URBAN FORM AND SOCIAL SUSTAINABILITY IN NEIGHBORHOOD-LEVEL

by

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Abstract

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New urban form movements in the United State such as, new urbanism, transit-oriented development, smart growth, and compact-city have been described as the most influential movement in the urban design and urban planning literatures since the modernist movement (Bramley & Morgan, 2003; McKenzie, 2004; Grant, 2006; Colantonio, & Dixon, 2011; Burton, Jenks, & Williams, 2003). In recent years, these theories' principles have been adopted for many neighborhood design efforts. They advocate the use of urban design as a way to advance environmental, economic, and social sustainability interests as a model of sustainable urban development (Colantonio, & Dixon, 2011; Burton, Jenks, & Williams, 2003).

This research considers the analysis of urban forms in the neighborhood scale from the social sustainability point of view. It reviews debates about social sustainability and highlights some expecting relationship to understand the ways that different variables related to sustainability. Claims and criticisms of proposed

urban design related to urban forms and social sustainability in neighborhood-scale are examined and the long-standing debates over the extent to which urban forms can affect social sustainability revisited.

Randomly selected neighborhoods from Dallas Fort-Worth metropolitan area were analyzed and structural equation modeling (SEM) procedure performed. The results derive from SEM indicate how far social sustainability could be explained by systematic relationships with different dimensions of urban form.

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Chapter 1

Introduction

This chapter presents the research problem, aims and objectives, limitations and structure of the manuscript.

In the 1990s, the idea of the ability of cities to sustain a high quality of life for all the citizens provided challenges and opportunities for encouraging urban planner and designer to propose a more sustainable pattern of development (Hardoy et al., 2001). The introduction of the concept of sustainable development generated a new debate centered on the urban form of a sustainable city. Scholars in various disciplines seek to discern an urban form that meets the requirements of sustainability and functions effectively (Breheny, 1992).

New urban form movements, such as New Urbanism, transit-oriented development, smart growth, and compact-city, claim that sustainable development goals can be achieved through compact urban form, particularly when there are mixes of land-use and housing type incorporated into the built environment. The advocates of these new movements claim that compact urban form neighborhoods will foster a greater commitment to walking among its residents and thereby advance social interaction among its residents and thus enhance the sustainability of the community and decrease social segregation. They frame the movement as a

pathway toward urban sustainability (Dittmar & Ohland, 2012; Duany & Plater-Zyberk, 2001; Calthorpe & Fulton, 2001; Katz et al., 1993).

Since the appearance of this new paradigm, it has received various criticisms from scholars of urban studies (Williams, 2000). There is a debate that if people have the choice, they will choose low-density suburban living rather than the proposed mixed-use, compact city (Jenks & Jones, 2010). Critics of this new paradigm argue the intensive use of existing lands means loss of open space and facilities. Socially the impact of a compact urban form may affect the quality of life for users, and the effects may in some respects fall unequally on the poor (Burton, 2000). Critics claim that these new urban design guidelines could lead to negative impacts such as less access to green spaces, poorer health, reduced living space, and less affordable housing (Colantonio & Dixon, 2011). They argue that while inner-city, mixed-use areas might achieve benefits of more social interaction, vitality, and better access to facilities, they also could suffer from social tensions, fear of crime, and bad neighbor effects (Jenks & Jones, 2010).

What emerges from this review of the literature is that there are competing claims regarding the extent to which physical designs influence social sustainability. These claims and debates have rarely been supported by empirical evidence (Smith, 2002; Colantonio & Dixon, 2011; Jenks & Jones, 2010; Thomas, 2004; Williams, 2000; Morgan, 2003; Ellise, 2002; Handy, 2005; Burton, Jenks, & Williams, 2000). Thus, this research focuses on the relationship

between the individual dimensions of urban form and social sustainability. It will examine the conduct of residents in neighborhoods with different types of residential density, land-use, transportation layout, and housing types with regard to social sustainability interaction to assess whether this physical design is associated with behavior that supports the move toward social sustainability. Then it will evaluate this claim by discussing how the practice of new urban form movements relates to socially sustainable development goals. It argues that urban development, under the banner of urban form new design guidelines, takes steps both toward and away from social sustainability.

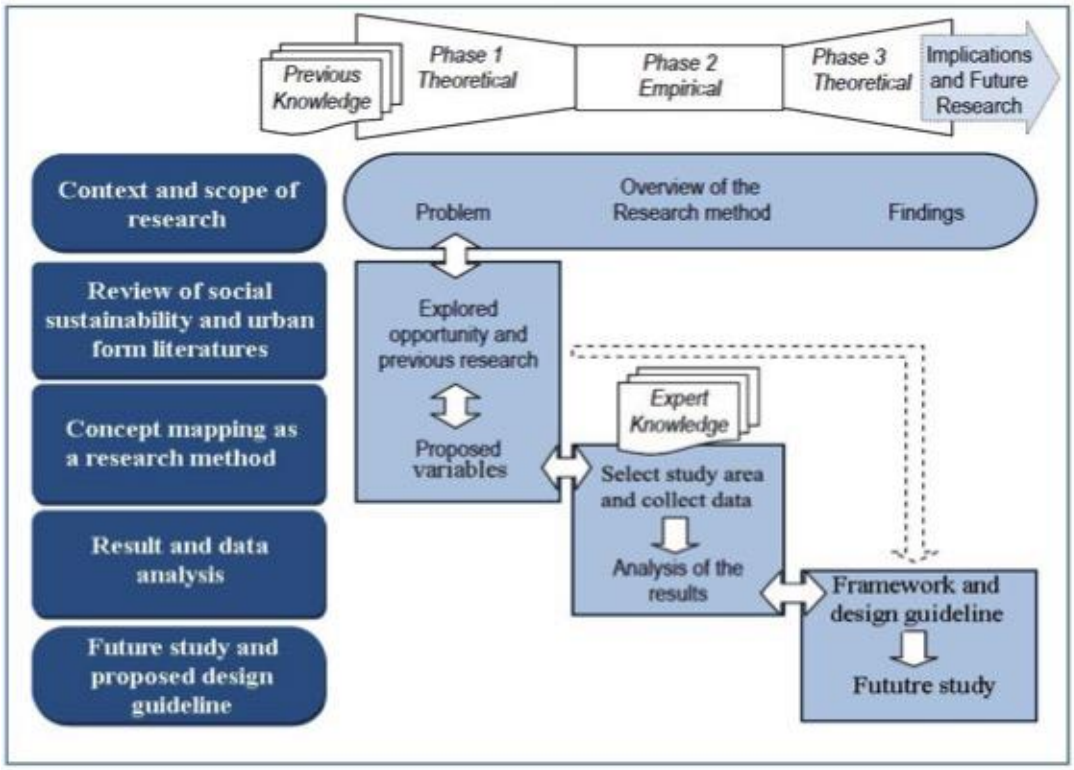


Figure 1 Research Process Framework

This study has been divided into four main parts. First, based on the review of literature, it endeavors to deconstruct the concept of social sustainability and to explore its evolutionary meaning to develop new appraisal methods and metrics in the social sustainability literature and to suggest a set of characteristics for future interpretations of this concept. Second, it attempts to figure out the relationship between the dimensions of social sustainability by the structural equation model (SEM) to aggregate the impacts of proposed criteria into a social sustainability model and to define the relationship between these dimensions and urban form dimensions in the neighborhood scale. Next, based on the results derived from SEM it will reveal how far different urban forms could be explained by systematic relationships with the various dimensions of social sustainability in neighborhood-scale. Finally, to increase the amount of social sustainability of the neighborhoods, some urban form design guidelines are proposed. Figure 1 shows the research process framework.

1.1 Problem Statement

According to United Nations Population Funds (UNPF) since 2006, more than 50 percent of the world population is living in urbanized area, five times more than this population around 1900 (UNPF, 2006). Besides the positive implications of the urbanization process there are also a number of negative ones such as an increase in traffic congestion, high-energy consumption, climate

change impacts, lack of social interaction, and difficulties in retaining economic livability, all of which have received increased attention in the urban development literatures over the last decades (Pattacini, 2012). In the twenty-first century, the problem of global sustainability is widely recognized by world leaders and a frequent topic of discussion by journalists, scientists, teachers, students, and citizens in many parts of the world (Adams, 2006).

The idea of sustainability dates back more than 30 years. In 1972, sustainability was a key theme of the United Nations Conference on the Human Environment in Stockholm. The concept attempted to suggest that it was possible to achieve economic growth and industrialization without environmental damage (Adams, 2006). In 1980, sustainability awareness increased as a global concern because of publications such as "Limits to Growth" and the Worldwatch Institute Reports, which proposed ways to overcome the negative implications of urbanization, protect the environment, generate economic prosperity, and encourage social equity (Brundtland, 1987).

As different people have their own perception of the word "sustainability," many studies about the definition have been published (Kearns & Turok, 2003). In 1987, the World Commission on Environment and Development (WCED)'s definition of sustainable development had come to be widely used. It defines sustainability as "a development that meets the needs of the present generation without compromising the ability of future generations to respond to their needs"

(Brundtland, 1987, 26). In 1997, building on this concept, the environmentalist and economist John Elkington developed a concept which is often referred to as the "Triple Bottom Line" approach to sustainable development. This approach explores the developments that promote economic prosperity, social justice, cohesion, and environmental protection. It presents these three approaches as a Venn diagram in which each of the circles is connected to the particular aspects of sustainability and the areas of overlap show the potential area of the collaboration between them (Meadowcroft, 1999).

The overlapping circles model (three-pillar or multi-pillar model) considers all of the aspects of the sustainability as having equal value in reaching sustainability. This model assumes social sustainability is a concern similar to environmental or economic sustainability (McKenzie, 2004). The proposed equal treatment of the three pillars is based on the conclusion that human needs cannot happen just by achieving economic prosperity and providing an ecologically stable and healthy environment, but that equally social and cultural needs must be taken care of as well. Economic, social, and cultural conditions, efforts, and values are considered to be resources that also need to be protected for future generations (Meadowcroft, 1999).

The concern over rising urban population sustainability has become one of the primary goals of urban development and urban form studies over the last several years. It is applied in the field of urban planning through ideas such as

smart growth and sustainable urban development (Landorf, 2011). This challenge has motivated scholars, planners, civil societies, and governments for redesigning an urban area to achieve sustainability (Wheeler 2000; Jenks, Burton, & Williams, 1996; Harrison 1997). Since most of the focus of sustainability concerned the environmental aspect of it, most arguments regarding the relationship between environmental impacts and urban development theories centered on energy use and the need to travel. This concern has created a debate in thinking between sustainability and more compact and walkable cities as designed forms of sustainable urban development (Landorf, 2011). As a result, the paradigm of city planning in recent decades has been to encourage a compact city and dense development focused around urban centers to reduce the need to travel long distances and to make cities more vibrant (Campbell & Oqist, 1996).

There is an on-going discussion, in the United States and elsewhere, on the concept of the sustainable urban development as the ultimate goal of planning. Marcuse (1998) was one of those that, in his paper "sustainability is not enough," criticized some aspects of sustainability. He brings out two reasons why many sustainable programs are not successful. First, he explains that "sustainability" is not a goal but a desire to reach other goals (Marcus, 1998). He argues that the goal is not sustainability, it is "meeting needs" and making them sustainable. He says if you consider sustainability as a goal only people who already have

everything would be happy. Moreover, he says, everyone likes change and no one wants to sustain things as they are now (1998).

Moreover, Harvey, in the book "the right of the city", says, there is a concern about the relationship between sustainability and injustice that makes many sustainable urban development programs unsuccessful. He says that sustainability sometimes is too passive and that the statistics are not accurate enough. Transformative politics regarding our relation to nature to reach environmental sustainability is important, but it would not happen without social concerns involvement (1997).

Marcuse (1998) also says that sustainability and social justice do not necessarily go hand in hand, since the promotion of sustainability may encourage maintaining an unjust status quo. He explains that the attempt to suggest everyone has common interests in sustainable development can hide the real conflicts of interests, violate other people's freedom, and lead to an unjust society. Marcuse says, "A landlord's profits are a tenant's expense; high-rise construction casts shadows on neighboring land uses. Accessibility for one is pollution for another; security for some is exclusion for others" (1998, p.34). People who try to obtain justice for their society are not interested in sustaining the now, but rather look for change and improvement for a future with less injustice. They want to develop the current situation, not stay in the status quo. (1998).

One of the favorite topics in urban development studies regarding sustainable development is based on the ideas that an urban planner and designer could realize a sustainable city by a suitable physical design. The European Commission was one of the first advocates of physical design and more compact urban forms to achieve a sustainable urban form (Ellin, 1996). In the United States, the movement now known as New Urbanism began to grow in the 1970s and 1980s, based on the intention of following and modernizing historic urban patterns and advocating for sustainability in the urban development area (Ellin, 1996). The organizing body for New Urbanism is the Congress for the New Urbanism, founded in 1993 to lead the organization of promoting walkable, mixed-use neighborhood development, sustainable communities, and healthier living conditions (Ellin, 1996).

New Urbanism encourages compact cities and higher density urban form to create smaller ecological footprints as a solution to reach to sustainability (Duany & Plater-Zyberk, 2001; Calthorpe & Fulton, 2001). Duany (2001), as one of the founders of New Urbanism, says residents in compact urban neighborhoods drive fewer miles and have significantly lower environmental impacts compared with those living in sprawling suburbs (Duany, 2001). The New Urbanism movement believes that with a mixed-use and compact form of development travel alternatives such as, walking, cycling, and using public transportation would increase and lead to more environmental, social, and economic benefits (Jenks &

Jones, 2010). Fainstein (2000) included New Urbanism among the three most important "new directions in planning theory," because of its ability to specify the right elements of good city form.

In addition to New Urbanism in the United States, transit-oriented development (TOD) began to encourage the creation of compact, walkable, mixed-use communities centered on high-quality train systems (Jenks & Jones, 2010). It believes in encouraging the growing trend of creating vibrant, livable, sustainable communities. This theory encourages living a lower street life without complete dependence on a car for mobility and survival. This theory is a combination of regional planning, city revitalization, suburban renewal, and walkable neighborhood ideas (Jenks & Jones, 2010).

Smart growth and compact city views similar to New Urbanism and TOD advocate compact, transit-oriented, walkable, bike-friendly urban development. The term smart growth has mostly been used in the United States and United Kingdom in the development of the compact city (Handy, 2005). It concentrates growth in compact, walkable urban centers to avoid sprawl. Smart growth values long-range, regional considerations of sustainability over a short-term focus. Its sustainable development goals are to expand the range of transportation, employment, and housing choices, equitably distribute the costs and benefits of development, and preserve natural resources (Handy, 2005; Burton, Jenks, & Williams, 2000).

Since their appearance, these theories have received various criticisms from urban studies (Williams, 2000). The first group argues that its sustainable aspect is more focused on environment and lacks focus on social concerns (Williams, 2000). They argue that the concept of social sustainability, mostly defined as the social condition necessary to support environmental sustainability, has been oversimplified in existing theoretical constructs (Williams, 2000). Jenks and Jones (2010) argue that developments of compact, mixed-use development ideas might make cities more sustainable by reducing ecological footprints, improving employment and health outcomes, and reducing urban sprawl. However, there is another debate among scholars that this perspective does not adequately address how humans might interact with other social structures such as the dispersed nature of employment and education in cities, the impact of economic change on work-life balance, continuing consumer preferences for privacy and personal space, and other interactions between humans and social systems (Jenks & Jones, 2010).

Ellise (2002) believes the intensive use of existing lands means loss of open space and facilities; he also argues that socially the impact of a compact urban form may affect the quality of life of users, and the effects may in some respects fall unequally on the poor. Marcuse claims that New Urbanism would hurt disadvantaged groups in the inner city and criticizes this new movement for ignoring complex urban realities (2000). He says New Urbanism is not new and

not urban. It contributes to the problems of the suburbs and that making suburbs beautiful does not undo injustice or stop sprawl (2000). Moreover, Davidson, Kellett, Wilson, and Pullen (2012) say the New Urbanism attempts to reduce urban sprawl by making urban growth boundaries and encouraging higher density development, which tends to force low-income residents into apartments while the wealthy can continue to live in suburban areas, leading to social injustice (2012).

This lack of social concern, according to Colantonio and Dixon (2011), would have a negative impact on a community. They explain that proposed high-density and mixed-use urban form would decrease community ties because of the increase in stress and facing of traditional relationships (Colantonio & Dixon, 2011). They discuss that while central mixed-use areas might achieve benefits of more social interaction and vitality and better access to facilities, they also could result in social tensions, crime or fear of crime, and bad neighbor effects (Williams, 2000). In more suburban residential areas, quality of life may be enhanced by access to greenery, stronger social contacts, and better safety and security, but poorer access to facilities and green space can lead to less social involvement (Masnavi, 2000). Moreover, Bramley and Morgan (2003) say living in high-density urban areas could have negative impacts such as poorer access to green spaces, poorer health, reduced living space, and less affordable housing (Bramley & Morgan, 2003). Mixed-use and compact cities may also affect the

aesthetics of places, and, hence, people's sense of attachment to and pride in their place of living, although it is far from clear whether resident relationships in this urban area would be positive rather than negative (McKenzie, 2004).

The second group criticizes these theories for making the same mistake that modernism made by believing that they could solve social problems through physical design (Fainstein, 2000; Harvey, 1997; Grant, 2006). Fainstein (2000) and Harvey (1997) say these new theories repeat the modernist error that is destroying communities by putting people in the arranged environments to raise living conditions. They believe this idea could stop the creativity arising from diversity and conflict and make a different quality of community that leads to injustice for its members (Fainstein, 2000; Harvey, 1997). Grant (2006) says New Urbanism follows the garden city and modernist idea advocating that building satellite cities and beautiful neighborhoods could control sprawl, protect agricultural land, and solve social segregation. He accused the New Urbanism of reactionary politics, social injustice, totalization, and disciplinary space (Grant, 2006).

Gans (1991) believes cities' basic problems of social injustice arise from poverty and racism not from the city's physical form. He argues against what he calls "physical determinism" (Gans, 1991). He uses "physical determinism" to question the link between physical design concepts and social outcomes. He critiques the compact city theory, which believes that rearranging the environment

is the most urgent social action needed to achieve the good life. He says providing people with green space and sunlight would not reduce crime and vice (Gans, 1991). He notes that the compact city idea sees urban problems as physical rather than social; as a result, they developed solutions such as beautification, fresh air, and modern architecture (1991).

Compact, mixed-use, transit-oriented development cannot alone solve poverty, unemployment, and political problems since most planners are not looking for the causes of urban decline. Gans (1991) critiques physical determinism as transforming the built environment toward a solution for job creation, antipoverty, and race relations. He believes in a user-oriented paradigm against physical determinism that focuses on urban residents as the ones who shape their cities rather than being passive victims (Gans, 1991; & Thomas, 2004).

David Harvey's 2010 book "Social Justice and the City" was one of the first studies that brought the term of social justice into urban planning debates (Smith, 2002). He is one of the primary neo-Marxist principals who transformed urban theory in the early 1970s (Smith, 2002). He explored exclusion of urban poor through the processes of capitalist production and reproduction and also the principles of social justice and their application to geographic and economic concepts (Smith, 2002). Harvey (1997) and Fainstein (2000) also criticize New Urbanism concerning physical determinism it cannot address the social injustices

of capitalism without the force of any social movement (Harvey, 1997; Fainstein, 2000). Although Harvey (1997) admires New Urbanism for designing a place and region as a whole with more organic, historical, and holistic styles; however, he criticizes them for describing Utopia and privileging spatial forms over social processes that will destroy social stability within a space frame.

Fainstein (2000) also critiques these new movements regarding the probability of achieving improvement in the quality of human life by physical design. She explains that these movements are a neo-traditional approach that paints a physical picture of a city through planning that primarily focuses on plans rather than the method of achieving them. She admires some of these ideas such as designing a variety of mixed-use buildings, public realm, and a nostalgic form of neighborhood, controlling damaging environments made by developing suburbia, developing design instructions that contain diversity and provide people what they actually want rather than what old zoning laws and greedy developers forced on them, and offering an urban form that stimulates community with physical design and aesthetic satisfaction (2000). However, she critiques them for advocating their products, encouraging an unrealistic physical determinism, and focusing on suburbia rather than overcoming metropolitan social segregation (2000).

Harvey (1997) has warned New Urbanists about falling into "the communitarian trap" of involvement with the current capitalist order (p. 2). Some

New Urbanism assumptions are not truly acceptable, such as the idea that community could solve world social problems or that the urban village could be a solution to industrialization (Harvey, 1997). The community has often been an obstacle to rather than a comforter of social change, and most of the people leave the village because there is more racism and class devaluation in this kind of environment. People move to the cities because of their excitement to explore the urban unknown that most of the villages lack (Harvey, 1997).

These new movements believe that modernist projects failed because their ideas of physical forms were imperfect. New Urbanism wants to solve this problem by looking to traditional forms of buildings, blocks, and neighborhoods that give shape to urban life rather than some radical new model (Harvey, 1997). Harvey says it is true that New Urbanists are wiser than modernists and have been able to create more humane urban spaces; however, since most of their members are architects, they are more comfortable working with the physical form of community development than with the social process that is needed for long-term success (1997). However, New Urbanism does not recognize that the fundamental difficulty with modernism was the idea of privileging spatial forms over a social process. Harvey says the basic concept of modernism was that human behavior could be controlled through the proper design of physical spaces and that New Urbanism is making the same mistake (1997).

The social or ethnic groups that people belong to affect the way people use the urban space. The social homogeneity of residential areas based on the neighborhood unit is the reason for the success of these neighborhoods and that physical determinism was not a chief determining factor in how successful neighborhoods were in forming stable units (Gans, 1991).

The term "underclass" increases differences between the deserving and undeserving poor and leads researchers to ignore the economic and social forces that have transformed American cities and hurt the lives of all poor and working-class Americans. It is not only the modernist beliefs; even Jane Jacobs put too much attention on the physical appearance of the cities when really social phenomena determine the way people use the space in the cities (Gans, 1991).

Physical determinism is no longer the urban planners' challenge; it is the notion of desired social outcomes that requires and needs to receive attention (Smith, 2002). The other significant challenge for an urban planner is how to construct an environment in ways that help affect behavior and explain desirable values to engage more with social movements and institutional transformations (Smith, 2002).

These new movements are less persuasive in their approach to social injustice since they must rely on private investors to pursue their goals. This reason could lead them to create a different style of suburbia that contains greater physical diversity but with the same social composition problems. New Urbanism,

TOD, smart growth, and the compact-city attempt to create local community by creating a physical environment to develop greater social contact within the neighborhood, but they would lead to more segregation within a class, race, and ethnicity (Fainstein, 2000).

What emerges from this review of the literature is that there is a variety claims regarding the extent to which physical designs influence social sustainability; however, these claims and debates have rarely been supported by empirical evidence. To address this gap, this research draws upon data sources to examine evidence on some aspects of social sustainability and their relationships to urban form in the neighborhood-scale. It focuses on the relationship between the individual dimensions of urban form in a neighborhood and social sustainability, based on evidence from randomly selected neighborhoods in DFW areas.

1.2 Research Questions

This research attempts to achieve a comprehensive study showing the criteria and perspectives of social sustainability while comparing different urban forms to understand whether there is a difference between them regarding social sustainability. Also, it explores which of them are more sustainable socially and why people choose to move to high-density, transit-oriented, mixed-use urban

development or remains in a conventional suburban residential environment. In this context, the research questions of this study are:

- What are the indicators and perspectives of social sustainability? And, what is the relationship between them?
- What are the dimensions of urban form at the neighborhood-scale?
- Which urban form variables at neighborhood level correlate with indicators of social sustainability, once intervening variables have been controlled?
- Whether new proposed urban form design ideas are enough to achieve a socially sustainable neighborhood?
- What are the best urban form design ideas to achieve a socially suitable urban development?

1.3 Goal and Objectives

1.3.1 The Primary Research Goal

The primary research goal is to provide a comprehensive analysis on the impact of urban form on social sustainability.

1.3.2 The Research Objectives:

1. To provide a detailed exploration of the concept of social sustainability and a brief review of the existing literature and debates of social sustainability criteria

and perspectives, highlighting some expected relationships and some areas of dispute and uncertainty.

2. To review debates about urban form and social sustainability and highlight some expected relationships and some areas of discussion and doubt to understand in what ways urban form contributes to social sustainability.

3. To Use structural equation modeling (SEM) to expand interrelated relationships of social sustainability and urban form.

4. To examine whether new movement proposed urban form is enough to have a socially sustainable neighborhood.

5. To relate these findings to the wider literature on urban form and sustainability, drawing out point for providing design guidelines.

1.4 Limitations

In particular, the primary limitation of this study is that the empirical framework base is on the selected neighborhoods in the DFW Metropolitan Area. Given the urban form impact on social sustainability perspectives, future research to validate the framework with whole urban areas in the United States and other countries would be useful. Also, the proposed social sustainability and urban form model would be helpful as scaffolding for future discussion among those neighborhood designs that aim to assess a comprehensive sustainable neighborhood development. Learning from these researchers has the potential to

broaden current understandings of the social dimension of sustainable development; however, there has been little effort to encompass this effort into a broader conceptual framework, as happened with both economic and environmental sustainability. Though it is necessarily more challenging, having reviewed the literature and this dissertation is just a fundamental research to study this relationship.

Chapter 2

Literature reviews

This chapter presents urban form and social sustainability definitions and dimensions.

2.1 Sustainability and social sustainability

During the last thirty years, the term "sustainable development" has developed gradually through the environmental concerns. Sustainability awareness increased as a global concern because of publications such as Limits to Growth (Randers & Meadows, 2004) and the Worldwatch Institute reports (Kearns & Turok, 2003). As different people have their own description of the word "sustainability," many studies about the definition of sustainability exist in the world. However, the World Commission on Environment and Development (WCED)'s definition of sustainability has come to be widely used. It defines sustainability as "a development that meets the needs of the present generation without compromising the ability of future generations to respond to their needs" (Brundtland, 1987).

Building on this concept, the interrelationships between the environmental, social, and economic aspects of sustainability are commonly developed by the environmentalist and economists John Elkington. In 1997, he developed what is often referred to as the "Triple Bottom Line" approach to sustainable

development. This approach attempts to explain developments that promote economic prosperity, social equity, and environmental protection. O'Riordan et al. (2001), and Lutzkendorf and Lorenz (2005) defined two alternative models of this approach. In the sustainable development discussion, this is explained in the form of overlapping circles, "Three Pillars" (Venn diagram interpretation) or, Russian Doll (one-pillar models). The first model (Three Pillars) illustrates sustainability as merging the three pillars of economic enterprise, social well-being, and environmental integrity. The second model, the "Russian Doll" (one-pillar models) explains the sustainability environment where economic capital is placed at the center as the basis for wealth creation, but at the same time it is imposed upon by environmental and social considerations (Lucas, Jones, Allen, & Manzi, 2010).

Figure 2 illustrates each of these approaches. In the Venn diagram, if each of the circles is associated with the interests of specific aspects of sustainability, then the areas of overlap show potential areas of collaboration or partnership between them (Meadowcroft, 1999). The Rio Declaration in 1990 suggested that sustainable development is about "adjustment" of these three aspects and reaching some type of exchange among them in the prioritization process. In contrast, the Russian Doll (one-pillar models) explanation proposes that sustainable development is responsible when used with economic development, which must

benefit society through hardly seen, unchangeable environmental limits (Lucas, Jones, Allen, & Manzi, 2010).

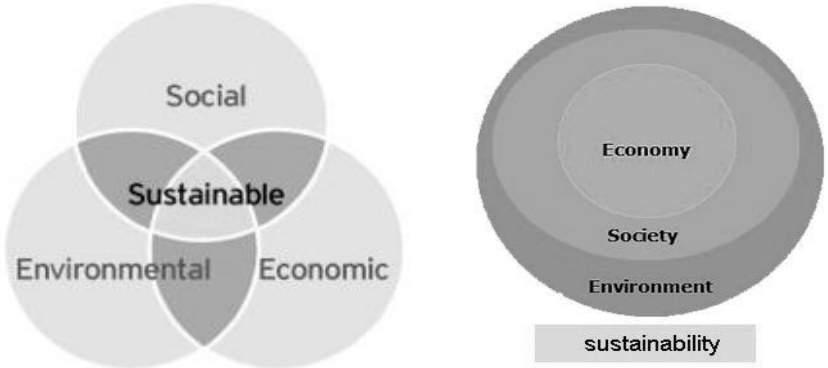


Figure 2 Sustainability Approaches

The Russian Doll (one-pillar) models of sustainable development clearly give priority to the ecological dimension. Based on that, sustainable development should mainly help preserve the ecological systems and resources necessary for economic and social life, as an essential prerequisite for meeting the future needs of humanity (Dillard, Dujon, & King, 2008). In this model the economy and what is rather vaguely described as social matters are taken to be the leading causes for environmental problems, which will obviously have to be improved or changed to ensure ecological sustainability (Omann & Spangenberg, 2002).

The overlapping circles model (three-pillar or multi-pillar models), considers all of the aspects of the sustainability as having equal value in reaching

sustainability. This model assumes social sustainability as a concern similar to environmental or economic sustainability (McKenzie, 2004). In Elkington's words, "the sustainability agenda, long understood as an attempt to harmonize the traditional financial bottom line with emerging thinking about the environmental bottom line, is turning out to be much more complicated than some early business enthusiasts imagined" (2004, p. 4).

The proposed equal treatment of the three pillars is based on the conclusion that human needs cannot be sufficiently met just by providing an ecologically stable and healthy environment, but the equally legitimate social and cultural needs ought to be taken care of as well. Economic, social, and cultural conditions, efforts, and values are deemed to be resources that also need to be preserved for future generations.

According to McKenzie (2004), the social aspects of sustainability are the most neglected elements of the triple-line model, since they are harder to quantify than economic growth or environmental impacts. As a result, previous research has mainly focused on the environmental and economic aspects of sustainability; they have been addressed in much greater depth than has social sustainability. Moreover, generally speaking, indicators of social sustainability are too general to be useful, and specific indicators need to be developed for particular parts of social sustainability studies (McKenzie, 2004).

Recently, social sustainability has been more known as a fundamental part of

sustainable development and has started to receive political and institutional verification within the sustainable development agenda and the sustainable urban form discussion (Lucas, Jones, Allen, & Manzi, 2010). Furthermore, academics, professionals and policymakers interested in social sustainability often hold varying perspectives about what social sustainability is and how it can be implemented and discussed. Surprisingly, little attention has been given to the definition of social sustainability in built environment disciplines. As a result, there is a need for a comprehensive discussion to clarify the understanding of social sustainability criteria and perspectives that help us to survey possible links between social sustainability and urban form (Porta & Renne, 2005).

2.2 Social Sustainability Perspectives

This section investigates the issues involved in defining social sustainability for the purposes of creating a common research agenda for use. Generally, there has been a strong focus on defining sustainability as a condition and measuring it with a series of indicators. My intention here is not to criticize other literatures, but rather to investigate their potential while also suggesting other possibilities.

Definitions of social sustainability usually describe it as either a currently existing positive condition, or as a goal that remains to be achieved. Generally, current discussions of social sustainability are structured around a definition of

the condition, a series of case studies and projects to compare from one situation to another and a measurement framework (Colantonio & Dixon, 2010; McKenzie, 2004; Sachs, 1999; Barron & Gauntet, 2002).

The measurement framework for the defined social sustainability is often a series of indicators that can be positive or negative. The majority of the work on social sustainability has focused on producing such indicator sets. Sachs (1999) in a discussion of social sustainability and whole development identified component elements of indicators to define a framework for social sustainability. She defined in great depth social sustainability as giving equal voice to a range of considerations within broader discussions of sustainable development in great depth. She recognizes social homogeneity, equitable incomes, and access to goods, services, and employment as general components of a socially sustainable community. Sachs (1999) states that social sustainability "must rest on basic values of equity and democracy" (p. 27). She explains that it is still unclear whether the concept of social sustainability means the social requirements for sustainable development or the need to sustain specific structures and customs in communities and societies (Such, 1999; Bacon, Cochrane, & Woodcraft, 2012).

Another example of studies attempting to develop indicators for social sustainability is Godschalk's 2004 study. He took quite a different approach to expose elements of social sustainability. Godschalk (2004) modified Campbell's (1996) urban planning principals of resource, development, and property conflicts

by adding a livability component of social sustainability. This perspective highlights ways in which the effect of some of the urban planning projects could actually be in opposition to having livable cities. This perspective is important because it offers another view to the sustainability discussions, which have largely assumed desirable outcomes for all. The coordinated recognition of these conflicts, and the acknowledgement that resident values and their understanding of livability can play into their long-term sustainability concerns, and can notify the design of livable cities that are also sustainable (Gough, 2015).

In this sense, McKenzie (2004) defined social sustainability as "a life-enhancing condition within communities, and a process within communities that can achieve that condition" (p. 120). He defined social sustainability as an equity of access to key services such as health, education, transportation, housing, and recreation, as well as equity between generations, meaning that future generations will not be disadvantaged by the activities of the current generation (McKenzie, 2004). In this perspective, social sustainability is a system of cultural relations in which the positive aspects of different cultures play an important role.

In contrast to social sustainability indicators, there is a lack of available literature to determine which dimension of social sustainability should be implemented, and the specific relationships between its different aspects. Since it is impossible to define social sustainability without referring to its conditions and to define its framework without explaining its features and methods of

implementation, it is certainly useful to have both definitions of social sustainability as a condition and indicators to measure it, although there are problems inherent in this approach.

Chiu's 2003 study is a relevant study that proposed physical and built environment perspectives of social sustainability. He identified three main approaches to the interpretations of social sustainability. The first interpretation identifies social sustainability to environmental sustainability and explains that the social sustainability of an activity depends on specific social relations, structure, value, and limitation of development. The second interpretation, which she calls "environment-oriented," refers to the social conditions required to achieve environmental sustainability (p.66, 67). According to this interpretation, social structure and value can change to carry out human activities within the physical limits of nature.

She calls the third interpretation "people-oriented," and it is about improving the well-being of people and the equitable distribution of resources to reduce social exclusions. She later adopts the second and third approaches to demonstrate how social conditions, housing quality, and equitable distribution of resources are key components of sustainable urban development (Chiu, 2003).

Another example of a study that defines social sustainability through implementation and framework is work by Bramley and Power (2009). They argue that social sustainability is often identified with social capital, social

cohesion, and social exclusion. They suggest that basic development issues, like access to necessary goods and services, have been successfully addressed, and studies should focus on what might be called "higher-order" needs. They believe sustainability of a community is about the capability of society as a local community to reproduce itself at a suitable degree of functioning (p. 30).

Bramley and Power (2009) propose a conceptual framework for social sustainability. It includes two typologies: social equity and sustainability of communities. The latter refers to social interaction through social networks in the community and pride, sense of place, and safety and security. The sustainability of the community is defined as "the ability of society itself, or its manifestation as local community, to sustain and reproduce itself at an acceptable level of functioning," and social equity issues are described as "powerful political and policy concerns, and center upon with concept of social justice" (p. 421).

The definitions of sustainability and related indicator sets are most useful when they are developed at a local level. Definitions broad enough to contain all factors in all situations tend to be too broad for use in specific situations (Bramley & Power, 2009; Gaugh, 2015). There have been case studies to reach a more detailed analysis. For example, Smailles and Hugo (2004), in a study of South Australia, used a clear framework in measuring the strengths and weaknesses of an individual community by applying a detailed set of indicators. They used these data to determine better planning measures to increase social sustainability in a

city. Another example is the Management of Social Transformations projects that have managed a series of case studies on cities and the social policies that indicate their social sustainability.

The model of social sustainability developed by Barron and Gauntel (WACOSS) in 2002 is one of the primary examples of defining social sustainability on a local scale. This model concerns a range of housing issues affecting low-income households and develops a set of criteria for identifying a socially sustainable community (Barron & Gauntel, 2002). This model has four elements: a definition of social sustainability, principles of social sustainability, characteristics of socially sustainable communities, and statements addressing the characteristics of socially sustainable communities. WACOSS defined social sustainability "as the formal and informal processes; systems, structures and relationships actively support the capacity of current and future generations to create healthy and livable communities." It explains that "socially sustainable communities are equitable, diverse, connected, and provide a good quality of life" (2002. p.421).

The social sustainability themes change from traditional themes, such as equity, poverty reduction, and livelihood to more intangible and less measurable concepts such as identity, sense of place, and the benefits of social networks (Colantonio, 2009). It shifts from hard themes towards softer concepts within the

social sustainability debates in recent years to bring happiness-oriented policies on existing government concerns (Colantonio, 2009; Colantonio & Dixon, 2011).

Other studies define social sustainability through the measurement framework. They used mixed qualitative and quantitative groups of data to measure social sustainability (Colantonio & Dixon, 2011). These groups of studies add soft factors like happiness, social mixing, and sense of place instead of hard factors like employment and poverty to measure social sustainability. In addition they believes social sustainability is concerned with how individuals, communities, and societies live with each other and set out to achieve the objectives of developmental models that they have chosen for themselves, also taking into account the physical boundaries of their places and planet Earth as a whole (Colantonio, 2009).

Other literatures debate of social sustainability and urban regeneration identified a number of dimensions and policies to explain social sustainability such as: demographic change (aging, migration, and mobility), education and skills, employment, health and safety, housing and environmental health, identity, sense of place and culture, participation, empowerment and access, social capital, social mixing and cohesion, and well-being, happiness and quality of life (Polése & Stren, 2010).

Barron and Gauntel, (2002) define social sustainability of a city as: "development that is compatible with the harmonious evolution of civil society,

fostering an environment conducive to the compatible cohabitation of culturally and socially diverse groups while at the same time encouraging social integration, with improvements in the quality of life for all segments of the population." They used ten large cities as case studies to analyze the success of social policies in six key areas: governance, cultural policy, public services, housing, transport, and employment (2002). Their focus on the local in all these matters is due to their recognition that "the social sustainability of cities is affected not only by nationwide spatial policies, but also, if not chiefly, by policy decisions and implementation at the local level" (2002, p. 22).

Macro-level social theory and policy has more success in developing sufficient frameworks for social sustainability (McKenzie, 2004). What is instead required is a focus on conditions to build up relative knowledge about the key elements that make urban designs successful. Urban design in this sense has a fundamental role in linking people and places together. They believe if the city is fragmented and unstructured, it contributes to social segregation and alienation (McKenzie, 2004) On the other hand, societies cannot be sustained without reference to the space they occupy, an observation that brings into play such things as the allocation of recreational and civic space, street design, the location of services in relation to population, and so on (McKenzie, 2004).

Oktay (2004) was one of the first to bring out the relationship between social sustainability and the urban form of the cities. He says people who live in cities

with heavy traffic are less likely to meet; in contrast cities designed based on pedestrian orientation are more socially and environmentally sustainable and have more social interaction and diminished crime (Oktay, 2004). Later, Chan and Lee (2008) identified factors of social sustainability and its relationship with the urban form through a questionnaire survey and factor analysis method. During this research, they provide the five factors that indicate the social sustainability dimensions including: "satisfaction of welfare requirements," "conservation of resources and the surroundings," "creation of harmonious living environment," "provisions facilitating daily life operations," "form of development," and "availability of open spaces" (Chan & Lee, 2008, p. 14). Chan and Lee (2008) reviewed significant success factors for socially sustainable projects that refer to development and improvement of the well-being of current and future generations. They explain that urban developments, to be socially sustainable, are a development of a relevant living environment, to reduce social inequality and improve the quality of life in general (Chan & Lee, 2008).

Table 1 indicates the summary of different author definitions and concerns related to social sustainability.

Table 1 Social Sustainability Definitions

Author/Authors	Social sustainability definitions
Yiftachel and Hedgcock	Social sustainability is about the long-term survival

(1997)	of a viable urban social unit and its elements contain, equity, community, and urbanity;
Sachs (1999)	Social sustainability makes a relevant living environment, reduces social inequality and improves quality of life for future generation;
Polese and Stren (2000)	Social sustainability is a development with harmonious evolution of civil society that encourages social mixture and improvements in the quality of life for all of the residents with increased access to services and facilities, and participation and interaction in the community activities;
Koning (2001)	Social sustainability is the capability of a human unit (individual, household, or family) to gain and maintain an adequate and decent livelihood;
Barron and Gauntlett (2002)	Social sustainability occurs when formal and informal processes, systems, structures and relationships actively support the capacity of future generations to create healthy and livable communities, and provide a good quality of life;
Briat (2002)	Social sustainability determines the minimal social requirements for long-term development;
Baroon and Gauntlet (WACOSS) (2002)	Social sustainability is the formal and informal processes, systems, structures and relationships that actively support the capacity of current and future generations to create healthy and livable communities. Their study explains that socially sustainable communities are equitable, diverse, connected, and democratic and provide a good quality of life;
McKenzie (2004)	Social sustainability is a life-enhancing condition within communities and a process within communities that can achieve that condition;
Godschalk (2004)	Social sustainability is the conditions that

	incorporated equity of access to key services, as well as equity between generations; meaning that future generations will not be disadvantaged by the activities of the current generation;
Littig and Grießler (2005)	Social sustainability is a quality of societies. It signifies the nature-society relationships, mediated by work, as well as relationships within the society;
Colantonio and Dixon (2009)	Social sustainability concerns how individuals, communities and societies live with each other. It stems from actions in key thematic areas, encompassing the social realm of individuals and societies, which ranges from capacity building and skills development to environmental and spatial inequalities;

Various writers have suggested that sustainability is essentially a contested concept and that the way in which debates over the definition and the relative importance of different indicators of sustainability are played out in the academic discussion is a reflection of these issues within society (Chan & Lee, 2008; Colantonio & Dixon, 2009; Oktay, 2004). I argue that, while the debate over definition is certainly helpful, practical concerns about the need for collective understanding of research results also need to be considered. I am not arguing here that a single definition should be adopted. I am noting that there remains a series of possibilities that depend on different research purposes that may be helpful to explore and that they are not currently being developed in the literature of social sustainability. All of these rely on having established a basic definition of social sustainability and an indicator system to allow this research to move

beyond contestations of definition and towards potential new models for understanding and collaboration between social sustainability and urban form design.

If we imagine creating a definition and measurement system for social sustainability, we might produce a basic list of the features of a social sustainability society, based on this research agenda. This study's definition of social sustainability is related to the interests and capabilities of this research. This definition would provide a framework for measuring social sustainability and find the relationship between its elements and urban form variables in a neighborhood.

This research intends to mix and expand the definition of social sustainability as a mixture of traditional social areas and principles, such as equity of access to facilities and health with soft features such as, participation and interaction in a community, safety, sense of place, and cultural diversity, and quality of life in the neighborhood scale.

Based on literature review and the interests of this research, the social sustainability definition by Colantonio and Dixon (2009) has been used. Colantonio and Dixon (2009) defined social sustainability as: "a development pattern characterized by a strong sense of community and the harmonious evolution of civil society that encourages social mixture, and improvements in the quality of life for all of the residence with increase access to services and

facilities, and participation and interaction in the community activities" (2009, p 54).

2.3 Social Sustainability Approaches

Social sustainability approaches have changed since sustainability theories were first developed. Based on definitions and expectations of the literature on social sustainability, this study divided these approaches into five main groups: the environment, social equity, community attachment, spatial justice, and emerging concerns approaches (Sterling, 2001).

The first approach is a mixture of environmental and social dimensions of sustainable development within the "ecological footprint" concept. Social sustainability is considered in connection with the social implications of environmental politics rather than as an equally constitutive component of sustainable development (Smith, 1995; Yiftachel & Hedgcock, 1997; Sachs, 1999). This group of studies assumes that the success of sustainable developments depends on their ability to attain the highest environmental living standards. As a result, social sustainability acts as an opportunity to reach environmental protection goals and defines it from an environmental point of view. Bridger and Luloff (2003) provide an interesting analysis of the potential link between social and environmental sustainability goals. Whereas the authors discuss the idea of

local social capital as being an important tool in reaching the aims of environmental sustainability, they also argue that the social well-being of a neighborhood is crucial in being able to meet the challenge of collective action needed to achieve the environmental goals of sustainability (Bridger & Luloff, 2001). These studies consider social sustainability as a proper tool to advocate goals of environmental sustainability. These studies have not been grounded in theory but rather on a practical understanding of plausibility and current political agendas (Smith, 1995; Yiftachel & Hedgcock, 1997; Sachs, 1999).

As three-pillar models have become more common, a new approach has developed that attempts to define social science as the focus of concern in sustainability research and development. The social element becomes as much a concern as other pillars of sustainability and it pursues social sustainability as one of the main elements of sustainability defined as separate from environmental and economic sustainability. This approach explains how basic needs and equity are consistently held as fundamental pillars of social sustainability (Chambers & Conway, 1992; Smith, 1995; Yiftachel & Hedgcock, 1997). These concepts are deemed necessary for the physiological and social survival of human beings, individually and as communities as a whole. This is because, at a basic level, there can be little doubt that shelter, food, clean water, and employment are essential requirements for the sustainability of individuals and communities. Similarly, equity is considered a crucial component of social sustainability

because of the increasing evidence that societies with lower levels of difference have longer life expectancies, fewer homicides and crimes, stronger patterns of civic engagement, and more economic vitality. A chronological analysis of social sustainability themes in this approach also finds traditional themes such as poverty reduction and livelihood, democracy, human rights, job opportunities, and equitable access to resources and social services. These studies determined these indicators to measure the effects of social policies and programs on social sustainability (Chambers & Conway, 1992; Smith, 1995; Yiftachel & Hedgcock, 1997; Polese & Stren, 2000; Littig & Griebler, 2005; Koning, 2001; Barron & Gauntlett, 2002; Briat, 2002; McKenzie, 2004; Godschalk, 2004).

The third approach describes the term social sustainability mostly in a range of community attachment concerns. During this period, the social sustainability themes change from traditional themes, such as equity, poverty reduction, and livelihood to more intangible and less measurable concepts such as identity, sense of place, and the benefits of social networks. Studies describe a shift from "hard" themes towards "softer" concepts within the social sustainability debates in recent years to bring happiness-oriented policies on existing government concerns. This approach explains social sustainability goals as how individuals, communities, and societies live with each other and set out to achieve the objectives of developmental models that they have chosen for themselves (Chan & Lee, 2008;

Holden, 2012). Table 2 indicates how social sustainability approaches have changed over time.

Table 2 Social Sustainability Approach

Social Sustainability Approaches	Enviromental Concerns (1970 - 2000)	Social Equity Concerns (2000- 2005)	Community Concerns (2005- 2009)	Urban Social Sustainability Emerging (2009- Now)
Selected Defenitions	Social sustainability synonymous with the environment and refers specifically to the preservation of the earth's resources for future generations	Social sustainability is the process of meeting the needs of people and communities today in a way that enables future generations to meet their needs.	Social sustainability is the continuing ability of a city to function as a long- term, viable setting for human interaction, communication and cultural development.	Social sustainability is a development pattern characterized by a strong sense of community and the harmonious evolution of civil society that encourages social mixture, and improvements in the quality of life for all of the residence with increase access to services and facilities, and participation and interaction in the community activities
Selected Objective	. Increase globalization concerns for enviromental protection . To make a relevant living environment . Maintanance enviromental sustainability	. Access to housing and enviromental health . Access to education and skills . Access to Employment . Equity of human rights and gender . Poverty . Social justic	. Social mixing and cohesion . Identity, sense of place and culture . Empowerment, participation in community . Health and safety . Social capital . Quality of life . Demographic changes (migration and mobility)	. Need equitable access to such as, . . Education, . Public services, . Affordable housing, green space, . Public transportation, . Employment . Sense of place . Cultural diversity . participation and interaction in community . safety and sense of security
Examples of Researches	Smith, 1995); Yiftachel and Hedgcock (1997) ; Sachs (1999); Rees and Wackernagel (1996); Metzner (2000);	Polese and Stren (2000); (Drakakis Littig and Grießler (2005); Koning (2001); Barron and Gauntlett (2002); Briat (2002); WACOSS (2002); McKenzie (2004); Godschalk (2004); Littig and Grießler (2005)	Chan and Lee (2008); Layard (2007); Smailles and Hugo (2004); Holden, (2007)	Bramley et al., (2006); Bramley et al., (2009); Jenks & Jones (2010); Arundel, (2011); Colantonio & Dixon (2009)

The fourth approach describes the term social sustainability in a range of social goals from material equity issues to psychological feelings of community. This approach is a combination of three previous approaches. Social sustainability overlaps with other concepts developed in the literature, such as social equity

(access to resources) and social cohesion (community attachment). These groups of studies define social sustainability as a development pattern characterized by a strong sense of community and the harmonious evolution of civil society that encourages social mixture, improvements in the quality of life for all of the residents with increased access to services and facilities, and participation and interaction in community activities (Bramley et al., 2006; Bramley et al., 2009; Jenks & Jones, 2010; Colantonio & Dixon, 2009).

2.4 Social Sustainability Elements

When considering the concept of social sustainability, many authors identify numerous primary elements and indicators related to the meaning of social sustainability. Reviewing literature on the concept of social sustainability shows how some traditional themes, such as equity, poverty, and livelihood are replaced by new concepts such as identity, sense of place, and the benefits of social networks (Glasson & Wood, 2009). The table below shows the social sustainability elements by literature.

Table 3 Social Sustainability Elements by Literatures

Author/Authors	Social Sustainability Elements
Yiftachel and Hedgcock (1997)	Equity, community, and safety;
Sachs (1999)	Equitable incomes, access to goods, services, and

	employment;
Williams, Jenks, and Burton (2000)	Better access to facilities, education, better job accessibility, better public transportation, health facilities, level of social segregation, affordable housing;
Polese and Stren (2000)	Accessibility to public service, safety, education, and employment;
Barton (2000)	Equity, community safety, health and choice;
Koning (2001)	Gender equity, social justice and quality of life, access to information, physical, psychological and reproductive health, access to life sustaining activities (nutrition, housing, employment, access to land and resources), and safety, equitable income distribution, employment, and equitable access to resources and social services;
Barron and Gauntlett (2002)	Equity, diversity, quality of life, inter-connectedness, and democracy and governance;
WACOSS (2002)	Equity, diversity, interconnectedness, quality of life, and democracy and governance;
Godschalk (2004)	Livability, economic growth, ecology and equity;
Littig and Grießler (2005)	Satisfy an extended set of human needs, sense of place, social justice, human dignity;
Colantonio and Dixon (2009)	Demographic change (aging, migration, and mobility), education and skills, employment, health and safety, housing and environmental health, identity, sense of place and culture, participation, empowerment and access, social capital, social mixing and cohesion, and well-being, happiness, and quality of life;
Cuthill (2009)	Social justice and equity, sense of place, social infrastructure, security, diversity, interaction in the

	community;
Bramleye et-al (2011)	Viability, health, interaction in the community and social networks, community participation, pride and sense of place, community stability and security, sense of place, access to facilities, and access to public transportation and open spaces.

Generally speaking, social sustainability literature concerns a variety of factors. On the one hand, a concern for social equity both within and across different societies is essential to achieving sustainability. As Vallance et al. (2011, p. 344) points out, it is "unrealistic to expect people to care about global warming or species extinction when they are cold, hungry, looking for work, or feel unsafe in their own home." Thus, creating built environments with equitable access to essential services, jobs, transportation, and housing is critical to sustainability (2011).

At the same time, social sustainability also draws attention to the fact that certain social conditions are necessary to support environmentally sustainable behavior (Bramley & Power 2009). Thus, on the other hand, developing sustainability of the community, which includes social interaction within a place, neighborhood pride, and participation in collective activities, is essential to creating a city where people want to live (Bramley et al. 2009; Dempsey et al. 2011). These concepts provide a framework that this research will use to trace

how New Urbanism practitioners have operationalized socially sustainable development (Garcés, Ródenas, & Vicente, 2003).

From review of these literatures potential connections between variations in the neighborhood built environment and outcomes of social sustainability are included two main components such as, access to resources and community attachment".

2.4.1 Access to Resources

The first concept relates to the idea of "fairness in the apportionment of resources in society" (Burton, 2000; Bramley et al., 2006). Access to resources concerns distributive justice or fairness in the apportionment of resources and equality of conditions. The social sustainability concept fundamentally concerns powerful political and policy issues and insists that fairness be a consideration in the distribution of resources within society (Burton, 2000).

Increased equity in access to resources results in decreased spending on prisons, security enforcement, welfare, and social services. It concerns fair and equitable access to livelihood, education, and resources and self-determination in meeting primary needs. Equity is the foundation of society, which cannot be maintained for a few at the expense of the many (Burton, 2000).

Equity of access to resources mostly concerns human-scale neighborhoods that provide shelter for all. Neighborhoods that offer a range of housing options, a

mix of uses, and access to a variety of jobs, are often intergenerational and diverse (Vallance et al., 2011; Cuthill, 2009; Barron & Gauntlett, 2002). Social sustainability is measured by accessibility to daily life services, in which residents and users have equitable access to education, public services, affordable housing, green space, public transportation, and job opportunities (Bramley, Dempsey, Power, & Brown, 2006; Colantonio & Dixon, 2009).

Transportation Equity

Access to affordable and reliable transportation widens opportunity and is essential to addressing poverty, unemployment, and other equal opportunity goals such as access to good schools and health care services. Residents who can drive and afford an automobile are probably better off now because they have more mobility (Litman, 2006; Sanchez & Brenman 2007). However, it would be a difficult situation for the residents who either cannot drive or would prefer to use alternative modes (because they dislike driving, want to save money, or enjoy the physical activity and social interactions of walking, cycling, and public transit). Daily life is probably worse for these groups of residents because their communities are less walkable, bus service have declined, and development patterns are more sprawled (Litman, 2006; Sanchez & Brenman 2007).

Transportation equity is necessary to connect communities to jobs, health care, and educational opportunities. Public transit, in particular, is vital to people

with low incomes and people of color who own fewer cars and tend to live further away from living-wage jobs. Not only is public transit better for the environment, but also it can act as a catalyst for a stronger economy by creating and connecting people to jobs. Public transportation provides vital connections and eases pollution and traffic congestion. It also makes the communities stronger by providing a lifeline for millions of disabled people who cannot or do not drive. It provides an essential link for individuals who cannot travel by private car. For people with disabilities, public transportation enables mobility, self-sufficiency, and access to the necessities of everyday life (Litman, 2006; Sanchez & Brenman 2007).

Public transportation also connects rural residents and people in smaller cities to larger urban commercial centers and services. While public transit provides a lifeline to hundreds of smaller communities, a lack of transportation options would limit many rural residents' access to higher education and job opportunities.

Affordable Housing

Affordable housing is one of the elements of sustainable social development. The most conventional definition of affordable housing comes from the Department of Housing and Urban Development (HUD) and reflects the economic ability of a household to afford housing. HUD defines affordable

housing as, “housing that costs no more than 30 percent of a household’s monthly income” (Nguyen, 2005). Depending on the location and what the mean income of a household is as well as the size of the family, the value of affordable housing could be different. For low-income families making below the average income, it becomes difficult for them to provide shelter for themselves (Gilderbloom, 2008). HUD defines affordable housing units as any units with restrictions involving rent and price so that the given units can continue to be affordable and serve those who are unable to pay more than thirty percent of their income towards housing (Gilderbloom, 2008). The economic perspective of the housing crisis is also closely related to age. When there are more people under twenty-five or over 65 there is greater a need for affordable housing. As there are more younger families without the financial means to provide for themselves there is more of a need for affordable housing and thus affordable housing resources are further exhausted (Gilderbloom, 2008). To ensure that communities have this option, social or public housing options are critical (Nguyen, 2005).

However, affordable housing is more than just low-income housing (Nguyen, 2005). It also involves a broader understanding of housing options, the relevance of other policy sectors for housing (environment, transportation, and education to name a few) and how they come together to impact equity, sustainability, and livability in communities (Nguyen, 2005). Affordable housing creates diversity (aging population, disabled, working to middle income) in

communities for both neighborhood development and economic growth (Brunick, Mainer, 2008; Aragones, 2002).

Additionally, whether housing is rental or owned, affordability allows individuals to live in areas close to work and education and this impacts transportation, urban sprawl environmental concerns, and many others prevalent issues facing the residents' lives (Brunick, Mainer, 2008). The problem with high rents is that they not only make it difficult for people to rent but also make it difficult for people to buy homes (Gliderbloom, 2008). Whether or not many of the residents see it a likely possibility in the future to purchase a home and how long they plan to stay living in an affordable housing unit will be covered more thoroughly in the research study (Garcés, Ródenas, & Vicente, 2003).

From an urban form perspective, affordable housing is not just about housing; it is also about providing a positive environment for people to reside in. Part of this process requires that there be an investigation into the layout of the units to determine whether or not they have a good quality of housing, which in studies has been shown to increase the overall mood of people (Gliderbloom, 2008).

Education

Educational equity is a federally mandated right of all students to have equal access to classes, facilities, and educational programs no matter what their

national origin, race, gender, sexual orientation, disabilities, first language, or other distinguishing characteristic (Garcés, Ródenas, & Vicente, 2003). Generally, research shows that basic education is the key to a nation's ability to develop and achieve sustainability targets. It can minimize crime and anti-social behavior, reduce population growth rates, enhance environmental protection, and generally raise the standard of living (Sterling, 2001). An educated community gains higher status and an enhanced sense of efficacy. It tends to desire a smaller family size and seek the health care necessary to do so (Hutchins & Sutherland, 2008).

In the context of urban form, equity is associated with students having access to educational facilities such as schools and libraries in their communities. It means students would be able to walk to (maximum 0.5 mile distance from center of neighborhood) elementary, middle, and high schools (Garcés, Ródenas, & Vicente, 2003; Sterling, & Huckle, 2014).

Access to Local Services

To meet the requirements of equity in urban development it is essential to provide appropriate opportunities in terms of access to local services (such as retail, repair, shop, supermarket, restaurant, church, clinic, and library). Research has shown that the availability of goods and services within local areas enables residents to participate fully in society (Gordon-Larsen et al, 2006). It indicates

that access to goods and services is an important indicator of social sustainability in a neighborhood. One's decision to move or stay within their neighborhood is presumably motivated by the desire to preserve, or in some cases advance, one's quality of life. Thus, it can be assumed that a person will make the decision to move when their needs are no longer being adequately met by their current situation, or in this case place of residence (Dutta-Bergman, 2005).

Residents whose needs are met have a tendency to have higher levels of social sustainability (Dutta-Bergman, 2005). Such needs include access to goods and services and distance from these resources have been found to be a major determinant of sustainability of a community; when resources are unattainable due to substantial distance, people characteristically report lower levels of social sustainability (Filkins, Allen, & Cordes 2000; Gordon-Larson et al, 2006). In general, satisfaction with the local services is a good indicator of overall social sustainability.

Access to Open and Green Spaces

One of the fundamental principles of access to resources is access to parks and open spaces. Parks and other natural public places are a public resource, and the benefits should be distributed equally. Those who lack adequate access to these resources are at risk for health problems and face more challenges to

enjoying the quality of life associated with parks and open spaces (Littig & Griessler, 2005).

The World Health Organization defines health as "a state of complete physical, mental and social well-being, and not merely the absence of disease or infirmity." Healthy People 2020, an initiative from the U.S. Department of Health and Human Services, also embraces this view of health and well-being by highlighting the interaction between factors that collectively influence individual and community health. A focus on the underlying social aspects can help the public health community strategically address multiple health objectives in a socially equitable way (Garcés, Ródenas, & Vicente, 2003).

The natural environment, often described as green space in urban areas is widely considered to be an important contributor to health. Green spaces, which are often described as ecosystem services, provide indirect and direct benefits to human health and well-being. Urban green space can regulate air and water pollution, mitigate urban heat effects, and enhance access to nutritious fruits and vegetables, which increase the physical health of urban residents (Littig & Griessler, 2005). Research indicates that the benefits from cultural services (e.g., landscape aesthetics, outdoor recreation, spiritual and cultural values) are no less important to health and well-being, yet their value may be frequently underestimated (Littig & Griessler, 2005). Outdoor recreation can increase a population's level of physical activity and potentially reduce the risk of obesity or

cardiovascular disease. Aesthetic aspects in natural landscapes can also reduce stress and anxiety. Enhanced understanding of green space could therefore help to inform health-related policy and decision-making (Garcés, Ródenas, & Vicente, 2003).

2.4.2 Community Attachments

After studying which variables are related to access to resources (the first component of the social sustainability) this section explains briefly how the community attachment variables (the second component of social sustainability) are related to social sustainability. The second concept is concerned with the continued viability and functioning of society itself (Bramley et al., 2009). It relates more directly to the concept of social sustainability as a set of social conditions that enable reaching collective goals. At the neighborhood level, the concept refers to the social networks and interactions between its residents, a concept which was famously observed by the critic of modernist planning, Jane Jacobs, who saw community as "the lifeblood of cities" and who described the network of relationships and cooperative action between people, often based on the collective impacts of the numerous and seemingly trivial encounters within the neighborhood space (Jacobs, 1961).

Sander (2002) states that stronger community attachment at the neighborhood level can also facilitate the mobilization of others for a social cause

or to help a neighbor in need, lead to improved information flows helping residents learn of anything from a job prospect, community news, to who can and cannot be trusted, help avoid the necessity of third-party mechanisms (such as government authorities) to reinforce social cooperative behavior, and make residents less likely to engage in unproductive defensive behavior (Sander, 2002; Bramley et al., 2009).

Participation in the Community Activities

Variable community attachment is part of a definition of social sustainability emphasizing that it is not just achieving a mix of characteristics of population within an area that matters, but also whether people actually personally interact with their neighbors. It explores community participation and is interested in the belief that if people participate in activities within their local community they will have stronger ties to the community (Littig & Griessler, 2005). A similar argument applies to the inclusion of the concept of pride and sense of place. This relates to the importance of feeling pride in one's area and of having a vested interest in the area—the idea being that if people feel attached to the neighborhood, they will want to stay living in the area and contribute to its continued development (Biart, 2002; Barron & Gauntet, 2002). Within the literature, neighborhoods with high turnover are more unsettled and undesirable neighborhoods to live in. Community safety is an essential prerequisite for

socially sustainable neighborhoods. The neighborhoods with crime and fear never will be successful as sustainable communities (Littig, & Griessler, 2005).

Generally it is about the capability of society as a local community to reproduce itself at a suitable degree of functioning. It must contain a sense of place and stability in a community, cultural diversity, participation and interaction in mixture of social behavior, and safety and sense of security (Arundel & Hollanders, 2011; Bramley et al., 2009; Dempsey, 2008; Talen, 1999).

Sense of Place

It has long been argued that physical settings, activities, and meanings are interrelated (Gehl, 2001; Lynch, 1960). Relph defined "sense of place" as "to be inside a place is to belong to it and to identify with it" (1976, p. 49), which can be as much about the physical environment as the people who inhabit it. On the other hand, Bramley et al. (2010) maintain that when residents feel more pride and attachment to their neighborhoods they will likely feel a greater satisfaction with the area (Bramley & Power, 2009).

Residential stability and satisfaction is clearly linked directly to the other community attachment goals of social sustainability and it has been argued that the length of residence in a community is one of the most formative variables in developing local social networks and psychological feeling towards a community, regardless of housing density or socioeconomic status (Kasarda & Janowitz,

1974). Resident satisfaction with an area measures the level of community stability, as a more satisfied resident is less likely to move out of the area (Bramley & Power, 2009). There is an important link between residential stability and social sustainability insofar as longer-term residents are more likely to participate in and commit to the well-being of a community (McCulloch, Ward, & Tekkis, 2003).

Resident mobility may be a symptom of the failure of a neighborhood or community, exacerbated by low social cohesion or reduced feelings of attachment illustrated by residents moving out of areas (Bramley & Power, 2009) However, resident turnover in a neighborhood may improve the overall contribution of new residents to its sustainability through their active participation and active citizenship (Kearns & Forrest, 2000). Low residential mobility has also been linked to increased feelings of attachment to neighborhoods and an increase in local social networks and interaction (Wilson & Taub, 2006). While it has been argued that community stability, or low residential turnover, is not necessary for social order to persuade (Wilson & Taub, 2007), it is widely regarded as a positive social quality, which can be put at risk by high levels of social mobility (Bramley & Power, 2004).

Safety

Another important aspect connecting urban form and social sustainability is safety of the built environment. Burton and Mitchell (2006) explain that safety within the built environment is related to the extent people can use, enjoy, and move around the outside environment while feeling safe (p. 128). Social interaction in community networks will be reduced if there are unsafe public places in high volume pedestrian areas at the heart of the community, or if the built urban fabric is fragmented and dominated by unsecure places (McCulloch, Ward, & Tekkis, 2003). Residents who are socially attached to their community will form partnerships with police, prosecutors, and neighborhood volunteers to reduce crime and increase safety. Increased neighborhood attachment can establish a system for residents to work together with police and with the community to reduce crime and make residents safer (McCulloch, Ward, & Tekkis, 2003).

Burton and Mitchell (2006) also explain several categories of fear that relate to the built environment. Among them are fear of being attacked, fear of being run-over, and fear of falling. The way the built environment is designed affects these fears either positively or negatively (Arundel, 2011). These feelings usually constrain people‘s willingness to participate and affect their behavior at a certain level in the outside environment. To ensure a safe environment, Burton and Mitchell (2006) identify several aspects that need to be considered. Among

them are: a mix of uses, pedestrians separated from traffic by trees; on-road parking or bicycle lanes; spaces and buildings designed and oriented to avoid areas of dark shadow or bright light; adequate street lighting; wide, well maintained footways; and proper traffic calming measures (Arundel, 2011; Burton & Mitchell, 2006). Figure 3 indicates two main social sustainability components and their related variables.

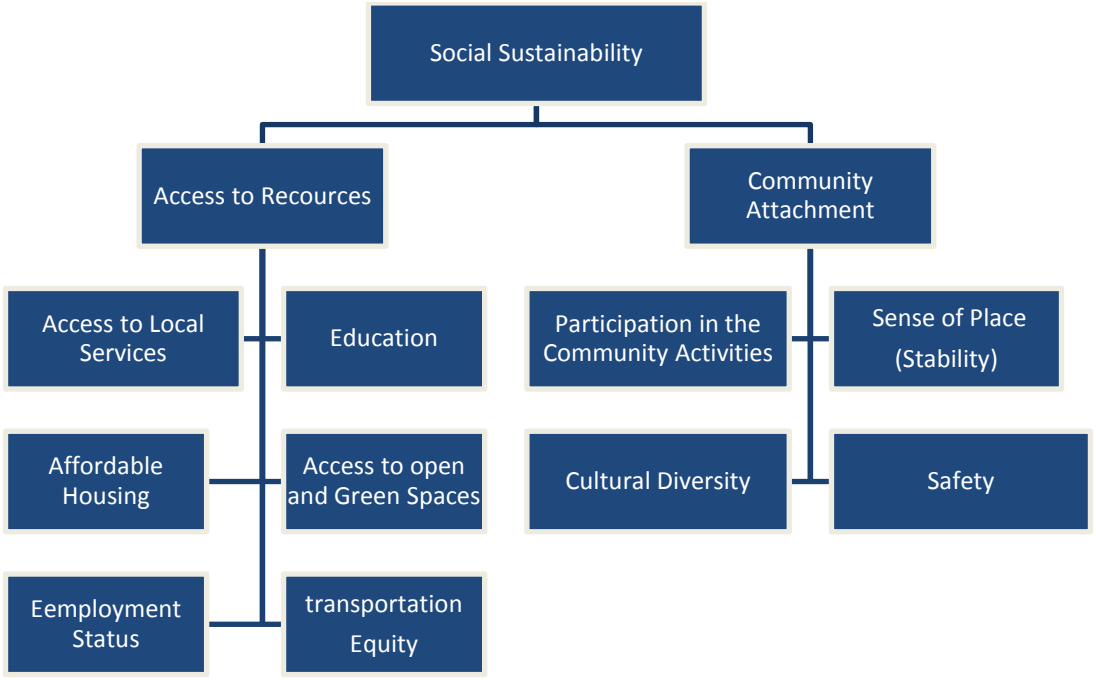


Figure 3 Social Sustainability Variables

2.5 Urban Form Historical Perspective

The definition of urban form varies in the literature. Some authors, at a

broad level, simply describe the physical characteristics of a city (William, 2000). While some authors only rely on land use to measure urban form in terms of the physical structure of a city (Herold et al., 2002; Huang et al., 2007), others include more physical aspects such as housing and neighborhood and street design. Some studies also include socioeconomic aspects such as population number or density (Frenkel & Ashkenazi, 2008; Kasanko et al., 2006). For this paper, the broadest definition possible of urban form is used. Accordingly, urban form here encompasses the detailed physical design of our environment in the enabling of populations and demonstrating a city's physical characteristics (Jenks & Jones, 2010).

In the 1920s, the ideas of modernist urban form began to be used in urban planning. The urban form of the modern city was one of plain, geometrical, functional building standing at regular free space (Campbell & Fainstein, 2012). Urban forms in the twentieth-century were influenced by the proposal of Ebenezer Howard for garden cities and the proposal of Le Corbusier for the radiant city (Morris, 2013). Ebenezer Howard initiated the garden city movement as one the first major urban forms theories. His urban form development idea was based on a decentralized working environment from the center of the cities and provided a healthy living space for the factory workers. Later he generalized this achievement into an urban form movement for the country as a whole (Morris, 2013; Davies, 2000).

Howard was inspired by Alfred Marshall's idea that industry needed a supply of labor that could, in theory, be supplied anywhere, and that companies have an incentive to improve workers' living standards since the company caused the unhealthy urban conditions in the big cities (Song & Knaap, 2004). His garden cities idea intended to plan self-contained communities surrounded by parks, including separate areas of residences, industry, and agriculture (Morris, 2013). The principles of the garden city soon applied to the urban forms of the suburbs. He believed that all classes of people should have free access to woods, gardens, and low-density housing with wide, tree-lined roads (Song & Knaap 2004).

Le Corbusier was one of the most influential urban forms planners. He believed that his new, modern urban forms would provide an organizational solution that would raise the quality of life for the lower classes (Morris, 2013). Le Corbusier believed in the urban form concept called "radiant city," which included segregated pedestrian circulation paths from the roadways and celebrated the automobile as a means of transportation, central skyscrapers, apartment blocks that set far back from the street, and criticized any effort at decoration (Morris, 2013).

He openly recommended sweeping away whole existing urban areas and replacing them with the open plan. Based on his idea, most of the modernist planners believed it was better to clear everything away and plan the cities completely over. Also, they assumed that urban form design should be

comprehensive, and the development plans prepared inevitably contained a whole series of proposals bound together in a single package (Relph, 1987).

Le Corbusier also suggested the idea of space as a set of destinations that humanity moved between, more or less continuously. He insisted on using the automobile as a transporter, and most importantly to build freeways in urban spaces (Fainstein & Campbell, 2012). His philosophies were useful to urban real estate development interests in Post-World War II America to destroy traditional urban space for high-density and high-profit urban concentration, both commercial and residential (Morris, 2013). Le Corbusier's ideas also sanctioned the further destruction of traditional urban spaces to build freeways that connected the center of the cities to low-density, low-cost (and highly profitable), suburban and rural locales, which were free to be developed as middle-class, single-family housing (Morris, 2013).

In following Ebenezer Howard's and Le Corbusier's urban form principles, the North American built environment has taken the form of low-density sprawl (Fainstein & Campbell, 2012). This development pattern is characterized by a dominance of single-family housing, reliance on automobile transportation, and a strict separation of land uses. These proposals followed the suggestion that new urban form should turn its back on existing cities and create an entirely new kind of urban settlement. These cities were ordered into great blocks or zones of single land uses and wide streets (Fainstein & Campbell, 2012).

By the late 1960s and early 1970s, many planners criticized modernism's urban form idea for lacking human scale, destroying vitality from the community, and increasing crime rates and social problems (Smith, 2002). In 1957, Michael Young and Peter Wilmott published a book regarding the loss of social contact and community life as the result of living in the modern cities. Young and Wilmott critiqued modern planning because its attention was focused on physical matters rather than social aspects of living in a neighborhood (Hobson, 2002). Ruth Glass critiqued the modernist idea that new proposed urban form would shape the quality of social life. She explains that the real life of social activities and relationships were not simply included within geographic areas (Hobson, 2002).

In 1961, Jane Jacobs' book, *Death and Life of Great American Cities*, blasted 20th-century urban form planning and proposed radically new principles for rebuilding cities. Jacobs compared cities to living things that change over time as they interacted with their environment (Song & Knaap, 2003). If the city was the organism, then the sidewalks, parks, streets, and neighborhoods were the various systems, each with a different function but tightly and seamlessly integrated. She believed the diversity of urban forms was an absolute requirement for healthy and vibrant urban communities (Smith, 2002). She explained the ideal urban form as a vibrant urban environment in which people of different ages and backgrounds use different parts of the city at different times of the day (Song &

Knaap, 2003). She believed diverse and highly dense population and urban form promote visible city life and help to void homogeneity (Smith, 2002).

By the 1970s, New Urbanism came as a solution to the problems that modernism made for American cities. The basic principles of New Urbanism were becoming clear by the early 1980s based on the ideas of Jane Jacobs, Christopher Alexander, and Kevin Lynch (Song & Knaap, 2003). Calthorpe, Duany, Moule, Plater-Zyberk, Polyzoides, and Solomon founded the Chicago-based Congress for the New Urbanism in 1993; it employed a variety of techniques and strategies to change urban forms into more walkable, mixed-use, and compact design forms (Hanlon, Rennie, & Vicino, 2009).

Modernism has been critiqued for being avant-garde and separating people's ties with the past. Duany (2000) says avant-garde buildings can occasionally be quite beautiful, but they sacrifice an enormous percentage of failed buildings at every level because each designer tries to separate the wheel instead of improving on established forms. The avant-garde has built on an idea that is far from real people's needs and reality (Duany & Brain 2005). He instead defends New Urbanism's idea that is based on nostalgia and traditional urban forms that encourage connectivity, diversity, mix, equity, and the importance of public spaces (Hanlon, Rennie, & Vicino, 2009). Moreover, Duany says that while modernism relied on the experts to make decisions about the form of urban

development, New Urbanism seeks participatory involvement from the stakeholders in the urban form development process (Duany & Brain 2005).

New Urbanism supported regional planning for open space, context-appropriate urban form, and the balanced development of jobs and housing. They believe their strategies can reduce traffic congestion, increase the supply of affordable housing, and control suburban sprawl (Hanlon, Rennie, & Vicino, 2009). Smith (2002) says residents in compact urban neighborhoods drive fewer miles and have significantly lower environmental impacts across a range of measures compared with those living in sprawling suburbs.

Andrés Duany and Elizabeth Plater-Zyberk describe an ideal New Urbanism neighborhood form as a neighborhood that has a discernible center and buildings placed close to the street, a well-defined outdoor room; the dwellings are within a five-minute walk of the center; it includes a variety of dwelling types; there are shops and offices of sufficiently varied types to supply the weekly needs of a household at the edge of the neighborhood, and small playgrounds are accessible to every dwelling (Leccese & McCormick, 2000). They also explain that an ideal neighborhood form has streets within the neighborhood that form a connected network that disperses traffic by providing a variety of pedestrian and vehicular routes to any destination. The streets are relatively narrow and shaded by rows of trees and parking lots; garage doors rarely front the street and certain

prominent sites at the termination of street vistas or in the neighborhood center are reserved for civic buildings (Leccese & McCormick, 2000).

In 2000 Duany and Plater-Zyberk promoted the term "sustainable development." They explained "sustainable development" in contrast to modernist suburban development with a focus on the environmental and social benefits of urban form (Leccese & McCormick, 2000). In 2004, Wheeler defined "sustainable urban development" as development that improves the long-term social and ecological health of cities and towns. He sketched sustainable urban form as: compact, efficient land use; less automobile use, yet better access; efficient resource use; less pollution and waste; the restoration of natural systems; good housing and living environments; a healthy social ecology; a sustainable economy; community participation and involvement; and preservation of local culture and wisdom (Wheeler, 2004).

However, the "sustainable urban form" concept of New Urbanism received various criticisms within urban studies (Williams, 2000). Some argue that its sustainable aspect is more focused on the environment part and lacks focus on social concerns (Williams, 2000). Jenks and Jones (2010) argue that development of New Urbanism ideas might make cities more sustainable by reducing ecological footprints, improving employment and health outcomes, and reducing urban sprawl, but that this perspective seems to not fully address how humans might interact with other structures (Jenks & Jones 2010).

Many studies criticized New Urbanism for being a neo-traditional approach that paints a physical picture of a city through planning that primarily focuses on plans rather than the method of achieving them. She says New Urbanism is encouraging an unrealistic physical determinism by focusing on suburbia rather than overcoming metropolitan social segregation (Fainstein & Campbell, 2012). These studies argue that New Urbanism creates a different style of suburbia that contains greater physical diversity but with the same social composition problems. It attempts to create local community by creating a physical environment to develop greater social contact within the neighborhood, but it would lead to more segregation based on class, race, and ethnicity (Harvey, 1997).

In the late 1980's, transit-oriented developed (TOD) appeared focused on its proximity and reliance on high-frequency transit. It promoted not only transit but also a more connected and safe walking and biking network (Lund, 2006). TOD encourages residents to live near transit services and to decrease their dependence on driving. It also advocates medium-to-high density urban form and typically features a mix of uses. It claims that reduced dependence on automobiles makes streets safer, reduces pollution, and promotes healthy cities (Cervero, Ferrell, & Murphy, 2002).

TOD projects were actually criticized from their beginning. Elizabeth Deakin (2001) says these projects seemed to be making a lot of sustainability

based excuses for building something relatively environmentally insensitive. Other critics have said that TOD has not provided a substantially differentiated experience from the suburban master planned developments it was meant to replace (Lund, 2006). Moreover, transit-oriented development has the potential to cause gentrification in low-income areas. TOD can raise the housing costs of formerly affordable neighborhoods, pushing low- and moderate-income residents farther away from jobs and transit (Cervero, Ferrell, & Murphy, 2002; Lund, 2006).

In the mid-1990s smart growth emerges as a movement to promote an alternative urban form growth. The Henry M. Jackson foundation aimed at updating local land use controls to emphasize more compact development patterns (Clapham & Nicholson, 2009). In a short period of time, the smart growth movement has become quite broad. One can find statements of support and evidence of activities on behalf of Smart Growth by a range of interests, including mixed-land uses, compact building design, housing opportunities, walkable neighborhoods, preservation of open space, and a variety of transportation choices (Goetz, 2005).

Although the smart growth movement was criticized for providing limited choice and opportunity. They argue initiatives such as urban growth boundaries and "development impact fees" increase housing costs, thereby reducing home ownership, especially for minorities (Geller, 2003). They also discuss transit

initiatives, contending that outside of downtown corridors, there is little that transit can do to reduce traffic congestion, and that, for the most part; public transportation is unable to compete with the convenience of the automobile. Also a major shift to transit is highly improbable, and higher densities will likely bring more congestion (Goetz, 2005; Geller, 2003).

These studies criticize the new urban form movements for making the same mistake that modernism made by believing that they could solve social problems through physical design. They believe these approaches repeat the modernism error that is destroying communities by putting people in the arranged environments to raise living conditions (Fainstein, 2000; Harvey, 1997). They critique these new movements regarding the probability of achieving improvement in the quality of human life by physical design. Colantonio and Dixon (2011) discuss that while central mixed-use areas might achieve benefits of more social interaction, vitality, and better access to facilities, they also could suffer from social tensions, crime or fear of crime, and bad neighbor effects. Mixed-use and compact cities may also affect the aesthetics of places, and hence, people's sense of attachment to and pride in their place of living, although it is far from clear whether resident relationships in this urban area would be positive rather than negative (McKenzie, 2004).

2.6 Urban Forms Elements

This section attempts to define theoretically different dimensions of urban form in a neighborhood. Jenks and Jones (2010) point out "urban form is closely related to scale." As a broad concept of physical characteristics of the city, urban form has also been described as the "morphological attributes of an urban area at all scales" (Williams et al., 2000 in Jenks & Jones, 2010). The characteristics of urban form can therefore vary at different scales, from individual design features of a building or dwelling up to the regional land use distribution or transport network of a city region (Jenks & Jones, 2010; Bramley et al., 2009).

Jenks and Jones (2010) organize urban form into four broad categories: density, land use, transport layout, and housing/building characteristics. The study undertaken herein recognizes the broad nature of urban form and attempts to include variables that encompass all the important dimensions described by Jenks and Jones (2010), while also recognizing that quantifying variations in every aspect of urban form would be impossible due to the lack of available data and the time and cost of attempting to collect and classify all physical elements within a complex urban system.

On the other hand, this study attempts, to a certain extent, an exploration of associations between urban form characteristics and the social sustainability of community indicators. The fact that there are limited existing studies that

specifically look at urban form characteristics beyond density and social sustainability outcomes supports a more broad examination of potentially significant associations (Dieleman & Wegener, 2004). The study therefore strikes a balance between collecting a wide a set of variables in relation to the exploratory nature of the research while remaining limited to elements that are both measurable and have the potential to impact social outcomes based on both logical assumptions and theory from the academic literature (Panczak, et al, 2013).

In order to reach a manageable balance, a grouping of variables related to certain urban form typologies was studied. The urban form groupings represent specific types of neighborhood physical environments that have certain clear or measurable qualities, which importantly have been recognized in studies as potentially impacting the social outcomes being investigated. The urban form typologies help to organize the variety of urban form characteristics being measured and link their potential impacts to the existing literature within each category (Panczak, et al., 2013). The urban form of neighborhoods and dwellings are thus categorized into four urban form typologies, each associated with a set of measurable indicators used in the study and relating to this research hypothesis. The urban form typologies themselves are derived from the discourse in related fields, although the frequent overlap between the groupings in the literature is also recognized (Colantonio & Dixon, 2011). The following sections will describe the

urban form typologies along with related theoretical background. The indicators included in the study will be introduced for each urban form typology. These four urban form categories include:

- The density of residential development (in terms of dwellings per hectare),
- Local road networks layout,
- Housing type,
- Use of land (separation or intermixed with residential and activities),

These elements are used as the elements of urban form to examine the effect that urban form has on social sustainability in neighborhood scale. Figure 4 indicates the urban form elements in the neighborhood scale.

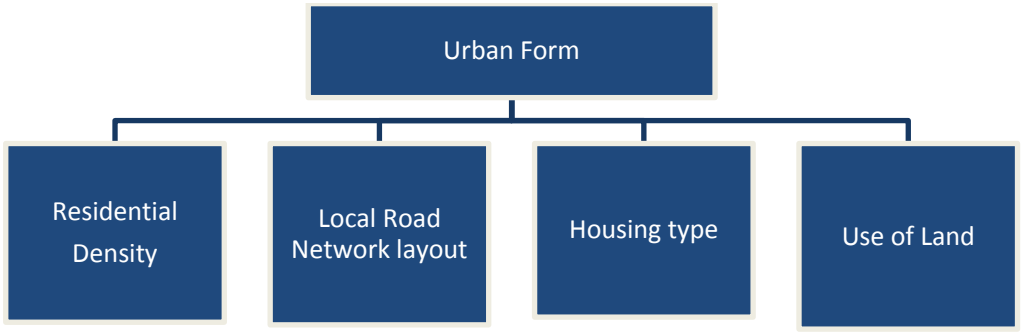


Figure 4 Urban Form Elements in Neighborhood Scale (Jenks & Jones, 2010)

2.6.1 Residential Densities

Urban density refers to the number of people inhabiting a given urbanized area and is considered an important factor in understanding how cities function. Recently, there have been a variety of arguments for densification as a solution to reaching goals of environmental sustainability, as well as health and social outcomes (Howley et al., 2009; Dieleman & Wegener, 2004). New Urbanism, transit-oriented development, smart growth, and compact-city planning advocates proposed to push for higher-density development and stop the suburban expansion (Dieleman & Wegener, 2004). They proposed high-density urban design as a strategy to reach sustainability goals such as protection of the countryside, reducing the need to travel by car, improving the opportunities for public transport use, and greater efficiency in using the basic infrastructure and utilities (Newman et al., 2009; Banister et al., 1997; Burchell et al., 1992).

Development projects with high-rise urban density are more likely to include amenities like plazas, pocket parks, green landscaping areas, and creative, publically visible, storm water treatments because they can achieve full build-out of allowed density without building over the entire site area (Newman et al., 2009). The proposed high-density urban design encourages provisions of public benefits and amenities in exchange for allowing bigger, taller buildings and is intended to create more livable environments. These include incentives for

various types of housing and environmental performance; historic preservation, public spaces, and other desired public goods (Newman et al., 2009).

Other researchers argue the benefits of low- and higher-density cities. One of the main arguments regarding density of urban areas concerns the relationships of density and livability. It determines that lower density areas associated with higher-levels of livability (Wang & Porta, 2011). The concerns include the potential for negative health and social outcomes (e.g. social isolation) and decreased livability associated with high-rise buildings. A study examining high-rise housing in Hong Kong and its relation to social, personal, and health consequences while controlling for poor housing conditions found that high-rise housing created no significant stresses for families or individuals in such developments (Wang & Porta, 2011). A recent Swiss study found that mortality rates decreased with increasing floors in high-rise buildings (Panczak, et al, 2013). These findings suggest that health and social outcomes may vary depending on factors other than height in isolation, such as income level and access to healthcare. They explain proposed high-density urban form would decrease livability of community because of the increase in stress and facing of traditional relationships (Colantonio & Dixon, 2011). They discuss that while high-density areas might achieve benefits of more social interaction and vitality and better access to facilities, they also could suffer from social tensions, crime or fear of crime, and bad neighbor effects (Williams, 2000).

Another concern is related to the crime rates. There is often a perception that crime rates are higher in high-rise buildings. The perception of crime in high-rise buildings often has to do with a lack of connection between outdoor spaces surrounding high-rise buildings and the residents of the building. Some studies show that the higher the building, the less of a connection individuals may have with the surrounding area, and therefore they feel less safe due to this disconnect (Gifford, 2007). According to a study by Newman and Franck, the perception, however, does not directly translate into an actual increase in crime solely based on density while controlling for other factors (Sharif & Murayam, 2013). In addition, high-rise buildings can be better integrated to allow for a greater connection with the surrounding environment regardless of building height (Sharif & Murayam, 2013).

An Australian study identified which factors contributed to neighborhood satisfaction among residents in higher density areas. The factors that seemed to impact residential satisfaction the most included design, facilities, noise, walkability, neighborhood safety, and social aspects of the neighborhood beyond the building itself (Buys, 2012). This study further supports the idea that high-rise buildings alone may not be the difference in how livable a building is, but instead the surrounding attributes and planning considerations of a neighborhood may have a greater impact. In addition, internal factors such as a building's design, amenities (for example provision of common areas), and activity programming

can play an important role in resident satisfaction and livability (Buys & Millers, 2012).

Moreover, they explain that raising densities results in more expensive real estate and increased road congestion and air pollution. They explain that traffic congestion is a result not of population density but how most urban spaces is used as parking lots.

Bramley et al. (2009) directly studied the relationship between density, various more detailed urban form variables, and social sustainability of community outcomes. The research looked at neighborhoods across five UK cities. The study provides a useful operationalization of the concepts of sustainability of a community with regards to the urban form context (Bramley et al., 2009). Unfortunately, the results remained focused primarily on the differences between low-density suburban and higher-density urban neighborhoods. Somewhat contradicting some previous research, the results indicate that residential satisfactions and stability of the neighborhood environment are, in fact, all negatively correlated with increased density. However, social interaction and group participation tend to improve at medium densities and decline again at the highest density levels (Bramley et al, 2009).

Therefore, assuming that high-density urban environments will continue to be an important feature of the urban landscape and likely increase in prominence, there is an important motivation for more research to focus within the realm of

higher-density urban forms (Buys & Millers, 2012).

Density as the most important element of urban form has been measured in this research by two parameters of net density and population density. Net density refers to the number of dwellings per hectare on land devoted solely to residential development. While it includes private driveways and private open space, it does not include public roads and areas of public open space (Buys & Millers, 2012). Different literature measures net density in different ways, but based on the purpose of the study here we are using the Colantonio and Dixon's (2011) definitions to determine what is meant by low, medium, or high density, based on measuring the net density and population density of a neighborhood.

Table 4 Density (Colantonio & Dixon, 2011)

	Approx. population density	Approx. net density
Very low density	Less than 60 per/acre	Less than 17 dw/acre
Low density	60 to 130 per/acre	17-33 dw/acre
Medium density	130 – 250 per/acre	34-67 dw/acre
High density	Greater than 250 per/acre	Greater than 67 dw/acre

Table 4 indicates how Colantonio and Dixon (2011) determined low, medium, and high density based on net density and population density of a land area or block area. A residential area with net density of less than 17 dwellings per acre is in very low-density category; between 17 to 33 dwellings per acre is

low density; 34 to 67 indicates medium density, and a high density residential area is defined by greater than 67 dwellings per acre (2011).

According to Colantonio and Dixon (2011) population density is used to measure intensity of land, expressed as the number of people per square mile. It is determined by dividing the population of an area by its land area. If an area is densely populated, that means a relatively large number of people live in a smaller amount of space. If an area is sparsely populated, however, a relatively small number of people live in a larger land area. Table 4 indicates how low, medium and high density is different related to the population density of a land or block area. Blocks with population density of less than 60 dwellings per acre are in very low-density category; between 60 to 120 dwellings per acre is low density; 130 to 150 is medium density, and high density population areas are determined by greater than 150 dwellings per acre (2011).

2.6.2 Road Network Layouts

As a way for movement and the principal public realm between private dwelling spaces, the street is an important component to the neighborhood experience. The characteristics of street design as well as the interaction between buildings and the roads are important concepts of urban form that can influence pedestrian activity and behavior. At the neighborhood level, the notion of road layout in the urban form considers the interface between local streets and

buildings (Frey, 2003).

In terms of a sense of community, street orientation of dwellings can encourage residents to feel propriety and responsibility over the surrounding neighborhood. Jane Jacobs praised the benefits of more street-oriented urban form for its potential to have a stronger sense of community (Jacobs, 1961). Street orientation of building design was seen to improve a local sense of propriety over the public realm, and Jacobs (1961) linked this to the idea of "eyes on the street" where neighborhood design and street animation created an informal surveillance of the street and a sense of safety (Frey, 2003). Although Jacobs' examination of the connection between urban form and community well-being included notions of urban form beyond street orientation, this quality of dwelling design was centrally important in her analysis of social life in traditional urban neighborhoods (Jacobs, 1961).

Road layout is often referred to at the street scale, such as grid or tree-like (cul-de-sac), or organic street patterns. It has an important influence on pedestrian movement and the way in which different places and spaces are connected to each other (Couch & Karecha, 2006). Road layout, whether or not it is "permeable" and easy to navigate, controls access and movement for pedestrians, and could influence other aspects of urban form such as land use or density (Hillier & Lida, 2005; Port & Renne, 2005). The transportation layouts of today's cities are largely artifacts of their historical development and planning and building regulations.

The configuration of the street network, in terms of its urban block sizes, their overall location within the city, and pedestrian and vehicular connectivity, can affect the functioning of a city by, for example, influencing the location intensity of activities (Porta & Shleifer, 2008).

Different street layout would change the neighborhood's block size. The small blocks are an iconic part of its urban form which provides a number of benefits including a friendly pedestrian environment and frequent breaks in the street wall that help provide light and air. Additionally, low- and mid-rise perimeter block developments work much better where there is room to have usable central courtyards with small blocks, and there is very little left after building around the edges. Dense and sometimes high-rise development helps ensure efficient use of these small blocks (Gehl, 2001; Gehl et al., 2004).

The connectedness and permeability of transportation layouts are claimed to determine the nature and extent of routes between and through spaces, which in turn has an influence on how lively and well used a space is (Cowan, 1997). Streets, which are well connected to services and facilities are more frequently used and are more socially active than deserted or quiet options (Gehl & Gemze, 2001; Guy & Marvin, 2001).

Jenks and Jones (2010) also study the relationship of transportation layout as one of the urban form features with sustainability in fifteen neighborhoods of five provincial British cities. They found out that a problem with conventional

subdivision loop and curl street patterns is that they inhibit walking and are disorienting and confusing to pedestrians as well as to drivers. They provide tranquility, safety, and security at the expense of connectivity. They control traffic well but often create bottlenecks at peak times in predictable spots. Jenks and Jones (2011) explain that street patterns can negatively affect the environment and neighborhood quality of life. Local streets add to the impermeable surface area with a negative impact on water quality and contribute to urban heat that affects energy demand for cooling. Street patterns can impede or enable walking and bicycling thereby influencing energy use for transport. They can restrict or accommodate the flow of traffic thereby affecting GHG generation (Guy & Marvin, 2000).

In one of the very few studies that didn't concentrate on density as the primary urban form variable, Mason (2010) looked at the apparent impact that "traditional street grid pattern," 'curvilinear street pattern," or "cul-de-sac streets," as well as the "existence of sidewalks" and "nearby parks or open space" had on trust levels in the neighborhood (Mason, 2010). The author also controlled for a variety of socio-demographic variables. The results showed that higher community trust was associated with the existence of sidewalks and with nearby parks or open space, presumably giving more opportunity for social interactions. However, contrary to many of the claims put forth by proponents of New Urbanism and some previous research, cul-de-sac streets were associated with the

highest level of social capital, although traditional grid streets still displayed higher-levels than curvilinear (Mason, 2010). Mason (2010) argues that each of the existing street patterns has positive attributes yet neither satisfies the entire set of environmental and quality of life criteria. He proposed using a combination of patterns, which is embodied in the Fused Grid. This uses a continuous grid of roads for district and regional connectivity and a discontinuous grid of streets for neighborhood safety. He claimed this type of road layout connects all streets, turning a neighborhood into a fully connected pedestrian realm (Maloutas, 2003).

Grammenos and Lovegrove (2015) found that traditional urban grids with their high intersection density are much more effective at increasing pedestrian activity than traditional suburbs. Using an agent-based simulation, which many assert performs well at recreating complex situations from human behavior, adaption, and reproduction, they modeled seven communities of various street patterns and layouts including two traditional grids, two traditional suburbs, two "traditional neighborhood design," and a "fused grid" (combining urban and suburban designs) (Grammenos & Lovegrove, 2015). They found that neighborhood designs similar to the fused grid exhibited considerably more walking activity (Grammenos & Lovegrove, 2015). The lowest amount of walking was found in the post-World War I conventional cul-de-sac form. Figure 5 and 6 show how these road layouts would be different in form of design for a neighborhood block.

Figure 5 Traditional Grid, Post-War Suburban I, Traditional Neighborhood Design I

Figure 6 Fused Grid, Post-War Suburban II, Traditional Neighborhood Design II

To understand the influence of the different types of road layouts on social sustainability this study used block size and the frequency of intersections by their distance from each other as parameters of measuring street layout in a neighborhood. Figure 7 indicates how difference in the number of intersection entries and the average size of blocks in a neighborhood could affect the permeable road network and accessibility of the neighborhood.

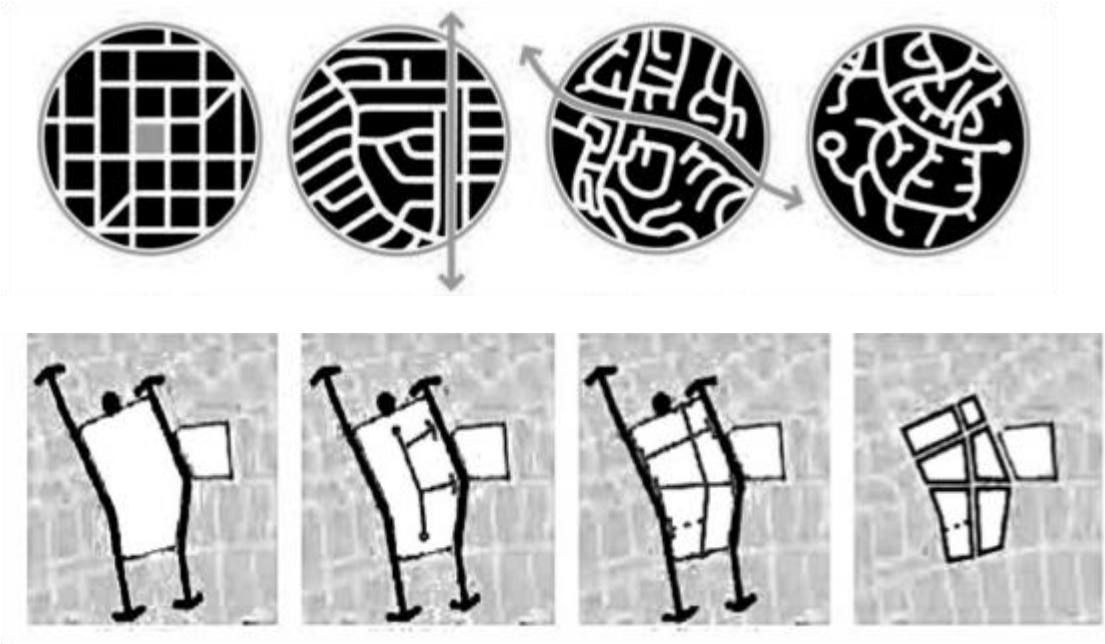


Figure 7 Local Road Layout

2.6.3 Use of Land

Broadly speaking, the term land-use is used to describe the different functions of the environment (Godschalk, 2004). Within the urban context, the dominant land-use tends to be residential but a functional urban area requires industrial, retail, offices, infrastructure, and other uses (Wang, Antipova, & Porta, 2011). The micro pattern of land-uses is crucial to the arguments about the efficiency of a city and potential sustainable urban forms in influencing urban travel patterns and the quality of life, for example through the existence of green space. There are also certain "locally-unwanted land uses" such as prisons,

factories, airports, or landfill sites claimed to be undesirable in residential mixed-use areas (Handy, 2005; Grant, 2006).

Planners have traditionally attempted to separate land-uses because of potential undesirable externalities but are now in favor of mixed-use developments both horizontally (at ground floor level) and vertically (within the same building) (Wang, Antipova, & Porta, 2011). However, land-use patterns are dynamic rather than static phenomena and are subject to real estate market forces. A key component of local land-use is the availability of local neighborhood services. The provision of services and facilities is dependent on the resident population's requirements so a particular mixed land-use therefore differs from neighborhood to neighborhood (Wang, Antipova, & Porta, 2011; Grant, 2002). The local urban context and the requirements of the population are therefore important in this matter. It is not clear, however, which services and facilities can and should be provided at which spatial scale (Handy, 2005).

2.6.4 Housing Types

The characteristics of housing and other buildings in urban settlements can have an important influence on everyday living. Dempsey (2005) further argues that dwellings that are strongly connected at the street level allow the residents to extend their private domain onto the community and public realm. He explains

that it is these overlapping spaces that encourage the social interaction as well as a psychological attachment to the community. The influence of building characteristics extends beyond the density of urban living. Factors such as building type, height, and age may have an effect on a number of sustainability issues (Holmes, 2007).

These might include a building's orientation and exposure to sunlight and daylight and the potential for modifications, such as changes to living space or work space or individual room conversion to continue incorporate the needs of an aging resident (Nguyen, 2005; Holmes, 2007). Other factors such as the amount of living space in dwellings, number and types of particular rooms, and lowest level of living space may also have significant influences on the efficiency of buildings in terms of character, operations, and life cycle energy (Nguyen, 2005).

Housing type in general has been categorized into three different types: single family (granny flat, cottage, and townhomes), multifamily, and other types of housing, such as mobile homes. A single-family housing is a classification of housing where housing is a freestanding residential building and the building is usually occupied by just one household and consists of just one dwelling unit (Gilderbloom, 2008). Most single-family homes are surrounded by a yard and attached front- or back-entry garage. A single-family detached home (home, house, or dwelling) is a freestanding residential building. It is usually occupied by

just one household or family, and consists of just one dwelling unit or suite. It is defined in opposition to a multi-family residential dwelling (Gilderbloom, 2008).

Figure 8 Single-Family Housing Types

A multifamily residence contains multiple separate housing units for residential inhabitants within one building or several buildings (Gilderbloom, 2008). A common form is an apartment building or condominiums, where typically the units are owned individually rather than leased from a single apartment building owner. Multifamily residential is a classification of housing where multiple separate housing units for residential inhabitants are contained within one building or several buildings within one complex (Gilderbloom, 2008). Sometimes units in a multifamily residential building

are condominiums, where typically the units are owned individually rather than leased from a single apartment building owner. Many intentional communities incorporate multifamily residences, such as in cohousing projects (Chiu, 2003).

Figure 9 Multi-Family Housing Types

Figure 10 Condominium Housing Types

Figure 11 Townhomes Housing Types

Townhouses are individual houses that are placed side-by-side, where one or two walls of each house are shared between adjacent homes. Most townhouses are built more narrowly than traditional detached homes and are usually two- or three-story buildings and usually have a small backyard and front yard (Bramley, & Morgan, 2003). Mobile homes are permanent housing units built in a factory on a permanently attached chassis before being transported to site. Townhouses are often multiple floors, with one or two shared walls, and some have a small yard space or rooftop deck. They are generally larger than a condo, but smaller than a single-family home (Bramley & Morgan, 2003).

2.7 Urban form and Housing Scenarios

Each of these housings typologies depends on neighborhood street typologies and density types which various scenarios can represent. Single-family housing types could vary depending on the lots size (as one of the local street network characters), such as: (1) single-family detached, large lots, (2) single-family detached, medium lots, (3) single-family detached, small lots, (4) single family attached, and (5) single family, pocket neighborhood (Barron, & Gauntlett, 2002). Multifamily housing types also could be categorized depending on lot sizes such as: (1) multi-family stack flats, (2) multi-family, manor house, (3) multi-family neighborhood mixed use, (4) multi-family, village clusters, and (5) mid-rise/high density housing (Barron & Gauntlett, 2002).

A single-family detached on a large lot is usually a main house with granny flat and garage apartment. Building is 1 to 2.5 stories with large lot and detached house with possible accessory unit (granny flat) in the back of lot or over garages, and the house faces the street with stoop or porch entry (Barron & Gauntlett, 2002). They are wood construction with a 2- to 3-car garage, separate from the main housing unit, preferably adjacent to an alley and there are 4 to 8 dwellings per acre. A single-family detached on a medium lots is usually a 1- to 2-story detached house facing the street with stoop or porch entry and wood structure. They include a 1- to 2-car garage attached to house or separate, preferably adjacent to an alley (Bramley & Power, 2009).

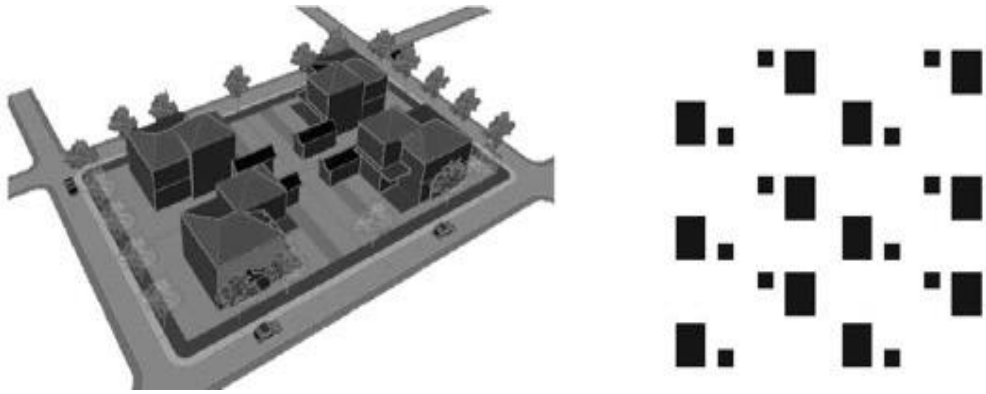


Figure 12 Single-Family Detached Large Lots

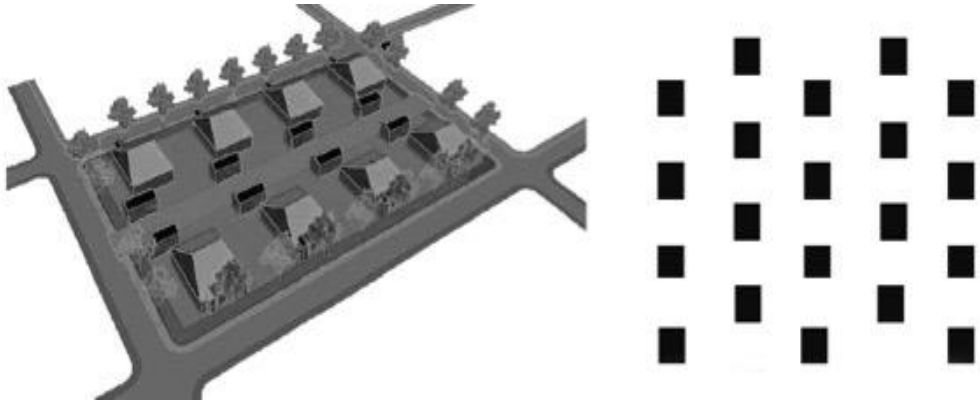


Figure 13 Single-family Detached Medium Lots

A single-family detached residence on a small lot has zero setback and a Charleston courtyard type of home. They are wood construction with a maximum of three stories and have an alley with individual garages and driveways augmented by on-street parking (Barron & Gauntlett, 2002). Another form of

single-families attached are townhomes, where buildings are 2 to 3 stories attached, with direct entry from street. The housing units can be paired with flats for increased density and have a brownstone or row-house look with wood or load bearing masonry contruction. They mostly have parking provided via alleys or private drives, with garages integrated into the footprint. Townhomes have a net density of 12 to 24 dwelling per acre (Barron & Gauntlett, 2002).

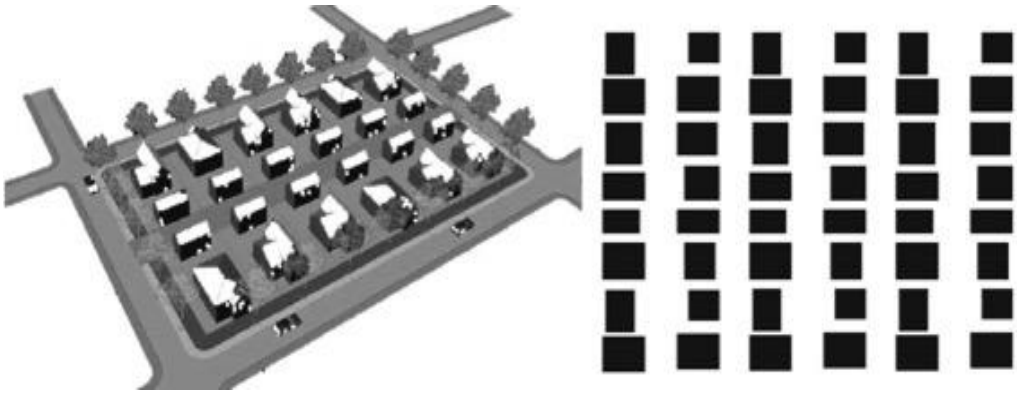


Figure 14 Single-Family Detached, Small Lots

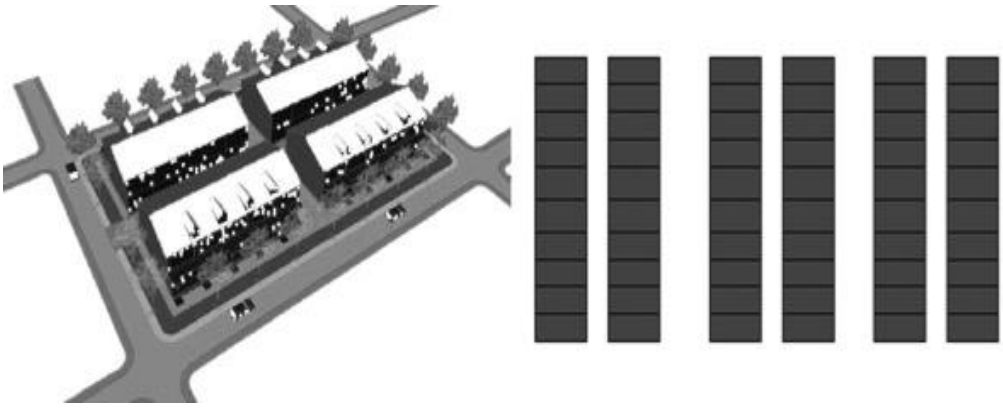


Figure 15 Single Family Attached (Town Homes)

A single-family residence in a pocket neighborhood is a classification of single-family housing located around a common space that creates a small-scale community within a single-use block (Barron & Gauntlett, 2002). These neighborhoods usually have 4 to 10 smaller houses arranged around a common green open space creating a closer sense of community with a compact, dense approach. The building structure is typically wood or masonry residential construction with maximum of 2 to 2 1/2 stories. Parking is screened from the street and tucked-away around the site although always adjacent to the house it serves (Aurand, 2010).

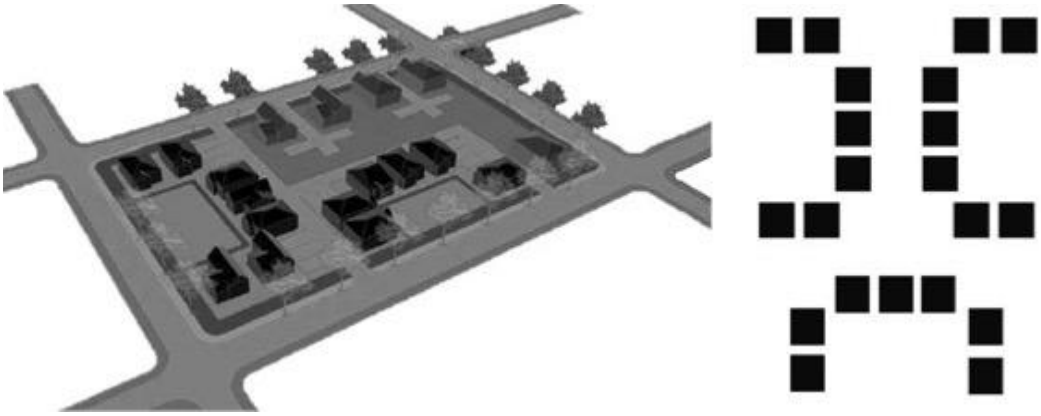


Figure 16 Single-Family Pocket Neighborhoods

The multifamily in stack flats category describes units that have different ownership stacked in a housing structure with a typical wood or masonry structure on single-use blocks. These housing types are 2- to 3-story residential buildings,

which are comprised of single-level multifamily units, stacked vertically. These neighborhood scaled buildings fit into a typical single-family neighborhood. Parking is located at rear of the building, accessed by a shared drive and the net density is between 15 to 20 dwellings per acre (Aurand, 2010).

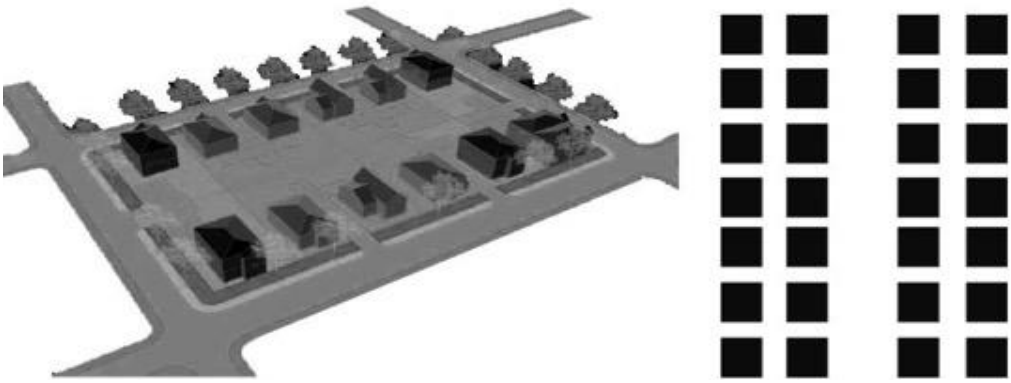


Figure 17 Multifamily, Stack Flats

Another type of multifamily housing is the manor house type with multiple residences in mansion style buildings and single-use blocks. Manor houses are 2 to 3 stories with multiple attached units in a larger house or mansion format, built with high-quality materials, wood construction, and having multiple grouped entries, easily fits into neighborhood density context (Aurand, 2010). Parking is provided either in the interior of the block surface or within rear tuck-under garages or rear separates garages. Net density of multifamily housing with manor house types is between 15 to 30 dwellings per acre (Aurand, 2010).

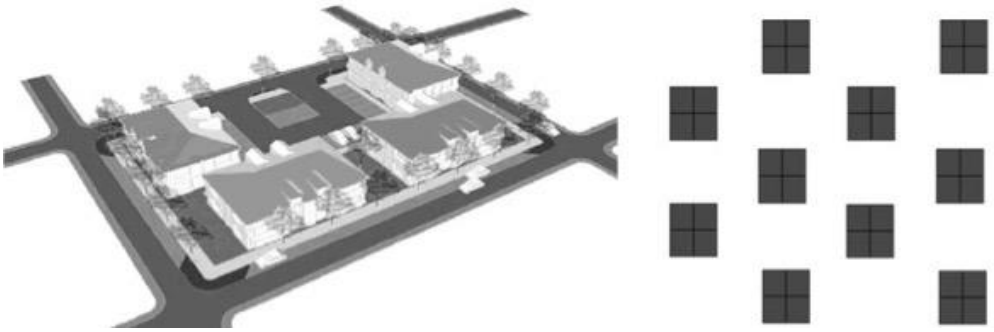


Figure 18 Multifamily, Manor House

Sometimes the multifamily housings are located in mixed-use neighborhood blocks with housing above retail or office spaces. They are 3 to 5 stories with multifamily apartments, single or double loaded corridors with lobby entrance, off-street parking in a structure or parking via rear and surface lots (Aurand, 2010). Ground floor uses include community retail, restaurants, or small-scale service offices. The building is wood construction with possible elevated concrete deck with 20 to 50 dwellings per acre (Aurand, 2010).

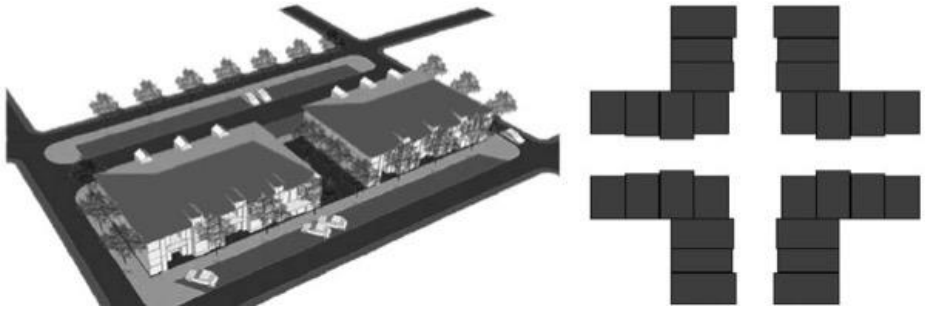


Figure 19 Multifamily, Neighborhood Mixed-Use

Multifamily housing village cluster types are small housing groups with surface parking acting as infill types of housing. These groups of multifamily housing are 3- to 4-story structures in a urban village configuration with street edge, a wall created through building articulation, interest through balconies, terraces, patios, stoops, and high-quality materials with carriageway entries (Gruber & Shelton, 1987). Rear tuck-under garages or surface parking courts, possibly free standing private garages, and on-street parking are necessary to meet parking ratios. The structures are typically wood construction with possible masonry veneer. The net density of village cluster housing is between 24 to 36 dwellings per acre (Aurand, 2010).

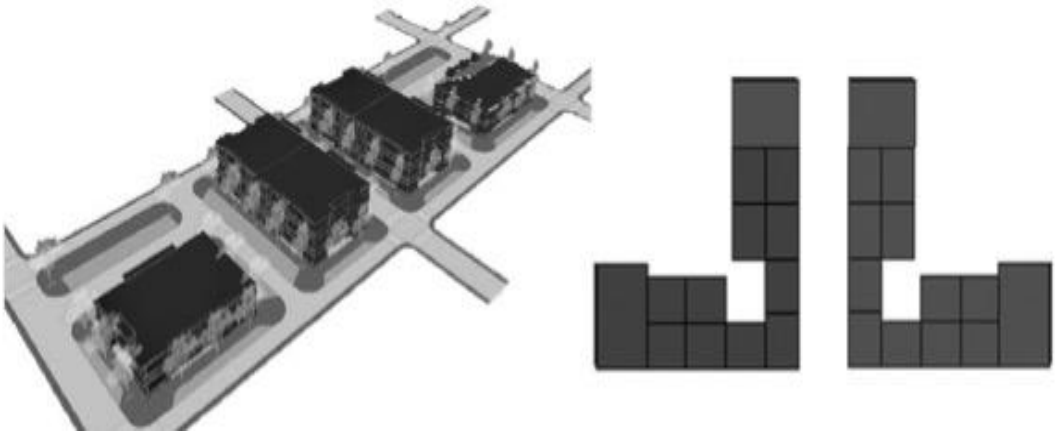


Figure 20 Multifamily, Village Clusters

Mid-rise, high-density multifamily housing is type of housing above podium parking or with a structure garage allowing higher density (Gruber &

Shelton, 1987). Mid-rise, multifamily residences are typically 4 to 5 houses in an urban edge street configuration. Street edge, wall created with the building articulated created via balconies, terraces carriageways, or stoops with 50 to 80 dwellings per acre (Aurand, 2010).

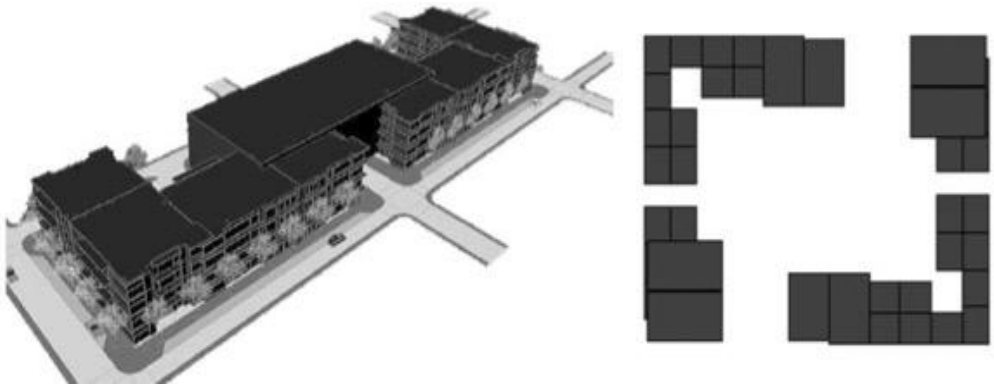


Figure 21 Multifamily, Mid-Rise/High Density Housing

2.8 Urban Form in Neighborhood-Scale

In discussing densification, associated changes in urban form and sustainability objectives, issues of scale become an important consideration. A lot of studies concern people experience changes in urban settlement patterns and at what scale can action to meet sustainability goals and what is the role of the local environment in human experience? In most of the social studies, neighborhood assumes an important setting for the experience of urban life and in the formulation of collective goals, action, and communal support (Kearns &

Parkinson, 2001; Kearns & Parkinson, 2003; Kenny & McCoach, 2003). The concept of neighborhood is difficult to define, although it is likely that most people would admit that there is such a thing as a geographic entity that they would consider their neighborhood even if its boundaries might not be clear (Kearns & Parkinson, 2001).

In the early twentieth century the idea of defining neighborhood as a unit was formed by Clarence Perry to provide a planning formula for the arrangement of playgrounds in the New York region (Kearns & Parkinson, 2001). It was an early diagrammatic planning model for residential development in metropolitan areas and created by Perry as a framework for urban planners to design functional and desirable neighborhoods in the early twentieth century in industrialized cities. It continues to be utilized by the New Urbanism paradigm as a means of organizing new residential communities to provide administrative and service requirements for residents (Logan, & Deane 2003).

In the 1929, Clarence Perry's neighborhood concept formulated neighborhoods as islands locked among a sea of vehicular traffic, to allow children to walk safely to nearby playgrounds. He defined neighborhoods as a basic unit of planning, which is limited in physical size, has a well-defined edge, and has a focused center. Later this concept developed to serve a much broader purpose such as providing an identity for the neighborhood and offering planners a framework for dividing the city into smaller areas (1929).

He offered to use neighborhood as model of the ideal layout for a specified population size (Lincoln, Lynham, & Guba, 2011). This model provided specific guidelines for the spatial distribution of residences, community services, streets, and businesses. This concept became popular as social and physical design principles were used to separate between vehicular and pedestrian traffic and make boundaries for a focused neighborhood cell form the greater urban area. It became a systematic modular usage in many countries across the globe (Lincoln, Lynham, & Guba, 2011).

Mumford's neighborhood definition was an effort to solve problems of a metropolis and was based on the idea of a neighborhood as a planned community. Mumford also defined a neighborhood as self-contained with respect to the basic needs of collective living and large enough to maintain an elementary school. He believed and demonstrated that the school could be used to bring the people of a school district together, and to cause social awareness (Sterling, & Huckle, 2014; Tomita, Terashima, Hammad, & Hayashi, 2003).

Perry in 1929 attempted to determine the relationships between the residential components of a neighborhood and the uses that could easily be traversed to and from by foot. His Neighborhood Theory was based on six principles were: 1) Major arterials are the boundaries of neighborhoods that should not pass through residential neighborhoods. 2) The streets that pass through neighborhoods should be designed based on the idea of having a quiet, safe, low volume traffic movement. 3)

The population of the neighborhood should be about 5,000 persons. 4) The center of the neighborhood included the elementary school and green spaces. 5) The radius of the neighborhood should be a maximum of one-quarter mile. 6) The edges of the neighborhoods are where that shopping districts could be located (Perry, 1929).

The image below is a sketch published by Perry in 1929 determining the relationships between the residential components of a neighborhood and the uses that could easily be traversed to and from by foot. His Neighborhood Theory was based on six principles: (1) Major arterials are the boundaries of neighborhoods that should not pass through residential neighborhoods. (2) The streets that pass through neighborhoods should be designed based on the idea of having a quiet, safe, low-volume traffic movement. (3) The population of the neighborhood should be about 5,000 persons. (4) The center of the neighborhood should include the elementary school and green spaces. (5) The radius of the neighborhood should be a maximum of one-quarter mile. (6) Shopping districts should be located at the edges of the neighborhood (Perry, 1929).

Lewis Mumford and later William E. Drummond developed the neighborhood concept as a unit in the social and political structure of the city with a focus on housing and community center and considered it the smallest local unit of the social and political organization of the city. It also became a notable aspect of designs of the New Town and Garden City movements. The neighborhood unit has provided the foundation for the New Urbanism movement of the 1980s, 1990s and today. It

has also provided the idea for today's suburbanization and road classification system (Logan, & Deane 2003).

Kearns and Parkinson (2001) view the concept of neighborhood as acting on several spatial scales and serving various functions for individuals as a place of belonging They point out that people function in different social networks at different scales, across different times and spaces, so that they may look for different things from their home area as a result and, therefore, the relative importance of the neighborhood would vary according to an individual's pattern of social and psychological ties across a wider region. Bridger and Luloff (2001) argue that it is at the local community level that change towards sustainability can best be developed. Action at the level of the local community, such as a neighborhood, helps to present issues in a way that is relevant to individuals' lives (Bridger & Luloff, 2001). Neighborhoods can represent an important local community scale in which problems can be analyzed and social cooperation towards collective goals organized (Bridger & Luloff, 2001; Ullman, & Bentler, 2003).

It is clear that the neighborhood still does represent a space of special importance to many individuals and to the social collective, and it is important to try to understand the variations in neighborhood social sustainability and the conditions that might encourage social sustainability goals (Colantonio, 2007). Thus, this study is concerned with the relationship between elements of the

neighborhood built environment and social sustainability.

2.9 Urban Form and Social Sustainability

In the 1990s, the idea of the ability of cities to sustain and evaluate a good quality of life for all the citizens presented challenges and opportunities for encouraging a more sustainable pattern of development (Hardoy et al. 2001). After the appearance of the sustainable development concept, a different discussion took place concerning the urban form of a sustainable city. Scholars in different disciplines attempted to seek a form of human settlement that provides the requirements of sustainability and to function in a more useful way than at present (Breheny, 1992).

The concept of sustainable development has raised the question that certain urban forms might result in lower energy consumption and lower pollution levels that lead to a more environmentally sustainable urban form (Breheny, 1992). This challenge has motivated scholars, planners, civil societies, and governments to suggest new frameworks for the redesigning and restructuring of urban areas. They try to achieve sustainability that has been addressed on different spatial levels: the regional and metropolitan levels, the city level, the community level, and the housing level (Wheeler 2000; Jenks, Burton, & Williams, 1996; Woolley, 2002).

The claims about the influence of urban form on social sustainability are complex and include issues of both quality of life and social equity. There is literature that positively links compact urban form to social equity (Porta et al., 2009). These claimed benefits included better access to facilities and jobs, better public transport, and opportunities for walking and cycling, lower levels of social segregation and less crime. This literature argues that higher densities and mixed-use urban forms lead to a better quality of life due to more social interaction, community spirit, and cultural vitality, because of easy access to work, shops, and basic social, educational and leisure facilities (Porta et al., 2009). Moreover, having a variety of uses and the means to access them nearby is also seen as a key to achieving social equity, especially for the more disadvantaged in society who may not have the resources and do not use a car (Porta et al., 2009). Also, mixed-use areas have a lower level of social segregation in comparison to sprawl areas. Mixed-use and compact cities may also affect the aesthetics of places, and, hence, people's sense of attachment to and pride in their place of living, although it is far from clear whether residence relationships in this urban area would be positive rather than negative (Jenks & Jones, 2010).

However, there are social sustainability arguments that contradict the expected underlying physical aspects. Critics claim that compaction leads to negative impacts such as poorer access to green spaces, poorer health, reduced living space and less affordable housing (Colantonio, & Dixon, 2011). Critics

argue that while inner city mixed-use areas might achieve benefits of more social interaction and vitality and better access to facilities, they also could suffer from social tensions, fear of crime, and bad neighbor effects (Williams, 2000). Moreover, living in high-density urban areas decreases community ties because of the increase in stress and facing of traditional ties (Bramley & Morgan, 2003).

Overall, the concept of social sustainability in the urban planning the literature is associated with scholars who encourage compact and transit-oriented developments that might produce more environmentally sustainable, walkable cities designed around transit nodes (Williams, 2000; Woolley, 2002). Such cities might link residents with education, employment, and health services through co-location with such services without necessarily requiring the use of a car (Williams, 2000; & Woolley, 2002). Developments of this nature might make cities more sustainable by reducing ecological footprints, improving employment and health outcomes, and reducing urban sprawl. In essence, such scholars are addressing the relationship between human agency and physical structure (Burton, 2000; Worpole, 2003). There is another scholarly debate that this perspective seems to not fully address how human agency interacts in complex ways with other structures such as the dispersed nature of employment and education in economic change on work-life balance, continuing consumer preferences for privacy, personal space, and other interactions between humans and social systems (McKenzie, 2004; Gleeson, 2008; Kuhn, 2012).

The evidence about these many claims raises some key questions. One clear message is that there is no single answer, as benefits differ by the type of urban form and its social context. For example, while inner-city, mixed-use areas might achieve benefits of more social interaction and vitality and better access to facilities, they also could suffer from social tensions, crime or fear of crime, and bad neighbor effects (Williams, 2000). In more suburban residential areas, quality of life may be enhanced by access to greenery, stronger social contacts and better safety and security, but may be affected by poorer access to facilities (Masnavi, 2000; Kunz, 2006). Questions also arise about the acceptability of living in such urban forms and whether there is a social capacity beyond which environments begin to be unsustainable (Williams et al., 1999; Jenks, 2000). More questions are raised about peoples' interest: whether or not they will change to follow more sustainable lifestyles (Williams, 2000; Carmona et al., 2001).

The way the built environment is designed is hypothesized to affect social sustainability either positively or negatively. Safety and security are threatened by wide streets designed for high volume traffic with minimal pedestrian facilities, and by absence of "eyes on the street" (Bacon, Cochrane, & Woodcraft, 2012). Social interaction in community networks is curtailed if there are insufficient or unsatisfactory public places in high-volume pedestrian areas at the heart of the community, or if the built urban fabric is fragmented and dominated by traffic.

Social equity cannot be achieved when poor neighborhoods lack public transit, walkable streets, and grocery stores. Pride and sense of place are fostered by beautiful places that community members feel belong to them, architecture and green places they use and protect (Bacon, Cochrane, & Woodcraft, 2012; Porta, Crucitti, & Latora, 2005).

Although the sustainability of certain physical aspects of the built environment such as density, compactness, and design have been the subject of many types of research, the link between social aspects of sustainability to urban form has received little empirical attention and as a result there is not enough evidence to show a clear link between such forms and social viability (Diepen, 2000; Bostrom, 2012; Williams et al., 2000; Carmona et al., 2001). The challenge for the empirical part of this research is to develop a comprehensive empirical research to assess this relationship.

Chapter 3

Methodology

3.1 Research Approach

In this chapter, the philosophical positioning of the research, research approach, objectives, and the method research that takes are described. The research addresses ways of measuring social sustainability indicators and urban form elements and tests the hypothesized relationships between selected aspects of urban form and social sustainability. The data draw primarily on Census Block and GIS data sources.

Empirical relationships are examined using Structural Equation Modeling (SEM) techniques. The model tests the relationship between social sustainability and urban form criteria at the neighborhood level. SEM has been used to test the hypothesis and to estimate the relationship between urban form and social sustainability. The results indicate how far different urban forms can be explained by systematic relationships with different dimensions of social sustainability at the neighborhood scale.

The following primary question is thus proposed:

Does the urban form of a neighborhood affect the social sustainability of the neighborhood?

Sub- questions include:

- What appears to be the relationship between variables of the stronger local road network of the urban form and social sustainability?
- What appears to be the relationship between variables of a higher density of residents' urban form and social sustainability
- What appears to be the relationship between the existence of mixed-use land opportunity in the neighborhood and social sustainability
- What appears to be the relationship between variables of stronger housing layout dominance of the urban form and social sustainability
- What are some key lessons that can be learned towards building a more sustainable urban form that meets social sustainability goals?

Figure 22 illustrates the methodology process of this research. It shows how the variables derived from theories would be tested based on their relationship to urban form and social sustainability. Urban form on the neighborhood-scale refers to four main elements: density, street layout, use of land, and housing types, which have been elaborated in section (2-5). Also, there are ten outcomes of social sustainability defined in the literature including: access to local services, affordable housing, job opportunities, and level of education, health and access to green spaces, access to transportation, participation in the community activities, cultural diversity, sense of place, safety (elaborated in

section 2-4). The control variables include a selection of measures at the neighborhood level according to what were considered important intervening variables in the related literature (elaborated in section 3-6).

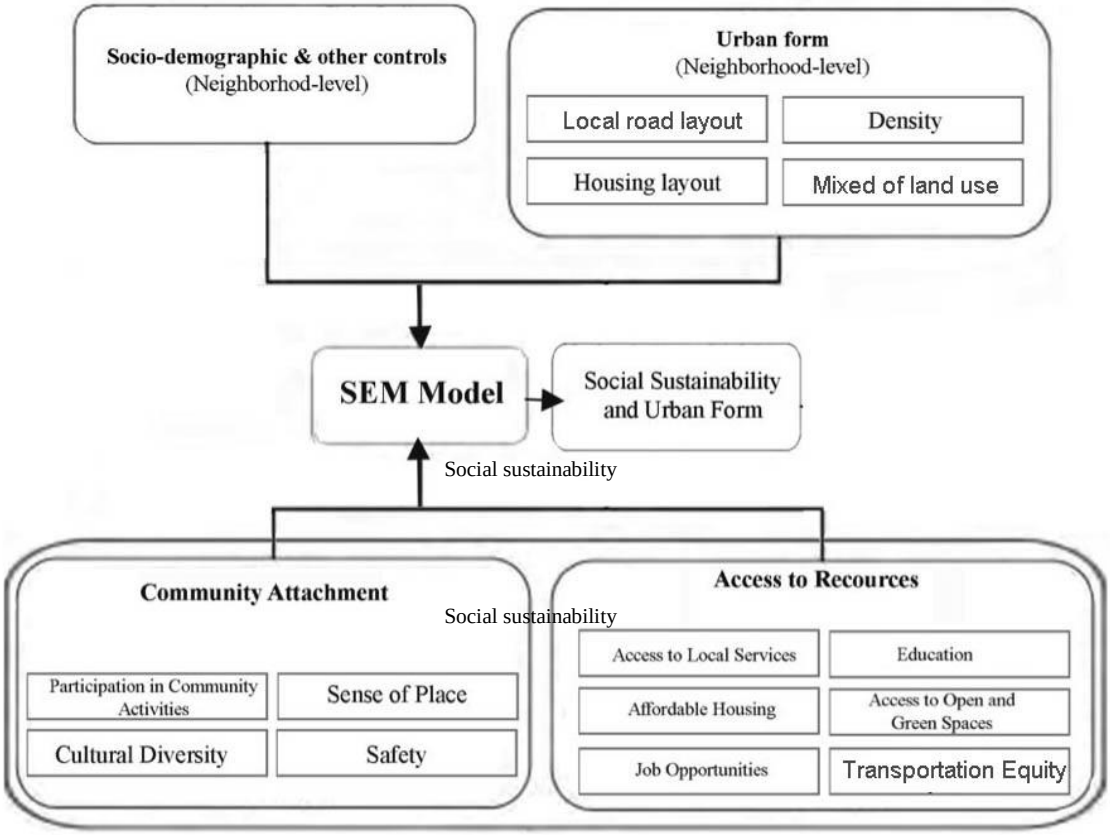


Figure 22 Methodology Process

3.2 Research Philosophical Position

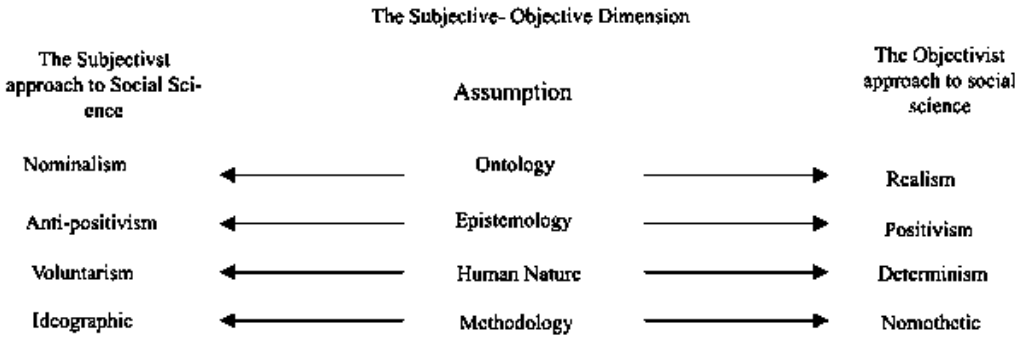
According to Remenyi et al. (1998), there are two major questions that require significant consideration by researchers such as “How to research?” and “Why research?” The first question would be answered by choosing between three types of research methodology included: qualitative, quantitative, or a mixture of both methods (mixing, and combining qualitative and quantitative methods). Also developing a philosophical perspective is necessary to answer the question of why a researcher is willing to do the research (Burrell & Morgan, 1979; Reza, Sadiq, & Hewage, 2011).

Researchers make several core assumptions concerning two dimensions: society, and science (Denzin & Lincoln, 2011). The sociological dimension involves a choice between regulatory and radical change. The science dimension involves either a subjective or an objective approach to research. The science method is based on empirical or measurable evidence subject to specific principles of reasoning (Burrell & Morgan, 1979).

The purpose of an experiment is to determine whether observations agree with or conflict with the predictions derived from a hypothesis (Kenny, & McCoach, 2003; Hussey, & Hussey, 1997). The overall process of the scientific method involves making hypotheses, deriving predictions from them as logical consequences, and then carrying out experiments based on those predictions

(Burrell & Morgan, 1979).

Table 5 Nature of Social Science (Hussey & Hussey, 2007)



These two major philosophical approaches are delineated by several core assumptions concerning ontology (reality), epistemology (knowledge), human nature, and methodology. These assumptions are consequential to each other (Denzin & Lincoln, 2011). Table 5 indicates two major philosophical traditions, their perspective assumptions, and the terminology associated with them. This research takes a science dimension and objective approach based on an epistemological philosophy. It incorporates a quantitative methodology in a large-scale data collection from randomly selected cities in DFW.

3.3 Statistical Hypothesis

In essence, the study represents a quantitative investigation comparing social sustainability criteria in a large number of neighborhoods forms in the

DFW metropolitan area. In order to carry out this investigation, this research first identified from literature all the claimed effects of urban form on social sustainability and selected the most frequently mentioned and effective criteria in neighborhood form on social sustainability. Finally, it will investigate through statistical methods urban form and social sustainability relationships.

Primary Hypothesis:

It is hypothesized that there is a significant relationship between the indicators of social sustainability and the urban form variables in the neighborhood-scale even beyond the effects of the socio-demographic and other control variables.

Table 6 Definition of Concept

Urban form variables	Urban form neighborhoods refer to four main elements of the urban form included: density, street layout, use of land, and housing types. Elaborated in section (2-5).
Neighborhoods	Neighborhoods are defined based on the determined boundaries by the related City and Clarence Perry's neighborhood concept. Elaborated in Appendix.
Indicators of social sustainability	There are ten outcomes of social sustainability definition by literatures included: access to local services, affordable housing, job opportunities, level of education, health and access to open and green spaces, transportation equity, participation in the community activities, cultural diversity, sense of place, and safety. These concepts are elaborated on the Section (2-4).
Control variables	The control variables include a selection of measures at the neighborhood level according to what the related literature considers important intervening variables. These include socio-demographics, and a partial attempt to control for self-selection. Elaborated in section (3-6).

Hypothesis I: Density

It is hypothesized that within the higher-density neighborhoods of the DFW metropolitan area, there will be the urban form variables that are significantly associated with the indicators of social sustainability elements (such as access to local services, affordable housing, job opportunities, level of education, health and access to open and green spaces, transportation equity, participation in the community activities, cultural diversity, sense of place, and safety). (Density is defined based on the selected indicators of urban form as follows: population density and residence density (described in section 2.6.1)).

Hypothesis II: Use of Land

It is hypothesized the neighborhoods higher percent of the mixed-use lands will display the higher levels of social sustainability elements (such as access to local services, affordable housing, job opportunities, level of education, health and access to open and green spaces, transportation equity, participation in the community activities, cultural diversity, sense of place, and safety), after controlling for intervening variables. (Use of land is defined based on the selected indicators of urban form as follow: Mixture of land-use (described in section 2.6.2)).

Hypothesis III: Street Layout

It is hypothesized that the neighborhoods in the DFW metropolitan area with the urban form features relating the higher level of permeability and connectivity urban form pattern will display the higher levels of social sustainability elements (such as access to local services, affordable housing, job opportunities, level of education, health and access to open and green spaces, transportation equity, participation in the community activities, cultural diversity, sense of place, and safety), after controlling for intervening variables. (Street layout is defined based on the selected indicators of urban form as follows: local road pattern and permeability (described in section 2.6.3)).

Hypothesis IV: Housing Layout

It is hypothesized that the housings exist in a neighborhood that provides more multifamily housing types will display the higher levels of the social sustainability elements (such as access to local services, affordable housing, job opportunities, level of education, health and access to open and green spaces, transportation equity, participation in the community activities, cultural diversity, sense of place, and safety), after controlling for intervening variables. (Housing layout is defined based on the selected indicators of urban form as follows: single family, multifamily, and other types of housings (mobile home, townhomes) (described in section 2.6.4)).

3.4 SEM Model

Structural Equation Modeling or SEM is a statistical technique for evaluating complex hypotheses involving multiple, interacting variables (Grace, 2006). The estimation of SEM models involves solving a set of equations. There is an equation for each 'response' or 'endogenous' variable in the system. They are affected by other variables, and may also affect other variables (Grace, 2006).

SEM is a very general statistical modeling technique, which is widely used in the behavioral sciences (Ullman & Bentler, 2003). It can be viewed as a combination of factor analysis, regression, and path analysis. It is a methodology for representing, estimating, and testing a network of relationships between variables (measured variables and latent constructs) (Savalei & Bentler, 2010). During the last two decades, Structural Equation Modeling (SEM) has evolved from a statistical technique for insiders to an established valuable tool for a broad scientific public. Traditional statistical approaches to data analysis specify default models, assume measurement occurs without error, and are somewhat inflexible (Savalei & Bentler, 2010). However, structural equation modeling requires specification of a model based on theory and research, is a multivariate technique incorporating measured variables and latent constructs, and explicitly specifies measurement error (Savalei & Bentler, 2010). Structural equation modeling (SEM) is a series of statistical methods that allow complex relationships between

one or more independent variables and one or more dependent variables (Ullman & Bentler, 2003).

SEM is a combination of factor analysis and multiple-regressions. It also goes by the aliases "causal modeling" and "analysis of covariance structure." The variables in SEM are measured (observed, manifest) variables (indicators) and factors (latent variables). The SEM can be divided into two parts. The measurement model is the part of model that relates measured variables to latent variables. The structural model is the part that relates latent variables to one another (Savalei & Bentler, 2010).

Kaplan (2008) proposes, that "structural equation modeling can perhaps best be defined as a class of methodologies that seeks to represent hypotheses about the means, variances and covariance of observed data in terms of a smaller number of "structural" parameters defined by a hypothesized underlying model" (p.1). The term "structural relation" refers to the core concept of SEM that presents the relationships between latent variables. Such relations are usually formulated by linear regression equations, graphically expressed by path analysis (Ullman & Bentler, 2003). SEM is very flexible because it deals not only with a single simple or multiple linear regressions but also with a system of regression equations. In contrast to ordinary regression analysis, SEM considers several equations simultaneously. The same variable may represent a predictor in one equation and a criterion in another equation (Savalei & Bentler, 2010).

Its main feature is to compare the model to empirical data. This comparison leads to so-called fit-statistics assessing the matching of model and data (Kenny & McCoach, 2003). If the fit is acceptable, the assumed relationships between latent and observed variables (measurement models) as well as the assumed dependencies between the various latent variables (structural model) are regarded as being supported by the data. Strictly speaking, the assumed model is not rejected. In some cases, only the fit of a measurement model is of interest. In this case, a SEM is a confirmatory factor analysis model (CFA) (Ullman & Bentler, 2003). In other cases, the parameters of the structural model may be of interest. SEM can tell if your model is adequate or not. Parameters are estimated and compared with the sample covariance matrix. The goodness of fit statistics can be calculated and will tell whether the model is appropriate or needs further revision. SEM can also be used to compare multiple theories that are specified a priori (Kenny & McCoach, 2003).

Variables that are solely predictors of other variables are termed 'influences' or 'exogenous' variables. They may be correlated with one another but are determined outside the system (Kaplan, 2008). Typically, solution procedures for SEM models focus on observed versus model-implied correlations in the data (Kaplan, 2008). The unstandardized correlations or covariance are the raw material for the analyses. Models are automatically compared to a 'saturated' model (one that allows all variables to intercorrelate), and this comparison allows

the analysis to discover missing pathways and, thereby, reject inconsistent models (Kenny & McCoach, 2003). The SEM model that has been considered for this research included 21 observed variables and one latent variable.

3.5 Why Structural Equation Models

For the purpose of this research, SEM has been chosen since this method opens up a vast variety of possibilities (Ullman & Bentler, 2003). It is a very powerful multivariate analysis technique that includes specialized versions of a number of other analysis methods as special cases (Kenny & McCoach, 2003). SEM enables the analysis of latent variables and their relationships, offering the opportunity to analyze the dependencies of constructs without measurement errors (Kenny & McCoach, 2003; Grace, 2006).

SEM seems the most relevant method for this research for the following reasons:

1. SEM requires specification of a model based on theory and research. It is a model that assesses the relationship between indicators base on relevant theory and past research (Ullman & Bentler, 2003).
2. SEM could impose the structure of hypothesized model on the sample data and then test how well the observed data fit the model (Savalei & Bentler, 2010).

3. SEM has the ability to impute relationships between unobserved constructs (latent variables) from observable variables (Kenny & McCoach, 2003). It provides an efficient way of describing the latent model underlying a set observed data (Savalei & Bentler, 2010).
4. SEM includes two components: The 'structural model' showing potential causal dependencies between endogenous and exogenous variables and the 'measurement model' showing the relations between latent variables and their indicator (Kenny & McCoach, 2003).
5. SEM represents a multitude of techniques under one umbrella. It allows for conducting and combining a vast variety of statistical procedures like multiple regression, factor analysis, and ANOVA. It is a very flexible methodology because it deals not only with a single simple or multiple linear regressions but also with a system of regression equations (Ullman & Bentler, 2003).

3.6 Primary SEM Model Diagram, Language, and Software

To perform a SEM analysis, the researcher first specifies a model based on theory, and then determines how to measure constructs, collect data, and then input the data into the SEM software package. The package fits the data to the specified model and produces the results, which include overall model fit statistics and parameter estimates (Kenny & McCoach, 2003; Grace, 2006).

SEM has a language all its own. Here is some of SEM Language:

Independent variables, which are assumed to be measured without error, are called exogenous or upstream variables.

Dependent or mediating variables are called endogenous or downstream variables.

Manifest or observed variables are directly measured by researchers.

Latent or unobserved variables are not directly measured but are inferred by the relationships or correlations among measured variables in the analysis.

Factor Analysis: This statistical estimation is accomplished in much the same way that an exploratory factor analysis infers the presence of latent factors from shared variance among observed variables (Savalei & Bentler, 2010).

Path Diagram: SEM users represent relationships among observed and unobserved variables using path diagrams.

Ovals or circles represent latent variables

Rectangles or squares represent measured variables.

Arrows: Correlations and covariance are represented by bidirectional arrows, which represent relationships without an explicitly defined causal direction (Savalei & Bentler, 2010). It means drawing a bidirectional arrow between two variables shows that they are related or associated, but no claim is made about one of them causing the other one, or vice versa. By contrast, Single-headed arrows in the path diagram represent causal effects. When there is a one-way arrow it claims

that one variable causes the scores observed on the measured variables (between latent variables and observed variables) (Savalei & Bentler, 2010).

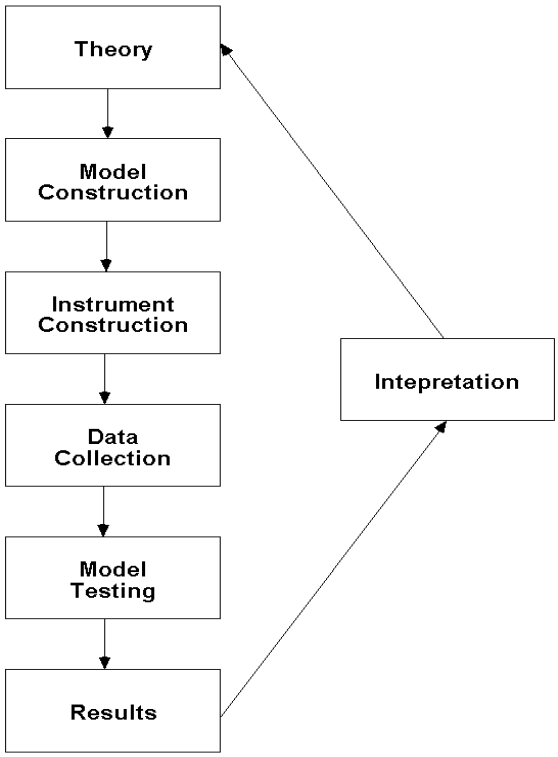


Figure 23 The Basic Approach to Performing a SEM Analysis

SEM assesses unobservable ‘latent’ constructs. It invokes a measurement model that defines latent variables using one or more observed variables and a structural model that imputes relationships between latent variables. Two main components of models are distinguished in SEM: the structural model showing potential causal dependencies between endogenous and exogenous variables and

the measurement model showing the relations between latent variables and their indicators (Ullman & Bentler, 2003).

SEM can conceptually be used to answer any research question involving the indirect or direct observation of one or more independent variables or one or more dependent variables. However, the primary goal of SEM is to determine a proposed causal process and model (Savalei & Bentler, 2010). Therefore, SEM is a confirmatory technique. Like any other test or model, we have a sample and want to say something about the population that comprises the sample. In this type of model there is a covariance matrix to serve as our dataset, which is based on the sample of collected measurements. The empirical question of SEM is therefore whether the proposed model produces a population covariance matrix that is consistent with the sample covariance matrix. Because one must specify a priori a model that will undergo validation testing, there are many questions SEM can answer (Ullman & Bentler, 2003).

SEM can tell you if your model is adequate or not. Parameters are estimated and compared with the sample covariance matrix. Goodness of fit statistics can be calculated that will tell you whether your model is appropriate or needs further revision. SEM can indicate the amount of variance in the dependent variables (DVs) such as both manifest and latent DVs are accounted for by the IVs. It can also tell the reliability of each measured variable. And, as previously

mentioned, SEM allows you to examine mediation and moderation, which can include indirect effects (Savalei & Bentler, 2010).

There are couples of SEM software programs that accept correlation or covariance matrix input. A researcher could compute these matrices using another software package (such as SPSS) and then input them into AMOS or another SEM package for analysis. For the purpose of this study AMOS software will be used (Savalei & Bentler, 2010; Kenny & McCoach, 2003).

3.7 Data

3.7.1 Neighborhoods as Unit of Data

Since the early ages of humanity people have tended to live close together in sections of an area and form communities for economical, practical, and sociological reasons, which has resulted in the formation of neighborhoods (Lloyd, 2009; Jenks & Dempsey, 2007). Neighborhoods have certain physical or social characteristics, which distinguish them from the rest of the settlement. The clustering of these neighborhoods has established cities (Lloyd, 2009).

In the early twentieth century the neighborhood concept was published separately in two forms. First was the neighborhood idea of Clarence Stein and Henry Wright, exemplified in their plan for Radburn. Second was the Neighborhood Unit idea of Clarence Perry (Jenks & Dempsey, 2007). The idea of defining neighborhood as a unit was formed by Clarence Perry (1929) as a

diagrammatic planning model for residential development in metropolitan areas and as a framework for urban planners to design functional and desirable neighborhoods in industrialized cities (Logan & Deane, 2003).

Later, Lewis Mumford (1954) developed the neighborhood concept as a unit in the social and political structure of the city with a focus on housing and community center and as the smallest local unit of the social and political organization of the city. He presented neighborhood as a fact of nature, which comes into existence whenever a group of people share a place. This concept became a notable aspect of the designs of the New Town and Garden City movement and has provided the foundation for the New Urbanism movement of the 1980s, 1990s, and today (Logan & Deane, 2003).

Despite such concepts, this research chooses neighborhood as the data unit since still provides the most logical basis for detailed planning and for studying urban form and the social sustainability variables. These neighborhoods as unit of data were selected randomly in DFW metropolitan area (Lloyd, 2009; Jenks & Dempsey, 2007).

To cover all different types of societies and neighborhood forms in this metropolitan area and to address the research question of whether the social sustainability values are different from neighborhoods of inner cities, edge cities, and suburb areas, three different zones, based on their distance from the center of the city, have been determined. The first zone has included both the cities of

Dallas and Fort Worth, the second zone covers both Dallas and Tarrant counties, and the third zone contains Collin, Denton, Rockwall, Parker, Wise, Elise, Kauffman, and Johnson counties. Neighborhood boundaries collected in TIGER/Line Shape files format from related cities, counties, and Esri Business Data Analysis website. According to the Esri website these boundaries were determined as geographical areas containing homogeneous socioeconomic and demographic characteristics.

3.7.2 Selecting Sample Data

This study addressed a wide variety of variables to measure both urban form and social sustainability. Variables of urban form and social sustainability were measured at the neighborhood-level, as both were considered to potentially relate to different resident experiences.

The DFW area has been selected because of its diversity of communities and urban forms. According to U. S. Census data 2010, the Dallas-Fort Worth metropolitan area (after the San Francisco Bay Area, Houston, Los Angeles, and Miami-Fort Lauderdale) is the fifth most racially diverse metropolitan area in the United States and the most ethnically diverse area in the nation (Kuhn, 2012; Humes, K., Jones, and Ramirez, 2011; Colby and Ortman, 2015). The DFW metropolitan has been growing physically and economically over the last decades and has attracted more than 146,530 new residents (about 23.4 percent growth).

DFW area's total population in 2014 was 6,703,020, making it the largest metropolitan area in the southern United States. DFW grew to the nation's fourth-largest metropolitan area, behind only New York, Los Angeles, and Chicago (Colby & Ortman, 2015).

To determine how many neighborhoods were needed in order to get results that reflect the target population, the "rule of thumb" by Jackson (2003) has been considered. The rule of thumb concerns the relation between sample size and model complexity. Jackson (2003) believes that about minimum sample size in terms of the ratio of cases (n) to the number of model parameters that require statistical estimates (q). An ideal sample size-to-parameters ratio would be 20:1 and less ideal would be an n:q ratio of 10:1. As the n:q ratio decreases below 10:1, the trustworthiness of the results will decrease as well (Jackson, 2003).

Since this research's SEM model includes 22 parameters, according to the 'rule of thumb', a sample size of at least 220 is required to reflect the population and to reach trustworthy results. For the purpose of this research, 300 neighborhoods (unit of data) have been randomly selected from DFW metropolitan area.

Figure 24 Sample Size Calculator and Random Integer Generator Website

As mentioned in previous section (page 123), to cover variety types of neighborhood forms in this metropolitan area, three different zones based on their distance from the center of the city have been determined. The number of selected neighborhoods from each zone is obtained based on the ratio of existing neighborhoods in each zone to the total of existing neighborhoods in the DFW metropolitan area. This linear approximation can be formulated as:

$$Total\ Number\ of\ Random\ Neighborhoods = 300 = \sum_{i=1}^{3} A_i$$

$$A_i = \frac{P_i}{Total\ existing\ Neighborhoods\ in\ DFW} * 300 \qquad (1)$$

Where Ai and Pi are the randomly selected and total existing neighborhoods in each zone respectively. These values are calculated and shown in table 7.

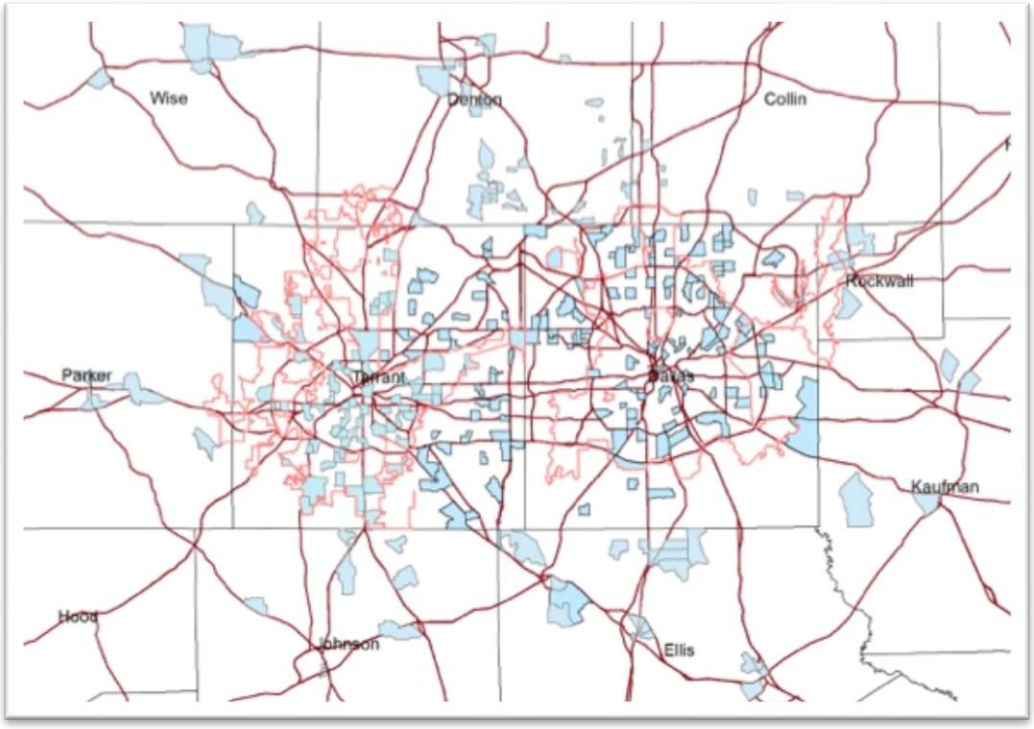
Table 7 Number of selected neighborhoods in each zone

	Randomly selected	Total existing
Zone 1	127	1625
Zone 2	83	1361
Zone 3	90	1645
DFW area	300	4361

Table 7 Indicates that from the total 300 sample data, zone 1, 2, and 3 have 127, 83, and 90 sample data respectively.

"Random Integer Generator" software (figure 24) is used to select neighborhoods randomly from the total number of existing neighborhoods at each zone. This software offers the true random number that comes from atmospheric noise, which for many purposes is better than the pseudo-random number algorithms typically used in computer programs. The neighborhoods have been selected from the list of existing neighborhoods from each zone based on the random number selected by the software. Map 1 shows the location of 300

randomly selected neighborhoods in the DFW metropolitan area and related counties.



Map 1 Randomly Selected Neighborhoods

For this study, data were gathered from several different primary sources. The primary source to collect urban form data was GIS data of related cities and counties. Social sustainability variables and control variables have been collected from three different sources of U.S. Census data, American Community Survey data, and Esri Business Data Analysis (Figure 25).

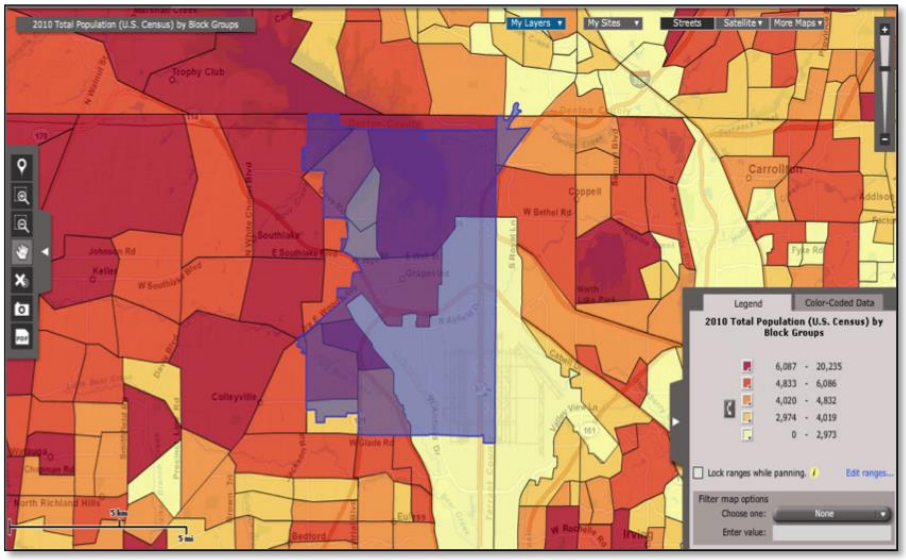


Figure 25 Esri Business Data Analysis Screenshot

The following section explains what the variables definitions are and how they have been measured and what data sources have been used.

3.8 Variables and Data Sources

The study addressed a wide variety of variables to measure both urban form and social sustainability. Both urban form and social sustainability variables were measured at the neighborhood level as both were considered to potentially relate to different resident community experiments. Esri BOA website, GfK MIR, and Applied Geographic Solutions (AGS) research groups, provided a key resource as it included useful crime risk, demographics, residences public participation data. These data have been geocoded in different scales of USA,

State, County, Census Tract, Block Group, Place, ZIP Code by GIS Esri website. Other measures were obtained from a variety of sources, such as the national statistical database (Colby, & Ortman, 2015) and the detailed spatial map of Dallas-Fort Worth metropolitan area provided by The North Central Texas Council of Governments (NTCCOG) HIS data center (Colby, & Ortman, 2015).

3.8.1 Social Sustainability Variables Measurements and Definitions

Access to Local Services

To meet the requirements of social sustainability in a neighborhood, it is essential to provide appropriate opportunities in terms of access to local services (such as: retail, repair, shop, supermarket, restaurant, church, clinic, and library) (Gordon-Larsen et al, 2006). Research has shown that the availability of goods and services within local areas enables residents to participate fully in society. It also affects residents' quality of life and their decision to move or stay in a neighborhood (Dutta-Bergman, 2005).

There is a probability that residents who live close to the edge of neighborhood boundaries will most often use the local services in walking distance from the neighborhood. To this end, a buffer zone of five minutes walking distance (1200 feet) is created from the boundary of each neighborhood as presented in figure 26 (Zhao et.al, 2003; Dempsey & Jenks, 2005).

To create these buffers around neighborhood boundaries GIS “Buffer” tool used. Buffer GIS tool allows drawing these buffers around features (neighborhood boundaries) at a specified distance from that feature (1200 feet). Once the buffer area is created, access to local services is estimated as the ratio of the sum of the areas of all existing local services, such as retail, repair, shop, supermarket, restaurant, church, clinic, and library, located in the neighborhood and assigned buffer area to the area of each neighborhood. And in a final step multiply by 100 to get an integer figure.

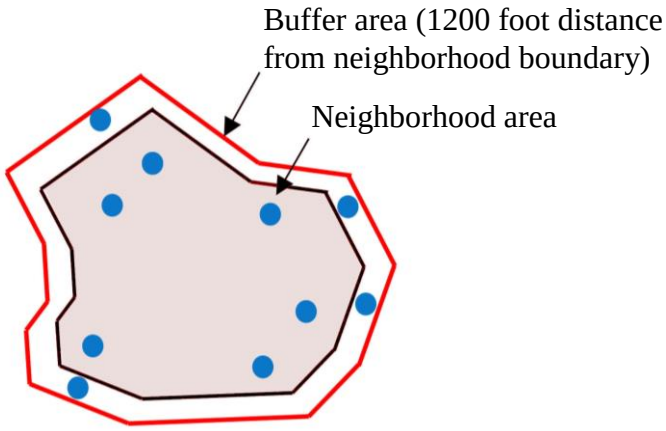


Figure 26 Walking Distance Buffers from Neighborhood Boundaries

Figure 26 illustrates how these buffers are created for each neighborhood. In this figure the red line represents the 1200-foot buffer area and the small blue

circles represent local facilities. GIS software is used to create buffers and to measure and add the total area of these facilities.

Table 8 Variable of Access to Local Services

Variable	Code	Description	Source
Access to Local Services	asar	Percent of total area of retail, repair, shop, supermarket, restaurant, church, clinic, and library located at the 1200 foot radius buffer from the neighborhood boundaries to the total area of the each neighborhood in square feet (percent)	City Exiting Land use GIS File Code 211, and212

Affordable Housing

Affordable housing is one of the essential variables of social sustainability. Housing is a basic necessity that provides shelter from the elements, facilitates the essentials, and is the setting for the communal life of the household. It is linked to the health and well-being of individuals and families. When a market lacks a sufficient supply of affordable housing, lower income families are often forced to limit expenditures for food, medical care, and other necessities in order to pay rent (Downs, 2004).

The lack of affordable housing within a community can contribute to family residential instability, as families are forced to move frequently, live with other

families in overcrowded conditions, or experience periods of homelessness. Access to affordable housing is an object of attachment and a source of identity and also has a significant relationship to psychological well-being (Anderson et al., 2003). To measure affordability of housing of the neighborhoods, percent of median housing rent price divided to median household income in the neighborhood.

Table 9 Variable of Affordable Housing

Variable	Code	Description	Source
Affordable Housing	afar	Percent of median housing rent price divided to median household income in the neighborhood	Census Data

Employment Status

Employment is one of the major focuses of social sustainability, which is dealing with the satisfaction of basic needs and the quality of life (Stiglitz, 2002). It is taken to be essential for social sustainability to open up new opportunities and provide additional ways to ensure social welfare (Omann & Spangenberg, 2002). Employment does not only provide the most important source of income, but the working area offers a place for social contact and interaction, which are essential to improve the feeling of social well-being of the citizens and to arrange

and structure society and individual lives (Omann & Spangenberg, 2002). For individuals who lose their jobs, it is not only the loss of income that matters, but also for many, having a job means other people acknowledge their contribution and understand how their activities benefit their organization (Stiglitz, 2002).

In addition, studies show that the employment rate could have an effect on community work-life balance, social interactions in the community, and level of happiness (Colantonio & Dixon, 2011). Poverty, social exclusion, welfare dependence, family problems, and social disorder decrease with increasing employment rates (Colantonio & Dixon, 2011). A community with unemployment problems has higher rates of divorce, suicide and incidences of alcoholism, and lower living standards and way of life (Stiglitz, 2002). Employment measured by percent of employment divided to total working-age population of (15-64) in the neighborhood (Miilunpalo, 1997).

Table 10 Variable of Employment Status

Variable	Code	Description	Source
Employment Status	joar	Percent of employed people divided to working-age population of (15-64) in the neighborhood	Census Data

Open and Green Spaces

Open spaces with greenery in particular are recognized as major contributors to human health and social well-being because they effectively improve the physical health of the residents and reduce human stress (Littig & Griessler, 2005). Green spaces provide indirect and direct benefits to human health and well-being. It can increase a population's level of physical activity and potentially reduce the risk of obesity (Littig & Griessler, 2005). Moreover, open and green spaces provide buffer zones in crowded areas to facilitate social gathering and public interaction (Chiu, 2003). The aesthetic aspect in natural landscapes can also reduce stress and anxiety (Chiu, 2003).

Since there is a probability that residents who live close to the edge of neighborhood boundaries more often use the open and green space in the walking distance from the neighborhood, a buffer zone of five-minute walking distance (1200 feet) is created from the boundary of each neighborhood. To create these buffers around neighborhood boundaries Buffer GIS tool used. Buffer GIS tool allows drawing these buffers around features (neighborhood boundaries) at a specified distance from that feature (1200 feet) (see figure 26).

Given that the created buffer area's access to open and green space is estimated as the percent of the total areas of open and green space located in the neighborhood, the assigned buffer area is divided by the area of each

neighborhood. The index below shows how access to open and green space variable is calculated.

Table 11 Variable of Open and Green Spaces

Variable	Code	Description	Source
Open and Green Space	gaar	Percent of the total areas of open and green space located in the neighborhood and the assigned 1200 foot buffer area divided by the area of each neighborhood (percent)	Census data GIS data source

Education

Access to education is one of the primary variables of social sustainability. Studies show that a community with a higher level of education has lower rates of crime, anti-social behavior, and population growth (Sterling, 2001). An educated community gains higher status, an enhanced sense of efficacy, and standard of living (Hutchins & Sutherland, 2008).

The education variable has been counted by calculating the percent of the total number of people who have the high school or more than high school education degree divided by the total number of population of the neighborhood.

Table 12 Variable of Education

Variable	Code	Description	Source
Education	edar	Percent of total number of people who have the high school or greater than high school education degree divided by the total number of population of the neighborhood (percent)	Census data

Transportation Equity

The transportation equity variable includes two criteria. The first one considered the mean of vehicles (car, van, or truck) available per household. And the second one concerned the percent of average number of people who use public transportation (taxicab, bus, streetcar, subway, railroad) to go to work to the total means of travel to work (including all of the transportation options such as car, truck, van, drove alone, carpooled, public transportation (taxicab, bus, streetcar, subway, railroad), motorcycle, bicycle, and walked). The index below index illustrates how access to public transportation is measured.

$$\text{ptar} = 100 * \frac{Average\ number\ of\ people\ who\ use\ public\ transportation\ to\ work}{Total\ means\ of\ travel\ work} \quad (2)$$

Table 13 Variable of Transportation Equity

Variable	Code	Description	Source
Access to Car	ncar	Mean of vehicles (car, van, and truck) available per household	Census data
Access to Public Transportation	ptar	Percent of average number of people who use public transportation to work to total means of travel to work	Census data

Participation in the Community Activities

The variable of participation and interaction in the community has been counted by the number of residents who participated in public and community events in the last 12 months divided by the total population of each neighborhood. The Esri BOA website and GfK MIR research group were the data source. According to the GfK website this data was provided from the survey's vast database of media usage, demographics, psychographics, and consumer behavior. GfK is the trusted source of relevant market and consumer information.

More than 13,000 market research experts combine their passion with GfK's long-standing data science experience. The GIS Esri website is using GfK data that has been geocoded and categorized into different special levels. This information has been used to calculate the median amount of residence public participation in the last 12 months. The participation in the community activities

variable is measured by percent of residents who participate in any public activities in the last 12 months to total population of the neighborhood.

Table 14 Variable of Participation in the Community activities

Variable	Code	Description	Source
Participation in the community activities	pcca	The percent of residents who participate in any public activities in the last 12 months to total population of the neighborhood	GIS Esri BOA online and GfK MRI

Safety

There are debates in the literature regarding measuring the safety and security on a neighborhood scale. Here we used the crime risk number for each neighborhood as the main and most mentioned method of measuring safety in the literatures (McCulloch, 2003; Arundel, 2011; Burton & Mitchell, 2006). Crime risk is intended to provide an assessment of the relative risk of seven major crime types and their summarization to the block group scale.

The crime risk data come from Esri Business Analysis source that contains statistics and data related to the major categories of personal and property crime. On an annual basis, the FBI collects data from each of about 16,000 separate law enforcement jurisdictions at the city, county, and state levels and compiles these into its annual Uniform Crime Report (UCR). The Data sources for AGS were the latest national crime reports obtained from the FBI web site in Excel format.

According to Esri BOA online data, this data has been updated semi-annually and uploaded form Applied Geographic Solutions (AGS) website.

The crime risk database consists of a series of standardized indexes for a range of serious crimes against both persons and property. The crimes included in the database are the "Part 1" crimes and include murder, rape, robbery, assault, burglary, theft, and motor vehicle theft. These categories are the primary reporting categories used by the FBI in its Uniform Crime Report (UCR) in different scales of state, city, county, and block groups.

Table 15 Variable of Safety

Variable	Code	Description	Source
Safety	cca	Crime risk number in the neighborhood	GIS Esri BOA online and Applied Geographic Solutions (AGS)

Sense of Place

Sense of place or how residents perceive and feel about their neighborhoods (Bramley & Power, 2009) can be measured by stability of residents living in that neighborhood. A more satisfied resident is less likely to move out of the area (McCulloch, 2003). If people feel attached to the neighborhood, they will want to stay living in the area and contribute to its continued development (Parkes, Kearns, & Atkinson, 2002). Resident satisfaction with an area measures the level of community stability, as a more satisfied resident is less likely to move out of

the area (Bramley & Power, 2009). There is an important link between residential stability and social sustainability insofar as longer-term residents are more likely to participate in and commit to the well-being of a community (McCulloch, Ward, & Tekkis, 2003).

Within some of the literature, areas of high turnover are perceived to be unsettled and undesirable areas, which mean an urban community, will be socially unsustainable over time (Bailey & Livingstone, 2007; Bramley & Morgan, 2003; Bramley et al., 2000). Sense of place for the purpose of this study has been measured by percent of geographic mobility (population change) in the past 12 months to the total population in each neighborhood.

Table 16 Variable of Sense of Place

Variable	Code	Description	Source
Sense of place	spca	The percent of geographic mobility (population change) in the past 12 months to the total population of the neighborhood (percent)	Census Data

Cultural Diversity

Race/ethnicity data are obtained from the U.S. Census data to calculate diversity measures. Race/ethnicty data is categorized in the seven categories of White (non-Hispanic), Hispanic, African American, Asian, American Indian, Native Hawaiian, and two or more races (Colby & Ortman, 2015). This research

used the Meyer and Overberg probability index to measure the diversity variable for these neighborhoods. Below is the Meyer and Overberg (2001) diversity index to measure the race diversity of the race in each neighborhood area.

Diversity Index = $1 - \Sigma p^2$ (3) (Meyer & Overberg, 2001).

Where P obtains the probability a certain race type will occur. To calculate the diversity index first for each race (White (non-Hispanic), Hispanic, African American, Asian, American Indian, Native Hawaiian, and two or more races), calculate its percentage frequency in the area and then convert the percentage to a decimal and treat it as the probability that a person chosen at random will be of that race. Square that percentage and sum the squared probabilities for the separate races. Subtract this probability from 1 to get the probability that two random people are different. And in the final step multiply by 100 to get an integer (Meyer & Overberg 2001). The index below indicates how diversity has been calculated for each of the neighborhood areas.

Diversity of each neighborhood = 1-(W2 + H2 + AA2 + A2 +AI2 + NH2 + 2R2)

(4)

Where W is the probability of White race, H is the probability of Hispanic race, AA is the probability of African American race, A is the probability of Asian race, AI is the probability of American Indian race, NH is the probability of Native Hawaiian race, and 2R is the probability of two or more races. The probability for each neighborhood in the DFW area is calculated and sorted from 0 to 100, where 0 is totally homogeneous and 100 is totally heterogeneous (Meyer & Overberg 2001).

Table 17 Variable of Cultural Diversity

Variable	Code	Description	Source
Cultural Diversity	cdca	Using diversity index to measure the race diversity	Census Data

3.8.2 Urban Form Variables

An attempt was made to reach a balance between an exploratory examination of a wide variety of urban form characteristics and a focus on the most theoretically relevant and quantifiable measures. A variety of sources were used in compiling variables of the urban form and the process involved extensive Geographical Information Systems (GIS) analysis among other data procedures. The goal was to capture the nature of the urban form of neighborhoods through a broad set of pertinent indicators. These indicators were selected based on what

was found to be relevant in previous related research and that described the spatial characteristics of these urban neighborhoods. A full list of urban form variables and descriptive statistics are presented in the following sections.

Density

Residential density is the most common objective in popular philosophies of urban form literatures, such as New Urbanism, transit-oriented development, and traditional town planning (Cervero & Kockelman, 1997).

Wide ranges of different measurements have been used to calculate the density of a given area. Using a number of density measures has been argued to be stronger than using one single density indicator, which cannot exactly measure the density of a given area (Dempsey & Jenks, 2005). Two types of density indicators were selected to provide as complete a picture as possible of the overall density of the neighborhoods, such as population density and housing density. Population density is defined by dividing the population by total area of the neighborhoods in square miles. The housing density has been calculated by dividing the number of housing units in each neighborhood by total area of the neighborhoods in square miles (Dempsey & Jenks, 2005). GIS software used to measure area of each neighborhood in square mile.

Table 18 Variable of Density

Variable	Code	Example of features measured	Source
Population Density	pduf	Population to total area of the neighborhoods in square mile (pop/sq mi)	Census data Local authorities GIS data source
Housing Density	iduf	The number of housing units in each neighborhood to total area of the neighborhoods in square mile (dw/sq mi)	Census data Local authorities GIS data source

Mixed of Land Use

Segregated land uses are also on most lists of neighborhood urban form. Conversely, mixed and integrated land uses sit atop lists of pedestrian-friendly, transit-oriented, and smart-growth patterns. Mixed use of land is the composition of uses within a given geographic area. Mixed-use developments are those with a variety of offices, shops, restaurants, banks, and other activities intermingled amongst one another (Ewing & Cervero, 2010). A descriptive statistic known as an entropy index was developed to describe the evenness of the distribution of built square footage among seven land-use categories. Below is the Ewing and Cervero (2010) entropy index to measure the distribution of the seven land-use categories.

The entropy index was based on:

Level of land use mix (entropy value) = [single family • log10 (single family)] + [multifamily • log10 (multifamily)] + [retail and services • log10 (retail and services)] + [office • log10 (office)] + [entertainment • log10 (entertainment)] + [institutional • log10 (institutional)] + [industrial/manufacturing • log10 (industrial/manufacturing)] (5)

This equation resulted in the development of a normalized value between a minimum of 0 and a maximum of 1. The number derived from this index shows the amount of mixing use in each neighborhood (Ewing & Cervero, 2010).

Table 19 Variable of Mixed of Land-Use

Variable	Code	Description	Source
Mixed of Land-Use	mlu	Measuring mixed-use development by using Ewing and Cervero (2010) "mixed-use developments index"	Census data Local authorities GIS data source

Local Road Layout

Accessibility is one of the main functions of urban form. After all, it is the streets that connect the land uses, homes and work places. Different road design types could affect the accessibility and permeability urban form of a neighborhood (Jabareen, 2006; Slaev, & Arch, 2004).

According to Ewing et al. (2013) street connectivity is related to block size since smaller blocks translate into shorter and more direct routes and large block sizes indicate a lack of street connections. Intersections distance is the second variable that has been considered in this research to measure permeability of the neighborhoods' road network layout. Intersections are where street connections are made and cars must stop to allow pedestrians to cross. The less distance between the intersections, the more permeable are the neighborhoods (Jacobs, 1993). Intersection density has become the most common metric in studies of built environmental impacts on individual travel behavior (Ewing & Cervero, 2010; Produit, 2009).

The indicators used to measure accessibility cover the pattern of local road and permeability based on the distance between the intersections and median block size. The average distance between the intersections measures permeability (suf) and connectivity is measured by the median block size of neighborhood in square feet (pbuf). To measure the average distance between the intersections of the neighborhoods and the median block size of neighborhoods GIS tools have been used.

Table 20 Variable of Local Road Layout

Variable	Code	Description	Source
Permeability	suf	The average distance between the intersections of the neighborhoods in feet	GIS data source
Connectivity	pbuf	The median block size of the neighborhood in square feet	GIS data source

Housing Layout

The research divides the housing layout variable into three types: multifamily, single family, and other types of housing (such as mobile homes and cottage). Multifamily residential is a classification of housing where multiple separate housing units for residential inhabitants are contained within one building or several buildings within one complex. Sometimes units in a multifamily residential building are condominiums, where typically the units are owned individually rather than leased from a single apartment building owner (Jabareen, 2006). A single-family home (detached or attached) is usually occupied by just one household or family, and consists of just one dwelling unit or suite (Jabareen, 2006).

To understand the variety of housing patterns in the neighborhoods and their effect on social sustainability, the housing type variables was divided into three categories. The first category considers the percent of the total area of

single-family area to total area of the neighborhood square in square feet (sfuf). The second category includes the multifamily housing, which is estimated by the percent of total area of multifamily area to total area of neighborhood in square feet (mfuf). The third category includes other types of housings in the neighborhood, which is determined by calculating the percent of total of other housing type's area to the total area of neighborhood in square feet (tfuf). GIS software was used to measure and sum the total area of each of these categories.

Table 21 Variable of Housing Layout

Variable	Code	Description	Source
Single-Family	sfuf	Percent of total of single-family area to total area of neighborhood in square feet.	Local authorities GIS data source
Multi-Family	mfuf	Percent of total of multifamily area to total area of neighborhood in square feet.	Local authorities GIS data source
Other Types of Housings	tfuf	Percent of total of other housing types area to total area of neighborhood in square feet.	Local authorities GIS data source

3.9 Control Variables

It is clear that other factors would likely have an impact on the outcomes

beyond the spatial dimensions and therefore it is necessary to include these variables as controls in an attempt to isolate the relationships between urban form and social sustainability (Scholz & Schöner, 1999). It is absolutely essential to include variables in trying to properly solve the complex relationships between the neighborhood urban form elements and outcomes examined. As the framework scheme outlined the attempt is to control for as many as possible intervening variables with the goal of isolating the relationship between urban form and the social sustainability indicators. Control variables are chosen based upon the support of the theory and empirical findings in the literature (Scholz, & Schöner, 1999).

Most similar studies include at least some of the selected control variables and many of them are statistically significant for at least one or more of the outcomes. The study includes measures of income, language, age, and time of commute, at the neighborhood levels, according to their noted importance in a variety of previously discussed studies (Pendola & Gen, 2008; Mason, 2010; Jackson, 2003; Leyden, Goldberg, Michelbach 2011). These variables often had impacts on the outcomes in related studies and therefore it was clearly important to control for any effects they might impart. It is very likely that an area with a specific urban form, such as more apartment flats and more traffic nuisance would also happen to be areas of lower-income families and that this factor could strongly impact on the social sustainability outcomes (Pendola & Gen, 2008).

Higher income was also associated with higher-levels of a sense of place and stability (Pendola & Gen, 2008; Kawachi et al., 1997).

In other cases, age different impacts were found depending on the study and specific context, however, they were nonetheless of consistent statistical significance. Jackson (2003) and Putnam (2000) also found that automobile ownership and commuting times were of importance towards social interaction and therefore these variables were included as control variables (Mason, 2010). Since outcomes such as community attachment are based on the idea of making emotional connections to others in the neighborhood, the degree to which others are speaking the similar language can likely impact the level of social sustainability. However, since the cultural diversity is already one of the indicators in the model it would cover this matter. Also, the distance of each of these neighborhoods has been used to measure the time of commute in these neighborhoods. Other variables including age and income have been included in model as control variables. Overall the control variables for the purpose of this study include income, age, and distance to the center of the city.

3.10 Model

Since the relationships between the dimensions of urban form and the measures of social sustainability are too complex for simple ordinary least squares (Grace, 2006), it is necessary to use structural equation modeling (SEM) to

estimate the full complexity of the relationships (Grace, 2006). SEM models were estimated with the software package Amos (version 7.0, SPSS 2007) and maximum likelihood procedures (Jackson, 2003). The path diagram in Figures 2 is copied directly from Amos. Causal pathways are represented by uni-directional straight arrows. Curved bi-directional arrows represent correlations. By convention, circles represent error terms in the model, of which there is one for each endogenous (response) variable (Jackson, 2003).

The ovals shapes represent latent variables. A latent variable in a SEM model has not been directly measured but is inferred by the relationships or correlations among measured variables in the analysis (Jackson, 2003). This research model considers the social sustainability variable as a latent variable that is inferred by correlations among 11 measured variables came from literature reviews. As the figure 27 shows these measure variables have been connected to their related latent variable with arrows that represented their correlation. These arrows would be represented by uni-directional straight arrows directed from latent variable and would be ended to the related measure variable (Jackson, 2003).

All of the paths shown in the path diagrams except of other types of housings (tufu) are statistically significant. The other types of housings (tufu) variable that represent the total area of non-single family and non-multifamily housing types (townhomes and mobile home) that is theoretically significant

though not statistically significant p-value >0.05. This variable has been removed from the model.

The main goodness-of-fit measure used to choose among models was the chi-square statistic. In SEM, we seek a model with a small chi-square and large p - value (. 0.05) because that indicates that the data are not unlikely given that model (that is, the data are consistent with the model). The chi-square drives form this research model equal 9.051 that is small enough to accept the model.

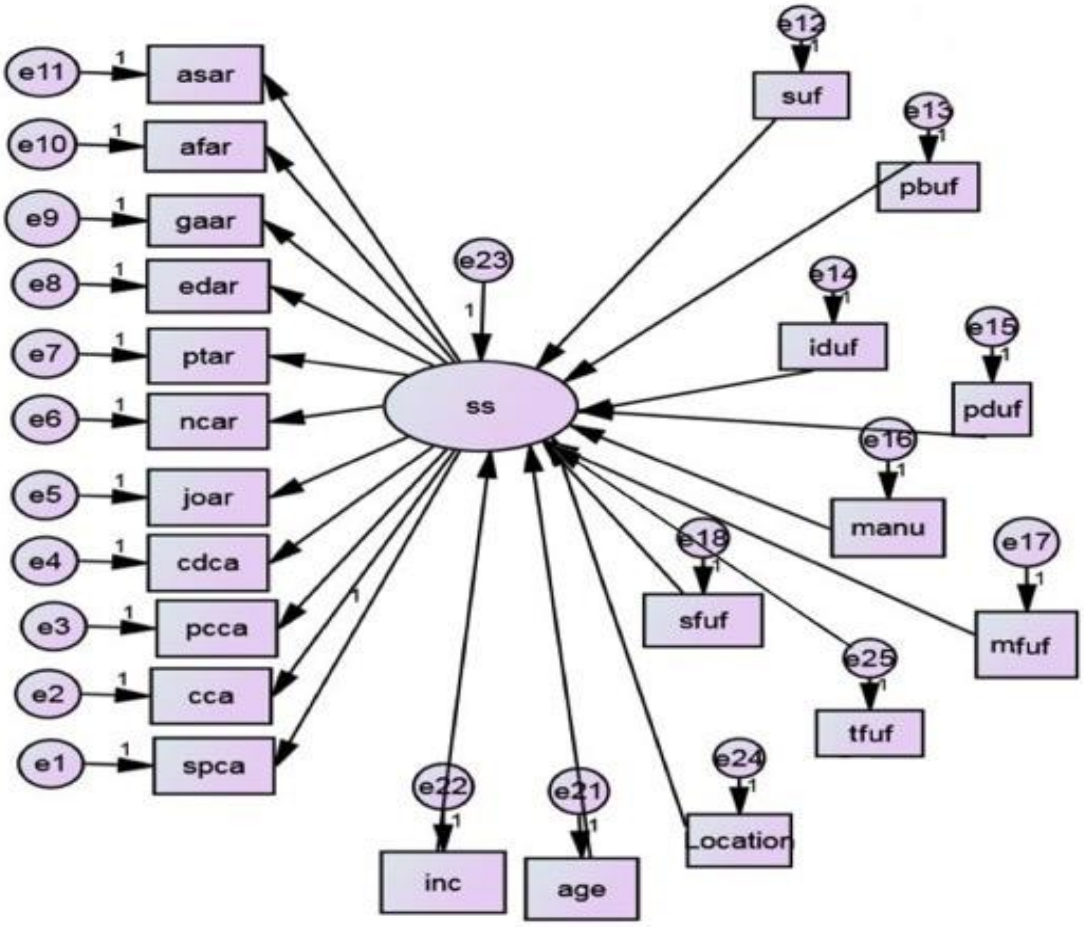


Figure 27 SEM Model

Probability statements about an SEM model are reversed from those associated with null hypotheses. Probability values (p -values) used in statistics are measures of the degree to which the data are unexpected, given the hypothesis being tested. In null hypothesis testing, a finding of a p –value \ 0.05 indicates that we can reject the null hypothesis because the data are very unlikely to come from a random process.

Chapter 4

Data Analysis and Model Result

4.1 Data Descriptive Statistics

Descriptive statistics are used to describe the basic features of the data in a study. They provide simple summaries about the sample and the measures. Descriptive statistics simply help to describe what's going on in our data.

Table 22 shows the simple summary of data in a sensible way. The data indicates the percent of access to local services to total area of these neighborhoods (asar) ranges from zero to 40.43%. Also, this average percent of access to local facilities to total area of the neighborhood is 12.47%. Data shows the average access to housing affordability is about 17.34 in, which means on average each household is spending about 49 percent of their income for housing. Moreover, the average employment status for each residence is about 60.72 percent and the minimum of 19.62 percent.

The mean percent of green space area to the total area of neighborhood is about 15%. Also, the average percent of people who at least have a high school degree in these neighborhoods is 36.80%. The access to public transportation data shows that only 2.30% of the DFW population is using the public transportation to work. Also, on average, for every two-people, there is a car that is being used to go to work. The cultural diversity score varies in these neighborhoods from a

minimum of 1.52 to 99.0 score from a total of 100 scores. Also, the mean cultural diversity score for these neighborhoods is about 68.41.

On average, 58.31% of residents have participated in public activities. The mean number of safety, which measured by average risk of crime in each neighborhood, has varied from a minimum of 0.21% to a maximum of 59.20%. The data shows the mean number of crime risk in these neighborhoods is around 14.32%.

The sense of place in this research is measured by percent of geography mobility (population change) in the past 12 months to the total number of population in the neighborhood. Based on this definition the sense of place score varies from 0.57 to 2.20 and the mean number of sense of place for these neighborhoods is about 1.03.

The data shows that on average there is a 4,256.38 feet distance between every two entry intersections in these neighborhoods which present the permeability value of the neighborhood street layout. That means on average each person needs to walk at least approximately 4,256.38 feet from one intersection entry to another.

Connectivity variable is calculated by measuring the median block size of the neighborhood in square feet. This table indicates the average block size in DFW area is about 635248.50 square feet. Moreover, the collected data shows how low-density neighborhoods are in DFW area since the average housing

density in this area is about 1855.12 (dw/sq mi) and the average population density is about 4207.11 (pop/sq mi). In addition, the average mixed of land-use score from 0 to 100 in the DFW area is about 0.09, which indicated the low level of mixed-use of land in this area.

Also, the housing types data shows that on average 87.20% of neighborhood housing units in the DFW area are single family in comparison to only 4.52% of units that are multi-family and 1.90% that are other types of housing (such as cottage, and mobile homes).

Table 22 Data Descriptive Statistics

Variable	Definition	N	Mean	SD	Min	Max
asar	Access to Local service (percent)	300	12.47	9.14	0.0	40.43
afar	Affordable Housing (percent)	300	27.45	8.20	2.40	63.36
joar	Employment Status (percent)	300	60.72	12.92	19.62	97.36
gaar	Access to Open and Green Spaces (percent)	300	15.00	12.10	0.0	92.04
edar	Education (percent)	300	36.80	19.88	6.85	100.00
ptar	Access to Public Transportation (percent)	300	2.30	0.18	0.0	27.11
ncar	Access to Car	300	0.55	0.44	0.0	4.12
cdca	Cultural Diversity (percent)	300	68.41	20.17	1.52	99.0
pcca	Participation in the Community	300	58.31	14.68	6.59	88.70

	activities (percent)					
cca	Safety (crime risk)	300	14.32	0.34	0.21	59.20
spca	Sense of Place (percent)	300	1.03	0.01	0.57	2.20
suf	Permeability (ft)	300	4,256.38	75,07.69	19.50	77,623.38
pbuf	Connectivity (sq ft)	300	635248.50	540899.810	588.09	2901874.87
iduf	Housing Density (dw/sq mi)	300	1855.12	1859.75	22.90	13448.16
pduf	Population Density (pop/sq mi)	300	4207.11	3587.24	113.05	30695.11
manu	Mixed of Land Use	300	0.09	0.15	0.003	0.32
sfuf	Single-Family (percent)	300	87.20	4.52	0.0	94.60
mfuf	Multi-Family (percent)	300	4.52	0.61	0.0	87.46
tfuf	Other housing types (percent)	300	1.90	11.64	0.0	14.11
Income	Income	300	78,737.11	48,572.96	18,745	294,570
Age	Age	300	35.19	0.42	21.30	83.40
Loc	Location (mi)	300	18.13	7.27	0.10	36.50

4.2 Urban Form Pattern in the Metropolitan Area

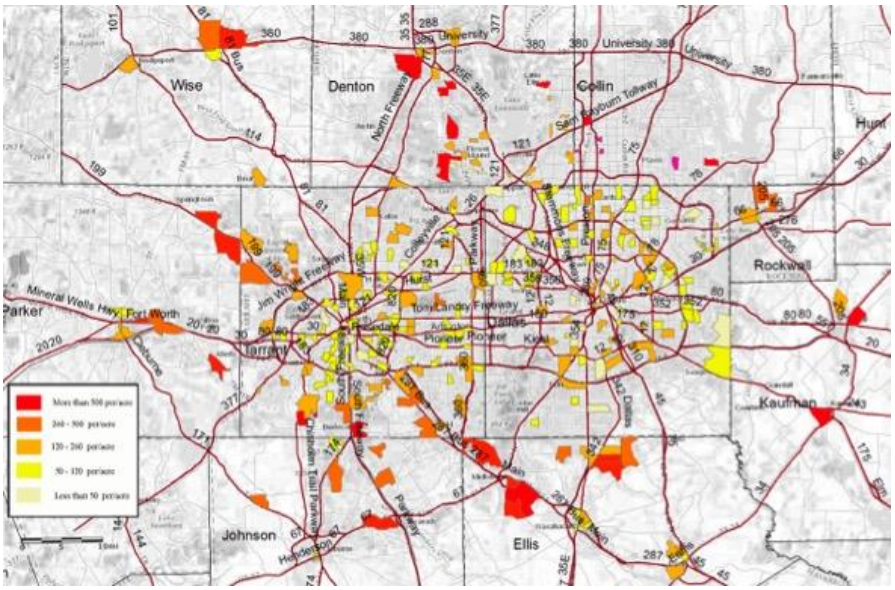
The following maps show the distribution patterns of urban form in the DFW metropolitan area. These maps indicate how the urban design form is different in these neighborhoods and if these urban forms follow any specific pattern depending on the neighborhood distance from the center of Dallas and Fort Worth cities.

Map 2 illustrates the distribution of population density. The red color shows lower density and the yellow color shows higher density. As this map shows the majority of the neighborhoods in the center city areas (Dallas and Fort Worth cities) and mid-city area (Dallas and Fort Worth counties) have a higher density score. It shows that people living in the suburban areas live in the neighborhood forms with a lower density.

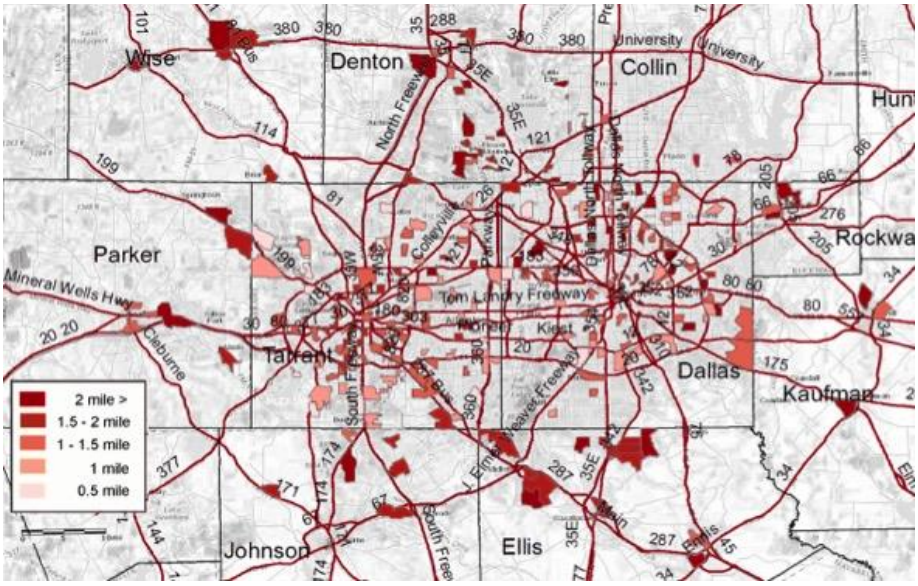
Map 3 shows the intersections' average distance (as the street layout indicators) in each randomly selected neighborhood. According to AASHTO (American Association of State Highway and Transportation Officials), the maximum distance that a person normally is willing to walk from one distance to other is about 0.5 mile. Based on this idea the map shows how neighborhoods that are closer to the center of the city (to Dallas and Fort Worth cities) have closer intersections to make the neighborhoods more walkable for the residents than do the neighborhoods in the outer cities (suburban areas). The neighborhood forms that are not walkable could lead to more use of cars and less social communication.

Maps 4 and 3 illustrate the medium percent of single-family and multifamily residences in each neighborhood. This map shows how most of the housing forms in the DFW area are single-family. Also how the percent of multifamily housing in comparison to single-family is low and in the majority of neighborhoods even less than 20% of the total housing. Moreover, as the single-family distribution

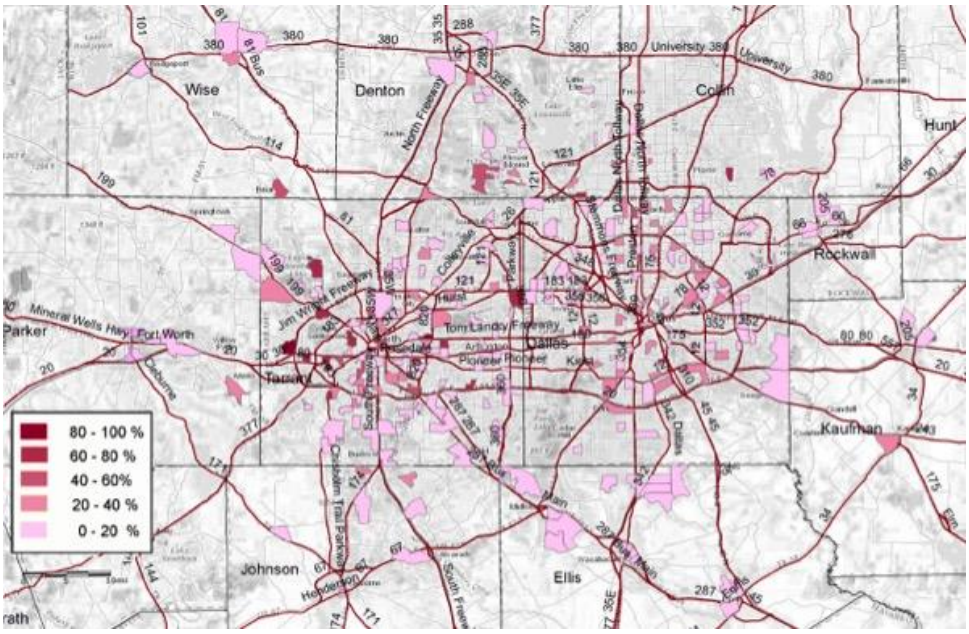
map shows, the majority of the neighborhoods in the suburban area have more than 80% of medium single-family housing types.



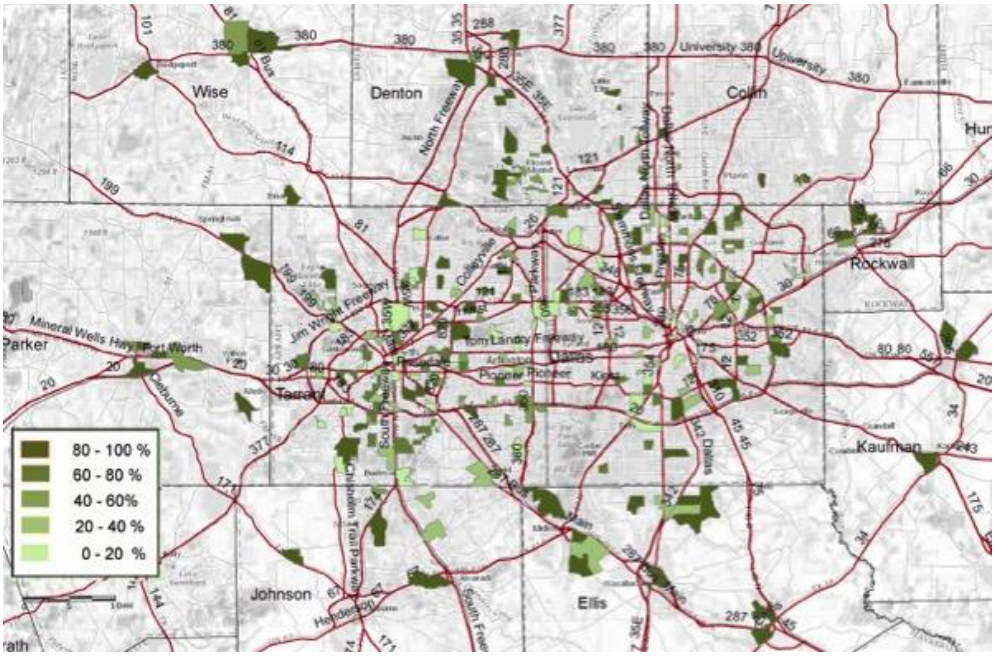
Map 2 Population Density Distribution in the Selected Cities in the DFW Area



Map 3 Street Layout (Intersections Distance) Distribution in the Selected Cities in the DFW Area



Map 4 Multifamily Distribution in the Selected Cities in the DFW Area



Map 5 Single-family Distribution in the Selected Cities in the DFW Area

4.3 Structural Regression Modeling Results

The next step in the analysis is to carry out structural regression modeling to see how far these patterns can be explained by systematic relationships with all of the variables available and social sustainability as a latent variable to this research. In particular, this research is interested in what effect urban form characteristics have once we have controlled for a raft of other exogenous and intervening variables. The technique is SEM model analysis, which is an appropriate standard technique to use when the variables we are seeking to explain/predict are individual that influence on a latent variable and selected based on theories.

The model is built in AMOS and the diagram is shown in Figure 27 (section 3.10). The standardized parameter estimates are shown in the graph. The squares represent the observed variables and the circles are for the error terms. One latent variable (social sustainability value) is assumed with a confirmatory factor analysis used to derive it. Ovals were used to indicate this latent variable. AMOS suggests the correlation structure between error terms of the confirmatory factor analysis after the initial model fitting without any correlated error terms. This helps improve the overall model fitting.

4.4 Tests of Absolute and Relative Fit

After running the model based on Figure 28 (on section 3.10) it is necessary to check the chi-square and degrees of freedom of the model. The low chi-square relative to model degrees of freedom and a high (. 0.05) p-value are indicators of good model fit. The results indicate that the model is acceptable (Hox, Moerbeek, & Schoot, 2010). If the fit of a model is not adequate, it needs to be modified by deleting variables that are not significant and adding variables that improve the fit (Spirtes, Scheines, & Glymour, 2001). To assist in this process the SEM software compute modification indices for each fixed parameter. Parameters are unknown fixed amounts that measure the relationships between two concepts. The SEM estimates the value of the parameters. The true value of parameters remains unknown but SEM is designed to produce estimates of the parameters (Spirtes, Scheines, & Glymour, 2001).

The value of the modification index is the minimum amount that the chi-square statistic is expected to decrease if the corresponding parameter is freed. The same method is used for this research to reach the minimum amount of the chi-square statistic given by modification indices, which for this model is around 10. Here we deleted the other types of housing variable (tfuf), which measured by percent of total of other housing type's area to total area of neighborhood in square feet to reach to a relevant chi-square. Deleting this variable would not be a

problem from a theoretical point of view since the other two variables of single-family housing type (sfuf) and multifamily housing type (mfuf) still would be presented in the housing types of the each neighborhood. Also, a covariance was added between permeability (suf) variable and connectivity (pbuf) variable to refit the model. Since these data both come from parameters to measure the street layout of neighborhoods, it seems reasonable to conclude that there may be shared variance between them. The inclusion of these changes results in a substantial drop in the model fit chi-square.

The goodness of fit test statistics is displayed in table 23 that shows the chi-square of 9.051, which is close enough to the minimum amount that the chi-square statistic is expected to decrease. Moreover, chi-square test statistic is significant at 0.05, which suggests that the model fitting is acceptable and would reject the null hypotheses that there is no significant relationship between social sustainability (latent variable) and urban forms parameter.

To test the relative fitness of the model, investigators often turn to various descriptive fit statistics to assess the overall fit of a model to the data other than chi-square. All these goodness of fit measures are some function of the chi-square and the degree of freedom. Most of these fit indices not only consider the fit of the model, but also its simplicity. AMOS software computes a variety of goodness of fit indices. These indices are functions of the chi-square statistics, but some

include a section function that penalizes complex models (Hox, Moerbeek, & Schoot, 2010).

Joreskog and Sorbom (1989) have introduced two indices for measuring the fitness of the SEM model called GFI (goodness of fit) and AGFI (Adjusted GFI). The GIF indices help to measure the fitness of the model and the AGFI attempts to adjust the GFI for the complexity of the model. If the model fits perfectly, the fit indices should have the value 1. Usually, a value of at least 0.90 is required to accept a model, while a value of at least 0.95 is required to judge the model fit as a "good" fit. RMSEA (Root Mean Square Error of Approximation) is used to assess how well a given model approximates the true model. If the approximation is good, then the RMSEA should be small and typically less than 0.05 (Joreskog and Sorbom, 1989).

The results drive from AMOS (table 23) shows that the RMSEA in this model is 0.019 and since it is less than 0.05, it indicates a good fit. The goodness of Fit Index (GFI) and Adjusted Goodness of Fit Index (AGFI) are larger than 0.9 (0.981, 0.972 respectively) and which again reflect a good fit, although GFI and AGFI may not be as informative as Chi-square test statistics and RMSEA (Spirtes, Scheines, & Glymour, 2001).

Table 23 Goodness-of-Fit Results

Result (Default model)

Minimum was achieved
Chi-square = 9.05
Degrees of freedom = 97
Probability level (p-value) = .093

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.019	.044	.059	.073
Independence model	.110	.114	.368	.033

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.915	.981	.972	.357
Saturated model	.000	1.000		
Independence model	11.753	.415	.219	.269

4.5 Path Diagram Output

The figure below comes from AMOS to display the parameter estimates. This model has several interesting features. First, it contains both latent (unobserved) and manifest (observed) variables. Second, it contains both causal relationships among latent variables, represented by single-headed arrows, and

correlational or bi-directional relationships among several of the residuals, which are represented by the dual-headed arrows connecting between e12 and e13.

As discussed above, because permeability (suf) and connectivity (pbuf) variables both come from parameters to measure the street layout of neighborhoods, it makes sense that they share variance. The values associated with each path are standardized regression coefficients. These values represent the amount of change in Y given a standard deviation unit change in X. (The corresponding unstandardized coefficients represent the amount of change in Y given a single raw score unit change in X).

The AMOS output also displays the standardized regression coefficients. The standardized coefficients and associated test statistics appear in Table 24. Each standardized regression coefficient represents the amount of change in the dependent or mediating variable for each one-unit change in the variable predicting it.

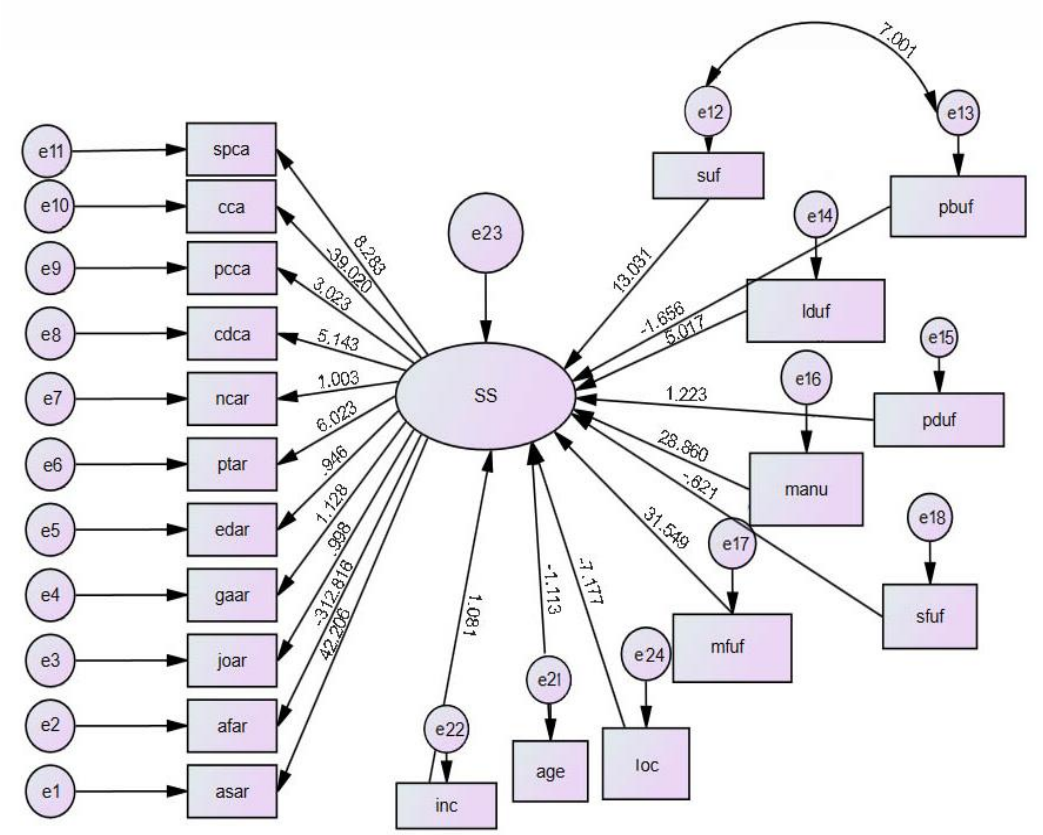


Figure 28 Social Sustainability and Urban Form SEM Model

Table 24 shows the coefficient form the latent variable regressed on coefficient to its standard error and a p-value is also given for each structural coefficient. Also, arrows in the table represent causal effects between endogenous and exogenous variables (Savalei & Bentler, 2010). This table includes two parts. The first part invokes the effect of observed variables (including the urban form variables and control variables) and social sustainability. The second part shows

how the social sustainability variables cause the scores on the social sustainability (latent variables).

The probability value associated with the null hypothesis that the test is zero is displayed under the p-value column. All of the regression coefficients in the standardized estimates model are significant except for the connectivity (pbuf) (p-value of .063), income (p-value of .071), access to car (ncar) (p-value of 0.84), access to affordable housing (afar) (p-value of .59), and access to local services (asar) (p-value of .061) variables. These variables are not as strongly significant as other variables. However, since the p-values are less than 0.1, we keep them on the model.

Table 24 illustrates two kind of information. First kind indicates the relationship between social sustainability and its variables (access to car, access to public transportation, access to open and green spaces, employment status, access to affordable housing, access to local services, cultural diversity, participation in the community, safety, and sense of place). Second kind presents how urban forms variables (permeability, connectivity, mixed of land use, housing density, population density, single family housing, and multifamily housing) are related to social sustainability.

Table 24 results show that access to affordable housing (afar), access to local services (asar), and safety (cca) have the most impact on social sustainability. Affordable housing (afar) variable has negative relationship with

social sustainability since it is measured by percentage of median of housing rent price divided by the median of household income in the neighborhood. This means the residents of the neighborhoods with smaller value of affordable housing (afar) will pay less percentage of their income for housing and have higher score of social sustainability. Within one unit increase of affordable housing value, social sustainability decrease 312.816. After access to affordable housing (afar), access to local services (asar) has the strongest relationship with social sustainability. Whereby an increase of one unit in access to services (asar), increases social sustainability by 42.206. Safety and social sustainability variable have negative relationship since safety variable measure by risk of crime score. It means within one unit increase of safety (risk of crime), the social sustainability value decrease by 39.020. Education (edar), employment status (joar), and access to open and green spaces (gaar) have the least impact on social sustainability of the neighborhoods. By one unit increase in education (edar), employment status (joar), and access to open and green spaces (gaar), the social sustainability value increases by 0.946, 0.998, and 1.128 respectively.

Moreover this table illustrates relationship between urban form variables on social sustainability. Multi-family (mfuf), and mixed of land use (manu) variables have a higher impact on social sustainability value of a neighborhood. Social sustainability value increases by 31.549 when multi-family value increases one unit. Another most effective value of urban form on social sustainability is mixed

land use (manu) variable, which one unit increase of this variable causes social sustainability value to increase by 28.860. After Multi-family (mfuf) and mixed of land use (manu) variables, permeability (suf) and location (loc) have higher level of impact on social sustainability value. Whereby, an increase of one unit in permeability (suf) increases social sustainability by 13.031. Also, one unit increases of location variable (loc) causes social sustainability variable to decrease by 7.177.

Table 24 Model Fit/ Standard Regression Weights: (Group number 1 - Default model)

				Estimate	S.E.	C.R.	P
SS	<---	suf	(Permeability)	13.031	.0103	13.834	***
SS	<---	pbuf	(Connectivity)	-1.656	7.032	-2.562	.063
SS	<---	manu	(Mixed of Land Use)	28.860	7.062	23.457	***
SS	<---	iduf	(Housing Density)	5.017	.032	1.304	***
SS	<---	pduf	(Population Density)	1.223	1.035	2.320	***
SS	<---	sfuf	(Single-Family)	-.621	2.754	-4.178	***
SS	<---	mfuf	(Multi-Family)	31.549	5.060	22.883	***
SS	<---	age	(Age)	-1.113	6.650	-.550	***
SS	<---	inc	(Income)	1.081	.001	22.053	.071
SS	<---	loc	(Location)	-7.177	13.152	-9.533	***
ncar	<---	SS	(Access to Car)	1.003	11.308	23.615	.084
ptar	<---	SS	(Access to Public Transportation	6.023	2.074	3.205	***
edar	<---	SS	Education)	.946	.901	2.780	***
gaar	<---	SS	(Access to Open and Green Spaces)	1.128	.018	8.970	***
joar	<---	SS	(Employment Status)	.998	.089	9.704	***
afar	<---	SS	(Affordable Housing)	-312.816	46.089	-1.049	.059

				Estimate	S.E.	C.R.	P
asar	<---	SS	(Access to Local service)	42.206	9.092	13.546	.061
cdca	<---	SS	(Cultural Diversity)	5.143	.513	.653	***
pcca	<---	SS	(Participation in the Community Activities)	3.023	36.001	11.257	***
cca	<---	SS	(Safety)	-39.020	2.442	-6.415	***
spca	<---	SS	(Sense of Place)	8.283	1.996	.006	***

Unstandardized estimates typically measure the amount that the dependent (or endogenous) variable changes in terms of its standard deviation with a one standard deviation change of the independent variable. Unstandardized estimates measure the change in the dependent variable (in terms of its unit of measure) with a one-unit change of the independent variable (in terms of its unit of measure). It also allows you to evaluate the relative contributions of each predictor variable and outcome variable, which in this model is the social sustainability value. The unstandardized estimates for the fitted model are presented below. There is a difference between the standardized and unstandardized coefficients in this model, probably because variables with very different measurement scales entered into the same model (Table 25).

Table 25 Model Fit/ Unstandardized Regression Weights: (Group number 1 - Default model)

		Estimate
suf	(Permeability)	15.143

pbuf	(Connectivity)	-1.351
manu	(Mixed of Land Use)	58.991
iduf	(Housing Density)	6.099
lduf	(Population Density)	.56
sfuf	(Single-Family)	-1.073
mfuf	(Multi-Family)	28.811
age	(Age)	-.677
inc	(Income)	12.993
Loc	(Location)	-2.912
ncar	(Access to Car)	.215
ptar	(Access to Public Transportation	4.098
edar	(Education)	2.840
gaar	(Access to Open and Green Spaces)	2.069
joar	(Employment Status)	.933
afar	(Affordable Housing)	-118.4
asar	(Access to Local service)	28.778
cdca	(Cultural Diversity)	3.459
pcca	(Participation in the Community Activities)	54.209
cca	(Safety)	-52.04
spca	(Sense of Place)	99.134

Table 26 Direct and Indirect Effect of Urban Form Variables on Social Sustainability

Variable	Parameters	Direct Effect on Social Sustainability	Indirect Effect on Social Sustainability	Total Effect on Social Sustainability
Density	Population Density (pduf)	.882	.341	1.223
	Housing Density (iduf)	1.229	3.788	5.017
Use of Land	Mixed of Land use (manu)	7.025	21.835	28.860

Road Layout	Permeability (suf)	8.055	4.976	13.031
	Connectivity (pbuf)	-1.008	-.648	-1.656
Housing Layout	Single-Family (sfuf)	-.441	-.180	-.621
	Multifamily (mfuf)	18.358	13.191	31.549
Control Variables	Location (loc)	-5.012	-2.165	-7.177
	Age	-.819	-.294	-1.113
	Household Income (inc)	.733	.348	1.081

Table 26 shows the direct effect, indirect effect, and total effect of each of the urban form variables on social sustainability variable (outcome variable). The results show that density variables (population and housing density), mixed land use, permeability, multifamily, and household income have a positive relationship with social sustainability. Also, there is a negative relationship between connectivity, single-family housing, location, and age and social sustainability. This table indicates that the multifamily housing, and mixed of land use variables have the most effect and median household income has the least effect on the social sustainability value of a neighborhood.

As Table 26 shows the household income (inc) variable has the positive relationship with social sustainability. With increase of one unit in the household

income, the social sustainability value increases by 1.081. The age control variable has negative effect on social sustainability, which means that the youngest community has the highest level of social sustainability. This result is in opposition to the assumption in most of the literature that youngest residents have the least interest in participating in social activities (Bramley & Power, 2009; Colantonio & Dixon, 2009; Chan & Lee, 2008; Polese & Stren, 2000; Oktay, 2004). Based on the results from the SEM model, the neighborhood with an average of younger residents has a greater chance of reaching a higher degree of social sustainability. The location standard coefficient result reveals that neighborhoods closer to the center of Dallas and Fort Worth cities (downtown areas) have a higher score of social sustainability. It shows that generally suburban areas have a lower degree of social sustainability. Within one unit distance of neighborhood from the center of the city, the social sustainability value of the neighborhood decreased by 7.177 units.

4.6 Hypotheses Testing

The results obtained from SEM model are utilized to test the hypotheses. The test of fitness rejects the null hypotheses that there is not any significant relationship between social sustainability and urban form parameters. Chi-square is significant which means there is a significant relationship between indicators of

social sustainability and urban form variables in the neighborhood-scale even beyond the effects of the socio-demographic and other control variables (primary hypothesis).

Table 26 shows the direct effect and indirect effect of each of the urban form variable parameters on the social sustainability variable (outcome variable). The result shows there is a positive relationship between population variables and social sustainability. Population density variable has 0.882 values directly effect, 0.341 value indirectly, and a total of 1.223 effects on social sustainability. That means that with a one-unit increase in population density of the neighborhood the social sustainability value increases 1.223 units. Also, housing density parameter has 1.229 direct effects, 3.788 indirect effects, and a total of 5.017 effects on the social sustainability outcome variable. A one-unit increase in housing density reflects a 5.017 unit social sustainability value increase. In conclusion, higher-density neighborhoods within DFW metropolitan are significantly associated with the indicators of social sustainability (hypothesis I: density).

The mixed of land use area (manu) variable has positively effect on social sustainability. Use of land has 7.025 direct, 21.835 indirect, and a total of 28.860 effects on social sustainability of the neighborhoods. While the use of land value increases by one unit, the amount of social sustainability of the neighborhood increases by 28.860. Neighborhoods with a higher percentage of mixed-use lands

will display higher levels of social sustainability, after controlling for intervening variables (hypothesis II: use of land).

This research considers two parameters to assess the effect of local street layout on social sustainability of a neighborhood. The first parameter considered is the average distance between the intersections (suf), which is helpful in measuring the level of permeability of the neighborhood. The second one assesses the level of connectivity of the neighborhood by measuring the medium block size of the neighborhood (pbuf). The result from SEM shows that there is a negative relationship between connectivity (pbuf) variable and the social sustainability value of the neighborhoods. The medium block size of the neighborhood (pbuf) variable has -1.008 direct effects, -.648 indirect effects, and -.1.656 total effects on the social sustainability. The negative sign shows that by one unit decrease in the medium block size of the neighborhood, the social sustainability value of the neighborhood decreases by .07142 units. This negative relationship affirms this research expectation that neighborhoods with smaller blocks size would have higher value of the social sustainability.

Permeability (suf) variable has 8.055 direct effects, 4.976 indirect effects, and 13.031 total effects on social sustainability. The results show the distance between intersections (permeability (suf)) variable has positive relationship with social sustainability. However the more distance between the intersections, the

less permeable are the neighborhoods (Jacobs, 1993). It means the less permeability in a neighborhood increases the social sustainability value of that neighborhood. This result is in contrast to the majority of research (Littig & Griessler, 2005; Sander, 2002; Bramley et al., 2009) that claim by increasing the permeability urban form of a neighborhood the level of social sustainability in the neighborhood increase. Thus, hypotheses III, which states neighborhoods in DFW metropolitan area with urban form features relating the higher level of permeability and connectivity urban form pattern, will display higher levels of the social sustainability, after controlling for intervening variables is not completely acceptable.

Another important feature of a neighborhood urban form is considering the neighborhood housing types. This research divided the housing types into three categories of single-family, multifamily, and other housing types. The standardized coefficients reveal a stronger relationship between effects of multifamily housing type on having a higher level of social sustainability.

The multifamily housing (mfuf) variable has the highest level of impact on social sustainability in comparison to other urban form variables. It has 18.358 direct effects, 13.191 indirect effects, and the total of 31.549 effects on the level of neighborhood social sustainability. If the percentage of multifamily housing to the total area of the neighborhood increases by one, the social sustainability of the

neighborhood increases by 31.549. Also, the relationship between the percentage of single-family housing in the neighborhood and the degree of social sustainability is negative. This percent of single-family housing (sfuf) variable includes the effect of -.441, indirect effect of -.0180, and total negative effect of -.621 on the social sustainability of the neighborhoods. As determined by the statistically significant unstandardized regression coefficients, by decreasing one unit of a percentage of single-family housing in a neighborhood, the degree of social sustainability of the neighborhood declines by .621. The result illustrates that when a neighborhood provides more multifamily housing types it will display higher levels of social sustainability, after controlling for intervening variables (hypothesis IV: housing layout).

Chapter 5

Discussion and Conclusion

5.1 Discussion

The results derived from the SEM model support some important insights into the relation between neighborhood urban form and outcomes of social sustainability. Although the study focuses on the randomly selected neighborhoods from the three different areas of the inner city, mid-city, and outer city of the DFW metropolitan area, there were still significant variations between neighborhoods' urban from and the community's features.

The results indicated from the SEM model help to untangle the relationships between these variables. Looking at the amount of coefficient and significance that the SEM model was able to explain at each of the urban forms variables helps to understand the predictive power of the SEM model. Noteworthy features of this model include the negative relationship between social sustainability and permeability. Since social sustainability and permeability (suf) variable have the positive correlation and increasing intersection distance (suf) variable leads to decreasing permeability, which contradicts previous assumptions and underlines the importance of a more detailed understanding of permeability (Littig & Griessler, 2005; Sander, 2002; Bramley et al., 2009).

Littig and Griessler (2005) refer to permeability as the ease to which pedestrians can move through an urban area by choice of routes. It relies on a framework and layout of the streets that is avoiding long stretches with no junctions that make the neighborhood more accessible, walkable, and having an

urban character. However, as Ewing and Cervero (2010) argue, the high level of permeability in some communities would cause the increase in the risk of crime and a lower level of safety. Underlining the importance of walkability and permeability features in some communities, like the neighborhoods of the DFW metropolitan area, it seems clear that has an adverse effect on the social sustainability of the community.

Another important point that this study has revealed is that density does not appear to be a significant factor in the relation to the social sustainability of a neighborhood, while more specific elements of the urban form (like mixed of land use and multifamily housing types) appear to play a more important role. This outcome contradicts previous assumptions and underlines the importance of a more detailed understanding of urban form. Many earlier studies focus on the variable of density as an overarching measurement, which was assumed to explain most of the variation between neighborhoods' physical forms and sustainability. Various related studies looking at similar outcomes almost entirely focus on density (e.g. Bramley et al. 2006; Talen, 1999; Yang, 2008) and therefore overlook the differences that can exist among areas of similar density.

The findings from this research contend that other factors of urban form beyond density could account for the various outcomes in previous studies. Littig and Griessler, (2005) proposed that differing sustainability outcomes might be due to the quality of the high-density neighborhoods although these variations

were not investigated. Furthermore, Colantonio and Dixon (2009) found a nonlinear relationship between density and social sustainability outcomes and conclude that further urban form variables likely have an impact. Finally, in a key British study higher densities were associated with worse sustainability of community results; however, beyond a certain density level, the relationships are either different or not apparent at all with the suggestion that additional factors, such as housing types and use of lands could play a role (Bramley et al., 2009).

It must be mentioned, however, that the results are limited to the DFW metropolitan area context and cannot necessarily be generalized to the metropolitan areas in other states and countries. There could be a cultural dimension, for example, to the acceptance of density (Burgess, 2000). DFW Metropolitan area undoubtedly represents a different environment to compare to the north Sunbelt cities of the United States and British cities, where most other studies have been undertaken and that have a successful central planning tradition while being characterized by high-density urban form shaped by a social democratic tradition (Fainstein, 2000; Schwanen et al., 2004).

The fact that the study found density levels to be less critical in comparison to mixed of land use, housing layout, and physical street layout features of urban form related to sustainability of community supports the claim that the quality of high-density urban form in the DFW metropolitan has likely managed to balance the tensions between livability and density. This is a significant finding since it

shows that the high-density could be the most important feature of urban form to meet environmental and economic sustainability goals while not compromising social sustainability.

5.2 Conclusion

In this research, we have discussed how social aspects of sustainability have come to be an increasingly important part of the sustainable development agenda. We have mapped out the development of our understanding of the concept of social sustainability. One of the main reasons that social aspects of sustainability have received such limited attention is that they are difficult to define, let alone to quantify (Burton, 2003). This research, therefore, has been an attempt to move these debates on, with the discussion highlighting the complexities involved. Our definition of social sustainability incorporates both social equity issues and sustainability of community issues (the key issues being identified from the Bramley et al., (2010) and Colantonio & Dixon (2009) studies).

The second part of the research explored some of the possible relationships between the different urban forms elements discussed in the literature. It is necessary to study the individual relationships between dimensions of urban form and social impacts. Otherwise, the social outcomes taken together can cancel each other out (Burton, 2003). In the empirical parts of the paper, data from the Census data, Esri BOA website, GfK MIR, Applied Geographic Solutions (AGS)

research groups, and using GIS tools collected. SEM model runs to test and to draw out of these variables relationships.

The messages from this analysis are quite complex. Broadly, the patterns of outcomes about urban form revealed from simple tabulations do recur when subjected to statistical SEM modeling, controlling for many other factors. More mixed-use neighborhood urban forms and their associated multifamily housing tend to be related somewhat to the best outcomes about social sustainability value. Some result patterns point out how different factors like permeable street layout have a negative relationship with social sustainability value of the neighborhoods. However, in particular, street layouts created by following the pattern of more connective street layout and mixed use of land are better in the direction of having more level of social sustainability for the community. This study also confirms other work in showing that neighborhood concentrations of mixed land use are often more strongly associated with social outcomes. In other words, who lives where within the mixed-use and multifamily housing types with more connective street layout urban forms, may be more key to making urban communities work.

This leads one to question whether there is any way in which the disparate dimensions of urban form can be divided into more details, which would enable one to arrive at more design features for street layout and housing types in a neighborhood.

Although whether such detail design of a street is appropriate is questionable. If one could do this, a likely outcome might be that the balance would be different for different features.

Moreover, since housing types in this research are limited only to three types of single-family, multi-family, and other types of housing, there is a place for future studies to divide this housing types to sub-categories based on their design elements (for example single family housing could be divided to two types of attached and detached single family housing types) which requires closer investigation.

It is important to note that even though this model fits the data well and provides a theoretically consistent set of findings; there may be other equivalent models that fit the data equally well. There may also be non-equivalent alternative models that fit the data better than this model. Researchers should strive to test and rule out reasonable alternative models whenever possible. The study creates an impetus for more research into the link between urban form and social sustainability in other types of cultural contexts. Moreover, there is more work to be done concerning emerging evidence on the role of nature in health and well-being (Brown, 2005).

The study also has the potential to draw out more particular features of urban form at all levels that affect social sustainability outcomes. Beyond this, it also calls for the importance of investigating the relationship of social

sustainability and urban form toward collecting data beyond the neighborhood level such as region, city, and metropolitan area that might directly or indirectly impact local social and community experience.

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Factor Score Weights (Group number 1 - Default model)

	suf	pbuf	manu	iduf	pduf	sfuf	mfuf	age	inc	loc	ncar
SS	.832	-3.332	8.717	.017	.432	-.454	5.011	.143	.601	-.011	.309

	ptar	edar	gaar	joar	afar	asar	cdca	pcca	cca	spca
SS	7.189	3.177	.044	.031	-4.113	.834	1.012	.313	-.871	1.456

Residual Covariances (Group number 1 - Default model)

	asar	gaar	edar	ptar	ncar	cdca	pcca	cca	spca	suf	pbuf	iduf	pduf	manu	sfuf	mufu	lnc	age	afar	joar	loc
asar	.000																				
gaar	-.029	.000																			
edar	.022	.002	.000																		
ptar	.069	-.019	-.005	.000																	
ncar	.054	.061	.024	.015	.000																
cdca	.034	.026	.026	-.029	.055	.000															
pcca	-.056	.056	-.037	.046	-.013	.092	.000														
cca	.047	-.017	-.029	.094	-.254	.039	.143	.000													
spca	.209	.037	.002	.005	.033	.003	.005	.291	.000												
suf	.071	.022	.019	-.061	.216	-.031	-.019	.080	.006	.000											
pbuf	.094	.049	.039	-.098	.043	.070	.101	-.037	.064	.699	.000										
iduf	-.046	.121	.014	.125	-.138	.028	-.040	.170	-.039	-.040	.090	.000									
pduf	.039	.165	.046	-.085	.159	.005	.140	-.226	-.061	.026	-.043	.910	.000								
manu	.028	.006	-.003	.040	.112	-.035	-.098	.052	.041	-.014	.090	-.017	.019	.000							
sfuf	-.044	.099	.034	.058	-.087	.048	.063	.181	-.148	.053	-.172	.011	.032	.356	.000						
mufu	-.029	.017	.025	-.106	.152	-.093	-.046	-.068	.019	.051	-.164	.066	.070	.024	.090	.000					
lnc	.144	.196	-.040	.163	.066	.259	.259	.065	.095	.025	.068	.147	.190	.030	.117	-.180	.000				
age	.120	-.089	.014	.068	-.004	.128	.244	.003	-.098	.030	.106	-.133	.213	.005	.026	-.187	.067	.000			
afar	.079	.082	.076	.171	.005	.022	.042	-.024	.041	-.039	-.021	.191	.120	-.045	-.148	.152	-.020	.150	.000		
joar	-.033	.012	.103	-.035	.032	.044	.200	.011	.102	.083	.031	.168	.032	-.052	.150	.245	.039	.024	.037	.000	
loc	-.094	-.138	.040	-.019	-.037	-.226	.003	.019	-.013	.006	.024	.005	.032	-.180	.051	.159	.143	.112	.037	.019	.000