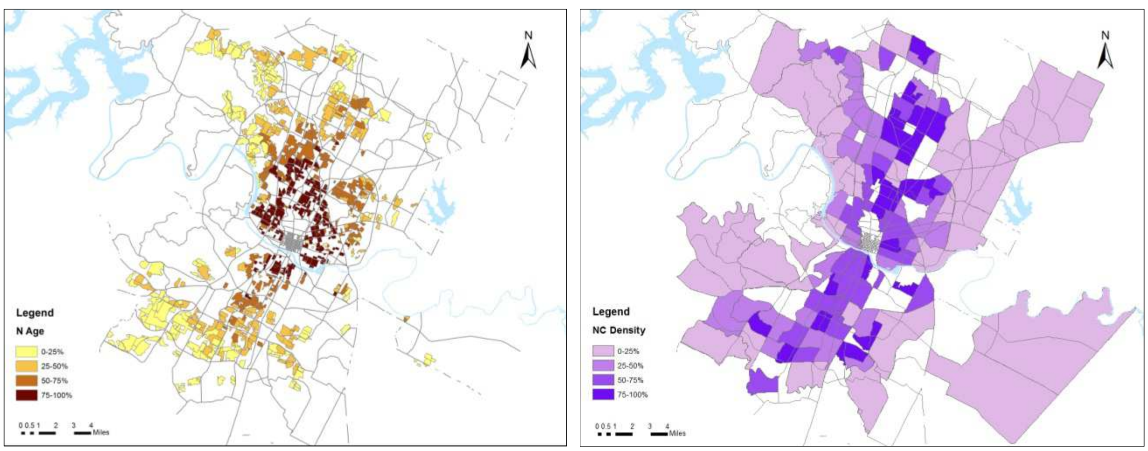


Figure A-5. Age of Neighborhoods and Density of Contexts

To overlay older neighborhoods nested in contexts with a higher density, the scores were given by quartile; the first quartile, 0-25 percent, was given one point, while the fourth, 75-100 percent, four points. The average age score of neighborhoods in the same context and the population density score of contexts were combined. Figure A-5 shows that most of the old neighborhoods with high-density contexts are placed around the urban core cutting through the Colorado River and some were spread out to the northeast.

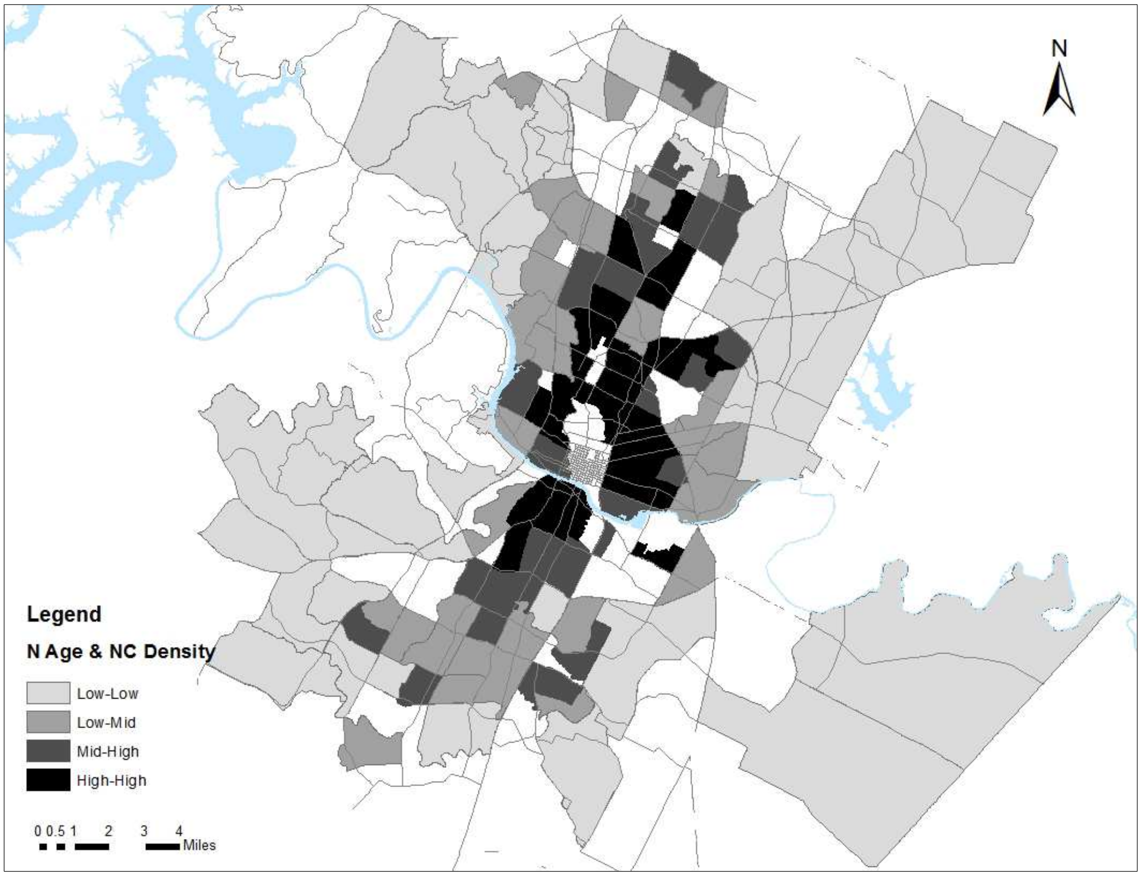


Figure A-6. The Distribution of Old and High-Density Areas

APPENDIX K

OLS REGRESSIONS AT TWO SEPARATE LEVELS

1. The Results at the Neighborhood Level

Tables A-10 and A-11 show the results of OLS regressions performed separately at the neighborhood and the context level. Variables are all grand-mean centered for comparison with the results of multilevel linear modeling. The average variance inflation factor (VIF) is 1.36.

Table A-9. Results of OLS at the Neighborhood Level

Variable	b	B	Std. Err.	t	P>t	Sig	VIF
Mean Turnover	10.312	.	0.133	77.35	0.000	***	
Structural Design Component							
Lot Size	-4.702	-0.338	0.494	-9.51	0.000	***	1.49
Housing Mix	-0.152	-0.050	0.104	-1.46	0.145		1.40
Dead-end Density	-6.535	-0.091	2.156	-3.03	0.003	***	1.07
Sidewalk Density	-0.218	-0.071	0.098	-2.23	0.026	**	1.20
Route to the Grocery Store	-0.884	-0.076	0.342	-2.59	0.010	**	1.02
Route to the Elementary School	0.037	0.008	0.142	0.26	0.794		1.09
Ecological Design Component							
Average Elevation	-0.005	-0.163	0.001	-4.36	0.000	***	1.65
Lake	0.143	0.015	0.296	0.48	0.629		1.14
Distance to Park $^{\Phi}$	0.035	0.107	0.010	3.43	0.001	***	1.15
Tree Ratio	-0.074	-0.136	0.017	-4.24	0.000	***	1.21
Tree Edge Density	-0.005	-0.311	0.001	-8.67	0.000	***	1.52
Three Shape Index	0.014	0.037	0.013	1.09	0.276		1.38
Other Condition							
Traffic	0.443	0.045	0.305	1.45	0.147		1.14
Housing Value	1.668	0.207	0.279	5.97	0.000	***	1.41
Built Year	-0.054	-0.243	0.010	-5.29	0.000	***	2.48
							R^2=0.373
							Adj. R^2=0.360

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

Φ The coefficient and standard error are multiplied by 100

2. The Results at the Context Level

Two different OLS were run at the context level. One only counted the turnover of 127,867 single-family homes nested in neighborhoods, which are defined as subdivisions that have more than 30 units. This is comparable to a means-as-outcomes

Table A-10. Results of OLS at the Context Level

Variable	b	B	Std. Err.	t	P>t	Sig	VIF
Only SF Units within Neighborhood					R^2=0.294	Adj. R^2=0.232	
Mean Turnover	9.790	.	0.158	62.04	0.000	***	
Structural Design Component							
Population Density	-0.274	-0.470	0.062	-4.39	0.000	***	1.87
Affordable Housing	35.687	0.238	12.931	2.76	0.007	***	1.21
Land Use Mix	-1.253	-0.150	0.885	-1.42	0.160		1.82
Street Connectivity	3.724	0.329	1.137	3.28	0.001	***	1.64
Ecological Design Component							
Park Ratio	0.526	0.019	2.462	0.21	0.831		2.28
Green Cover Ratio	1.316	0.070	2.220	0.59	0.554		1.23
Other Condition							
Median Income	0.000	-0.112	0.000	-0.88	0.380		2.61
Crash	0.004	0.045	0.007	0.52	0.606		1.21
On-going Project	0.262	0.056	0.376	0.70	0.487		1.05
Spillover Effect	-0.089	-0.075	0.096	-0.93	0.356		1.07
All SF Units within Context					R^2=0.298	Adj. R2=0.237	
Mean Turnover	10.300	.	0.254	40.57	0.000	***	
Structural Design Component							
Population Density	-0.441	-0.469	0.100	-4.39	0.000	***	1.87
Affordable Housing	23.450	0.097	20.807	1.13	0.262		1.21
Land Use Mix	-1.130	-0.084	1.424	-0.79	0.429		1.82
Street Connectivity	1.873	0.103	1.829	1.02	0.308		1.64
Ecological Design Component							
Park Ratio	-7.971	-0.174	3.961	-2.01	0.047	**	1.23
Green Cover Ratio	7.199	0.238	3.573	2.01	0.046	**	2.28
Other Condition							
Median Income $^{\Phi}$	-0.037	-0.317	0.001	-2.51	0.013	**	2.61
Crash	0.008	0.059	0.012	0.69	0.491		1.21
On-going Project	0.592	0.078	0.604	0.98	0.330		1.05
Spillover Effect	-0.336	-0.175	0.154	-2.17	0.032	**	1.07

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

Φ The coefficient and standard error are multiplied by 100

model. Another took into account all single-family homes nested in contexts (174,352 single-family units); if we want to examine neighborhood turnover at the context level only with OLS, we may need to follow this approach. The adjusted R square is 0.23and 0.24, respectively. The average VIF is 1.60.

3. Spatial Autocorrelation

In OLS, spatial dependency that leads to spatial autocorrelation needs to be checked since spatial clustering for the unexplained regression errors violates the primary assumption of independency among observation (Lin and Zhang 2007). After running separate regressions, spatial autocorrelation was checked with Moran's I with the inverse distance weights matrix. Spatial autocorrelation is not a concern at the neighborhood level (p>0.05). On the other hand, spatial autocorrelation was detected at the context level in both cases—only including single-family units within neighborhoods or all single-family housing units in contexts—if spillover effects were not considered. After spillover effects were included, spatial autocorrelations was adjusted. This indirectly informs us that trends of turnover occur uniquely in neighborhoods, while similarly in contexts.

Table A-11. The Value of Moran's I

Unit of Analysis		Moran's I	E (I)	SD (I)	z	p-value
Neighborhood		0.004	-0.001	0.011	0.529	0.299
Context (SF Units within N)	Spillover X	0.111	-0.008	0.017	6.888	0.000
	Spillover O	0.013	-0.008	0.017	1.222	0.111
Context (SF Units within C)	Spillover X	0.078	-0.008	0.017	5.001	0.000
	Spillover O	0.003	-0.008	0.017	0.677	0.249

*1-tail test

APPENDIX L

DISAGGREGATED AND AGGREGATED OLS

1. Disaggregated and Aggregated OLS

Table A-12. Results of the Disaggregated OLS

Variable	b	B	Std. Err.	t	P>t	Sig	VIF
Mean Turnover	10.251	.	0.130541	78.53	0.000	***	
NEIGHBORHOOD							
Structural Design Component							
Lot Size	-3.345	-0.241	0.506	-6.61	0.000	***	1.74
Housing Mix	-0.204	-0.068	0.101	-2.02	0.043	**	1.46
Dead-end Density	-6.254	-0.087	2.077	-3.01	0.003	***	1.11
Sidewalk Density	-0.243	-0.079	0.094	-2.58	0.010	**	1.23
Route to the Grocery Store	-0.584	-0.050	0.329	-1.78	0.076	*	1.06
Route to the Elementary School	0.073	0.016	0.137	0.53	0.596		1.13
Ecological Design Component							
Average Elevation	-0.002	-0.061	0.001	-1.53	0.125		2.04
Lake	0.241	0.025	0.284	0.85	0.395		1.17
Distance to Park $^{\Phi}$	0.037	0.112	0.012	3.19	0.001	***	1.61
Tree Ratio	-0.123	-0.377	0.014	-8.88	0.000	***	2.37
Tree Edge Density	-0.005	-0.282	0.001	-8.06	0.000	***	1.61
Three Shape Index	-0.018	-0.047	0.013	-1.38	0.169		1.52
Other Condition							
Traffic	0.365	0.037	0.293	1.25	0.213		1.17
Housing Value	2.785	0.345	0.369	7.54	0.000	***	2.75
Built Year	-0.037	-0.167	0.012	-3.21	0.001	***	3.55
CONTEXT							
Structural Design Component							
Population Density	-0.108	-0.074	0.058	-1.87	0.062	*	2.06
Affordable Housing	19.916	0.055	12.667	1.57	0.116		1.63
Land Use Mix	-1.183	-0.064	0.823	-1.44	0.151		2.58
Street Connectivity	2.847	0.112	1.184	2.40	0.016	**	2.87
Ecological Design Component							
Park Ratio	1.708	0.039	1.954	0.87	0.382		1.66
Green Cover Ratio	0.366	0.006	2.312	0.16	0.874		2.58
Other Condition							
Median Income	0.000	-0.072	0.000	-1.02	0.306		6.46
Crash	0.003	0.017	0.006	0.53	0.599		1.32
On-going Project	-0.261	-0.025	0.314	-0.83	0.405		1.17
Spillover Effect	0.041	0.015	0.083	0.49	0.622		1.21
							R^2=0.444
							Adj. R^2=0.425

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

Φ The coefficient and standard error are multiplied by 100

Table A-13. Results of the Aggregated OLS

Variable	b	B	t	D.F	P>t	Sig	VIF
Mean Turnover	9.813	.	0.137	71.44	0.000	***	
NEIGHBORHOOD							
Structural Design Component							
Lot Size	-3.531	-0.408	0.972	-3.63	0.000	***	2.96
Housing Mix	-0.229	-0.102	0.246	-0.93	0.354		2.81
Dead-end Density	5.147	0.092	4.303	1.20	0.235		1.38
Sidewalk Density	0.052	0.021	0.223	0.24	0.814		1.93
Route to the Grocery Store	-0.638	-0.067	0.696	-0.92	0.361		1.26
Route to the Elementary School	0.164	0.044	0.293	0.56	0.578		1.43
Ecological Design Component							
Average Elevation	0.002	0.103	0.002	0.79	0.429		3.98
Lake	0.907	0.143	0.492	1.84	0.069	*	1.42
Distance to Park	0.000	-0.040	0.000	-0.39	0.697		2.48
Tree Ratio	-0.068	-0.404	0.024	-2.85	0.005	***	4.73
Tree Edge Density	0.000	-0.036	0.001	-0.30	0.764		3.40
Three Shape Index	0.015	0.056	0.033	0.46	0.644		3.44
Other Condition							
Traffic	0.446	0.053	0.645	0.69	0.491		1.37
Housing Value	1.772	0.464	0.534	3.32	0.001	***	4.61
Built Year	-0.014	-0.120	0.021	-0.63	0.528		8.50
CONTEXT							
Structural Design Component							
Population Density	-0.206	-0.354	0.059	-3.52	0.001	***	2.38
Affordable Housing	14.276	0.095	13.602	1.05	0.296		1.94
Land Use Mix	-0.523	-0.062	0.854	-0.61	0.542		2.45
Street Connectivity	2.355	0.208	1.356	1.74	0.085	*	3.38
Ecological Design Component							
Park Ratio	-1.986	-0.070	2.774	-0.72	0.476		2.25
Green Cover Ratio	3.902	0.208	2.140	1.82	0.071	*	3.05
Other Condition							
Median Income	0.000	-0.167	0.000	-0.99	0.324		6.66
Crash	0.010	0.121	0.006	1.61	0.111		1.34
On-going Project	-0.186	-0.040	0.348	-0.54	0.593		1.30
Spillover Effect	0.009	0.007	0.091	0.10	0.924		1.38
							R^2=0.575
							Adj. R^2=0.469

* ρ <0.1   ** ρ <0.05   *** ρ <0.01

2. Spatial Correlation

Spatial correlation is not detected in an aggregated OLS model (p>0.05).

Table A-14. The Value of Moran's I

Unit of Analysis	Moran's I	E (I)	SD (I)	z	p-value
Disaggregated	0.003	-0.001	0.011	0.430	0.334
Aggregated	0.067	-0.008	0.017	4.355	0.000

s*1-tail test

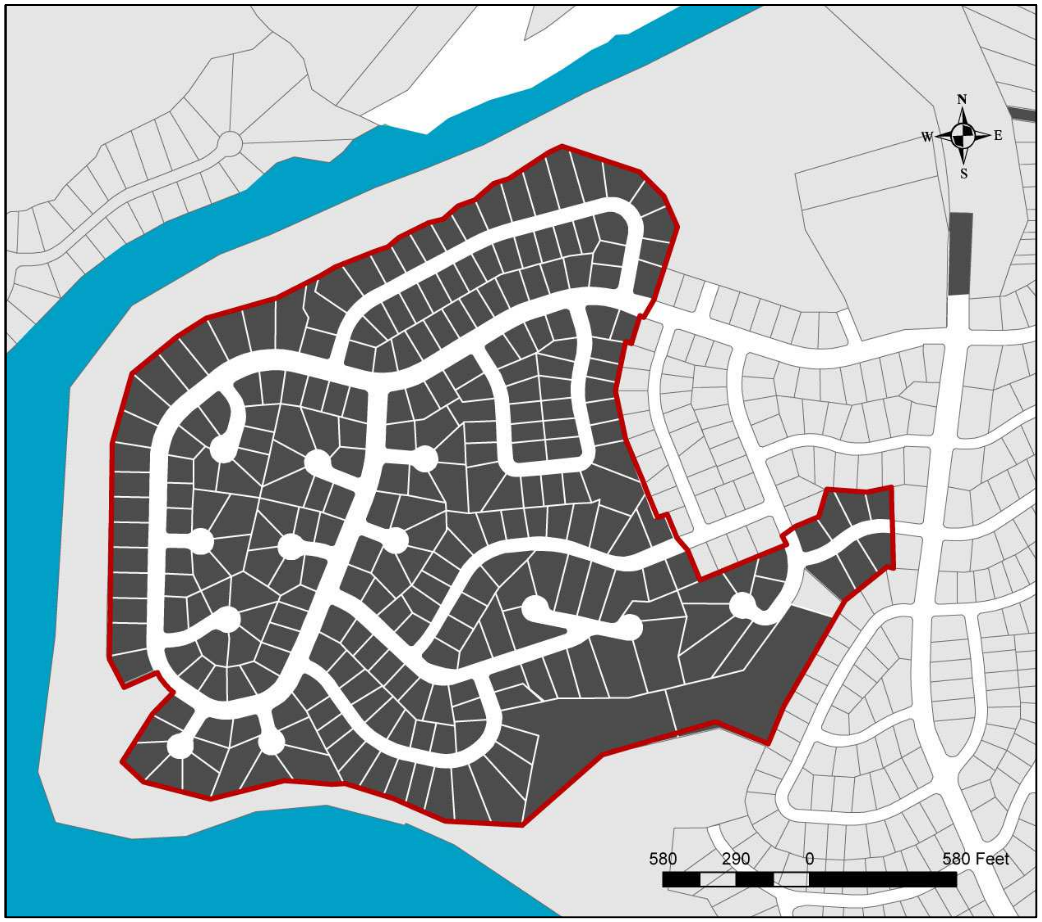
APPENDIX M

FEW NEIGHBORHOODS IN AUSTIN

Park Forest

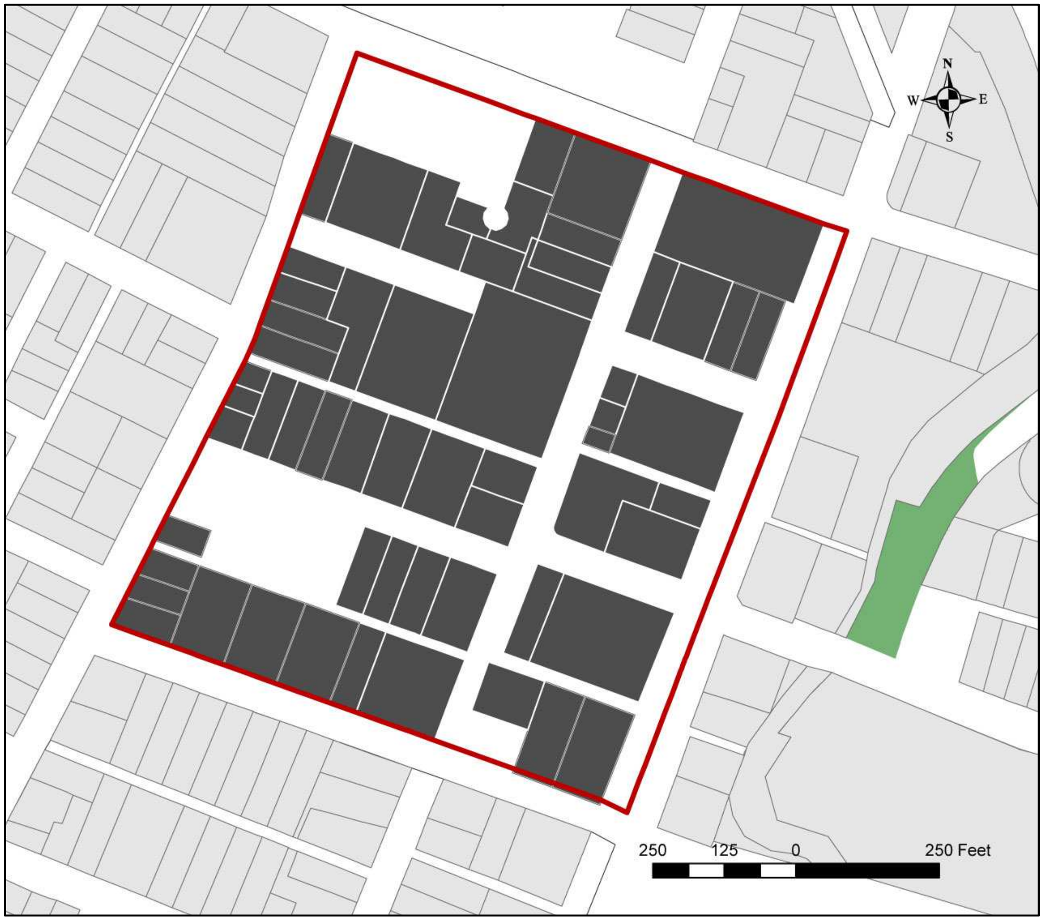
The View Point at Williamson Creek

Horseshoe Bend



Barton Hills

Silliman Subdivision



Country Side

APPENDIX N

THE CENTRALITY OF NEIGHBORHOODS IN CONTEXTS

To identify the reinforcing influence with regard to proximity from the center of a context, the distance from a center of context to a center of nested neighborhood was measured. There is a possibility that the impact of a hosting context may be likely to decrease, if a neighborhood is located farther away from a center of a context.

Neighborhood Level:

$$T_{ij} = \beta_{0j} + \beta_{1j}(LMEDLOT) + \beta_{2j}(LMSFRAT) + \beta_{3j}(DEADDEN) + \beta_{4j}(LSIDEN) + \beta_{5j}(LDSGRO) + \beta_{6j}(LDSELE) + \beta_{7j}(AVEELEV) + \beta_{8j}(LAKE500) + \beta_{9j}(DISPARK) + \beta_{10j}(TRRAT) + \beta_{11j}(TREDEN) + \beta_{12j}(TRLSI) + \beta_{13j}(TRAF500) + \beta_{14j}(LMEDVAL) + \beta_{15j}(MBUILT) + \beta_{16j}(EDGE) + r_{ij}$$

Context Level:

$$\beta_{qj} = \gamma_{q0} + \gamma_{q1}(POPDEN) + \gamma_{q2}(SMART) + \gamma_{q3}(MIXLAND) + \gamma_{q4}(BETA) + \gamma_{q5}(GRRAT) + \gamma_{q6}(PARKRAT) + \gamma_{q7}(LINCOME) + \gamma_{q8}(CRASH) + \gamma_{q9}(PROJECT) + \gamma_{q10}(NEIGH) + u_{qj}$$

for q=0, 1, 2, 6, 8, 14, and 15

$$\beta_{qj} = \gamma_{q0} \quad \text{for } q\text{=3, 4, 5, 7, 9, 10, 11, 12, 13, 16}$$

Yet, the magnitude of coefficients are slightly different, but the statistical significance remains the same with consideration of the centrality of neighborhoods within contexts. This indicates that the centrality of neighborhoods do not contribute to improving the original model; in other words, the location of neighborhoods in contexts do not have any impacts on neighborhood turnover.

Table A-15. Revised Model: Including the Centrality of Neighborhood

Variable	b	Std. Err.	t	D.F	P>t	Sig
NEIGHBORHOOD						
Mean Turnover	10.240	0.230	44.527	115	<0.001	***
Structural Design Component						
Lot Size	-3.665	0.716	-5.118	115	<0.001	***
Housing Mix	-0.098	0.098	-0.994	115	0.322	
** Affordable Housing*	0.598	0.305	1.959	115	0.053	*
**Median Income*	0.975	0.411	2.374	115	0.019	**
** Crash*	0.008	0.004	2.022	115	0.046	**
Dead-end Density	-5.970	2.055	-2.906	745	0.004	***
Sidewalk Density	-0.155	0.085	-1.817	745	0.070	*
Route to the Grocery Store	-0.397	0.319	-1.245	745	0.213	
Route to the Elementary School	0.048	0.140	0.346	115	0.730	
**Park Ratio*	-4.979	2.388	-2.085	115	0.039	**
**Green Cover Ratio*	4.592	2.038	2.253	115	0.026	**
Ecological Design Component						
Average Elevation	-0.005	0.002	-2.551	745	0.011	**
Lake	0.345	0.370	0.932	115	0.353	
**Green Cover Ratio*	-9.167	4.584	-2.000	115	0.048	**
**Spillover Effect*	-0.463	0.213	-2.175	115	0.032	**
Distance to Park $^{\Phi}$	0.034	0.015	2.224	745	0.026	**
Tree Ratio	-0.036	0.016	-2.257	745	0.024	**
Tree Edge Density	-0.004	0.001	-5.924	745	<0.001	***
Three Shape Index	-0.006	0.013	-0.479	745	0.632	
Other Condition						
Traffic	0.122	0.281	0.433	745	0.665	
Housing Value	2.680	1.013	2.645	115	0.009	***
**Green Cover Ratio*	-27.823	14.238	-1.954	115	0.053	*
Built Year	-0.042	0.027	-1.577	115	0.117	
**Population Density*	0.030	0.012	2.558	115	0.012	**
Centrality $^{\Phi}$	0.026	0.038	0.677	745	0.499	
CONTEXT						
Structural Design Component						
Population Density	-0.350	0.096	-3.637	115	<0.001	***
Affordable Housing	0.825	0.703	1.174	115	0.243	
Land Use Mix	-2.247	1.284	-1.750	115	0.083	*
Street Connectivity	2.405	1.610	1.494	115	0.138	
Ecological Design Component						
Park Ratio	2.314	3.240	0.714	115	0.477	
Green Cover Ratio	-3.537	3.583	-0.987	115	0.326	
Other Condition						
Median Income	-1.347	0.896	-1.504	115	0.135	
Crash	0.002	0.011	0.151	115	0.880	
On-going Project	0.863	0.545	1.582	115	0.116	
Spillover Effect	-0.383	0.140	-2.738	115	0.007	***

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

Φ The coefficient and standard error are multiplied by 100

APPENDIX O

THE VARIABILITY WITHIN NEIGHBORHOODS

There have been many discussions whether or not extreme cases should be included. Some argue that outliers need to be included because they are likely to be representative of the population as a whole (Orr et al. 1991), while others argue that the accuracy of estimates will increase if outliers are removed (Osborne and Overbay 2004). Thus, neighborhoods that have high CVs of lot size, house size, and housing price (CV> 1.0) were removed and models were rerun. The results remained almost the same in comparison with the model that included all neighborhoods. Yet, when neighborhoods with high variation in lot size were removed, the interaction term between housing value of neighborhoods and green cover ratio in contexts became statistically insignificant at the 0.1 level, while having planning projects turned into significant at the 0.1 significant level. When neighborhoods with high variability in housing size were removed, the interaction terms between lake and green cover ratio turned out to be insignificant at the 0.1 level. However, none of neighborhood characteristics can be an ideal criterion in taking away some neighborhoods that have relatively heterogeneous characteristics. All changed values turn significant or insignificant at 0.1 level. If we alter the criteria to 0.05 level, which are the broadly accepted criteria, we cannot say these changes are meaningful.

Table A-16. Revised Model: Excluding Heterogeneous Neighborhoods in Lot Size

Variable	b	Std. Err.	t	D.F	P>t	Sig
NEIGHBORHOOD						
Mean Turnover	10.230	0.232	44.143	115	<0.001	***
Structural Design Component						
Lot Size	-3.827	0.745	-5.138	115	<0.001	***
Housing Mix	-0.028	0.102	-0.279	115	0.781	
** Affordable Housing*	0.547	0.313	1.748	115	0.083	*
**Median Income*	0.848	0.418	2.030	115	0.045	**
** Crash*	0.008	0.004	1.901	115	0.060	*
Dead-end Density	-6.316	2.087	-3.026	712	0.003	***
Sidewalk Density	-0.150	0.086	-1.743	712	0.082	*
Route to the Grocery Store	-0.263	0.327	-0.805	712	0.421	
Route to the Elementary School	0.028	0.146	0.194	115	0.847	
**Park Ratio*	-4.092	2.480	-1.690	115	0.094	*
**Green Cover Ratio*	4.217	2.123	1.987	115	0.049	**
Ecological Design Component						
Average Elevation	-0.005	0.002	-2.752	712	0.006	***
Lake	0.261	0.400	0.652	115	0.516	
**Green Cover Ratio*	-10.549	4.885	-2.160	115	0.033	**
**Spillover Effect*	-0.458	0.235	-1.947	115	0.054	*
Distance to Park $^{\Phi}$	0.000	0.000	2.341	712	0.019	**
Tree Ratio	-0.026	0.017	1.686	712	0.092	*
Tree Edge Density	-0.004	0.001	-6.026	712	<0.001	***
Three Shape Index	0.006	0.015	0.398	712	0.690	
Other Condition						
Traffic	0.137	0.292	0.468	712	0.640	
Housing Value	2.713	1.062	2.554	115	0.012	**
**Green Cover Ratio*	-22.315	14.959	-1.492	115	0.139	
Built Year	-0.036	0.027	-1.345	115	0.181	
**Population Density*	0.028	0.012	2.334	115	0.021	**
Centrality	0.019	0.039	0.492	712	0.623	
CONTEXT						
Structural Design Component						
Population Density	-0.327	0.097	-3.381	115	<0.001	***
Affordable Housing	0.914	0.705	1.295	115	0.198	
Land Use Mix	-2.691	1.296	-2.077	115	0.040	**
Street Connectivity	2.288	1.621	1.412	115	0.161	
Ecological Design Component						
Park Ratio	-2.507	3.611	-0.694	115	0.489	
Green Cover Ratio	1.721	3.277	0.525	115	0.600	
Other Condition						
Median Income	-1.261	0.901	-1.40	115	0.164	
Crash	0.002	0.011	0.161	115	0.872	
On-going Project	0.980	0.550	1.782	115	0.077	*
Spillover Effect	-0.380	0.141	-2.694	115	0.008	***

* ρ <0.1   ** ρ <0.05   *** ρ <0.01

Φ The coefficient and standard error are multiplied by 100

Table A-17. Revised Model: Excluding Heterogeneous Neighborhoods in Housing Size

Variable	b	Std. Err.	t	D.F	P>t	Sig
NEIGHBORHOOD						
Mean Turnover	10.233	0.230	44.53	115	<0.001	***
Structural Design Component						
Lot Size	-3.723	0.711	-5.236	115	<0.001	***
Housing Mix	-0.096	0.098	-0.974	115	0.332	
** Affordable Housing*	0.606	0.306	1.982	115	0.05	*
**Median Income*	0.985	0.411	2.399	115	0.018	**
** Crash*	0.008	0.004	1.979	115	0.05	*
Dead-end Density	-5.693	2.049	-2.779	737	0.006	***
Sidewalk Density	-0.157	0.085	-1.843	737	0.066	*
Route to the Grocery Store	-0.445	0.319	-1.397	737	0.163	
Route to the Elementary School	0.049	0.140	0.349	115	0.728	
**Park Ratio*	-5.130	2.390	-2.147	115	0.034	**
**Green Cover Ratio*	4.704	2.048	2.297	115	0.023	**
Ecological Design Component						
Average Elevation	-0.005	0.002	-2.585	737	0.010	**
Lake	0.384	0.377	1.019	115	0.310	
**Green Cover Ratio*	-7.442	4.727	-1.574	115	0.118	
**Spillover Effect*	-0.483	0.217	-2.227	115	0.028	**
Distance to Park $^{\Phi}$	0.037	0.015	2.413	737	0.016	**
Tree Ratio	-0.036	0.016	-2.27	737	0.023	**
Tree Edge Density	-0.004	0.001	-5.976	737	<0.001	***
Three Shape Index	-0.004	0.013	-0.288	737	0.773	
Other Condition						
Traffic	0.084	0.281	0.300	737	0.764	
Housing Value	2.699	1.012	2.666	115	0.009	***
**Green Cover Ratio*	-29.197	14.243	-2.050	115	0.043	**
Built Year	-0.036	0.027	-1.312	115	0.192	
**Population Density*	0.032	0.012	2.652	115	0.009	***
Centrality	0.025	0.038	0.658	737	0.511	
CONTEXT						
Structural Design Component						
Population Density	-0.345	0.096	-3.588	115	<0.001	***
Affordable Housing	0.867	0.702	1.236	115	0.219	
Land Use Mix	-2.253	1.282	-1.757	115	0.082	*
Street Connectivity	2.330	1.609	1.448	115	0.150	
Ecological Design Component						
Park Ratio	-3.457	3.578	-0.966	115	0.336	
Green Cover Ratio	2.252	3.241	0.695	115	0.488	
Other Condition						
Median Income	-1.329	0.895	-1.486	115	0.140	
Crash	0.001	0.011	0.111	115	0.912	
On-going Project	0.854	0.545	1.567	115	0.120	
Spillover Effect	-0.387	0.140	-2.768	115	0.007	***

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

Φ The coefficient and standard error are multiplied by 100

Table A-18. Revised Model: Excluding Heterogeneous Neighborhoods in Housing Price

Variable	b	Std. Err.	t	D.F	P>t	Sig
NEIGHBORHOOD						
Mean Turnover	10.250	0.230	44.502	115	<0.001	***
Structural Design Component						
Lot Size	-3.713	0.733	-5.063	115	<0.001	***
Housing Mix	-0.087	0.099	-0.886	115	0.378	
** Affordable Housing*	0.599	0.306	1.956	115	0.053	*
**Median Income*	1.002	0.413	2.425	115	0.017	**
** Crash*	0.008	0.004	1.995	115	0.048	**
Dead-end Density	-5.938	2.064	-2.877	738	0.004	***
Sidewalk Density	-0.150	0.086	-1.749	738	0.081	*
Route to the Grocery Store	-0.375	0.320	-1.171	738	0.242	
Route to the Elementary School	0.043	0.140	0.309	115	0.758	
**Park Ratio*	-5.116	2.393	-2.138	115	0.035	**
**Green Cover Ratio*	4.572	2.048	2.233	115	0.027	**
Ecological Design Component						
Average Elevation	-0.005	0.002	-2.594	738	0.010	**
Lake	0.360	0.374	0.964	115	0.337	
**Green Cover Ratio*	-10.359	4.665	-2.221	115	0.028	**
**Spillover Effect*	-0.466	0.214	-2.176	115	0.032	**
Distance to Park $^{\Phi}$	0.035	0.015	2.283	738	0.023	**
Tree Ratio	-0.038	0.016	-2.374	738	0.018	**
Tree Edge Density	-0.004	0.001	-5.914	738	<0.001	***
Three Shape Index	-0.005	0.013	-0.370	738	0.711	
Other Condition						
Traffic	0.105	0.283	0.371	738	0.711	
Housing Value	2.750	1.027	2.677	115	0.009	***
**Green Cover Ratio*	-29.431	14.410	-2.042	115	0.043	**
Built Year	-0.038	0.027	-1.427	115	0.156	
**Population Density*	0.030	0.012	2.555	115	0.012	**
Centrality $^{\Phi}$	0.028	0.038	0.735	738	0.463	
CONTEXT						
Structural Design Component						
Population Density	-0.349	0.096	-3.617	115	<0.001	***
Affordable Housing	0.811	0.703	1.154	115	0.251	
Land Use Mix	-2.253	1.285	-1.753	115	0.082	*
Street Connectivity	2.443	1.612	1.516	115	0.132	
Ecological Design Component						
Park Ratio	-3.507	3.587	-0.978	115	0.330	
Green Cover Ratio	2.328	3.248	0.717	115	0.475	
Other Condition						
Median Income	-1.353	0.897	-1.508	115	0.134	
Crash	0.002	0.011	0.164	115	0.870	
On-going Project	0.858	0.546	1.571	115	0.119	
Spillover Effect	-0.385	0.140	-2.751	115	0.007	***

* ρ <0.1 ** ρ <0.05 *** ρ <0.01

Φ The coefficient and standard error are multiplied by 100