THE CONVERSION OF URBAN VACANT LAND: THE CASE OF FORT WORTH, TEXAS

A Dissertation

by

BO AH KIM

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

DOCTOR OF PHILOSOPHY

Chair of Committee,	Shannon S. Van Zandt
Co-Chair of Committee,	Galen D. Newman
Committee Members,	Yu Xiao
	Ann O'M. Bowman
Head of Department,	Forster O. Ndubisi

August 2016

Major Subject: Urban and Regional Sciences

ABSTRACT

Vacant land in inner cities and outside of urban areas have become a critical issue in every country across the globe. In the United States, the ratio of vacant land in inner city areas has increased, and it brings many negative impacts. Despite population and economic growth, the amount of vacant land is much higher in growing cities than in shrinking cities; despite the population and economic growth. However, well-maintained and protected vacant lands are often viewed as significant assets that can improve the quality of life. To address this issue, this study presents historical vacant land patterns and the influential factors that have a significant relationship with converting vacant land from non-vacant land in the city of Fort Worth, Texas. Fort Worth is one of the fastest growing cities in the United States. The population and economy are growing, and the physical land area is increasing due to annexation.

From this viewpoint, this research analyzes the conversion of vacant land in a growing city. To effectively conduct an analysis of transformed vacant lands, this study defines the transformation of land that is changed from vacant to non-vacant. This research explores the causes and effects of vacant land and then selects exploratory variables that can explain the conversion of vacant land. As well, through a descriptive spatial analysis, vacant land patterns are identified using a Geographic Information System (GIS). Subsequently, a discrete-time hazard model (STATA) are used for the most comprehensive analysis of the conversion of vacant land. This research suggests how

determining the factors contributing to vacancy would help cities, especially the vacancies and inner urban area vacancies of growing cities.

This study demonstrated that over time, vacant and abandoned properties were concentrated in the core city area. The conversion of non-vacant land to vacant is caused by a major non-white population, high-land-value, a further the distance from the CBD, and small parcel size in the inner city area of a growing city. This research also found that the built environment and annexation are the principal causes of increases in vacant land, rather than socioeconomic status.

DEDICATION

This dissertation is dedicated to my parents, Kyungsik Kim and Eunhyung Cho, and my precious brother Hyunjoong Kim, who have supported me with love and care through one of the arduous states of my life.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Van Zandt, and Dr. Newman, and my committee members, Dr. Xiao, Dr. Bowman, and Dr. Hollander, for their guidance and support throughout the course of this research.

Thanks also go to my friends and colleagues and the department faculty and staff for making my time at Texas A&M University a great experience.

Also, thanks to my mother and father for their endless love and my friends and Professor. Ryu for their support and encouragement. Finally, my little brother, you are always in my mind, miss you so much.

NOMENCLATURE

VAP	Vacant and Abandoned Properties
CFW	City of Fort Worth
NVL	Non-Vacant Land
VL	Vacant Land
SES	Socioeconomic Status
BE	Built Environment
GEO	Geographical
CBD	Central Business District
NCTCOG	North Central Texas Council of Governments
DTHM	Discrete-Time Hazard Model
COEF	Coefficient
OR	Odd Ratio
OBS	Observation
SD	Standard Deviation

TABLE OF CONTENTS

Page

LIST OF FIGURES

Page

LIST OF TABLES

Page

1. INTRODUCTION

Vacant or abandoned properties (VAP) can be found in every community and all city. Vacant or abandoned lands are related to low-income, minority, segregation, affordable housing, and other diversity issues because of these lands are located more in communities plagued by these issues. They cause many adverse effects that are detrimental to the image of the city (Wood, 1998), increase crime rates that intensify public safety concerns (National Vacant Properties Campaign, 2005; Eppig & Brachman, 2014), reduce the values of properties near or next to vacant parcels (Niedercorn & Hearle, 1964; Webber, 1968; Eppig & Brachman, 2014), decrease neighborhood quality (Carr, 1999; Hollander, Johnson, & Whiteman, 2016), and contribute to rapid urban decline (The Vacant Properties Research Network, 2015). Due to the ongoing depopulation and rapid deindustrialization, at least in part to this vacant and abandoned properties (VAP) in many cities are suffering.

Overall city population density in the U.S. decreased by 6% between 2000 and 2010; among the 200 largest populated cities in 2000, 21 had lost more than one-fourth of their residents between 1950 and 2008 (Dewar & Thomas, 2013), resulting in a loss of housing units and an increase in the number of abandoned properties. According to the 2010 Census, the U.S. had 131.7 million housing units, among them 15.0 million units (11.4 percent) were vacant. Between 2000 and 2010, the vacant units increased 43.8 percent from the 2000 vacant housing unit (10.4 million) (United States Census Bureau, 2011). Furthermore, the U.S. Census Bureau points out that the vacancy rates for

housing in inner cities (2.1%) is now higher than the vacancy rate of suburban environments (1.7%) (U.S. Census Bureau News, 2013). Because of these problems, there is a pressing need for many cities in the United States, both urban and suburban, to manage their vacant and abandoned properties (VAP) effectively and efficiently. Nevertheless, they bring many negative impacts and positive opportunities and possibilities. VAP can be viewed as significant assets that conduce to an attractive city with its economic growth. Well-maintained and protected VAP can actually increase the city image and quality of life (Carter & Polevychok, 2003; Popper & Popper, 2002).

According to some research, urban decline and the resulting vacant or abandoned land are not unique phenomena in the process of urban growth and progress (Carter & Polevychok, 2003). Urban evolution theory involves four successive development stages: urbanization, suburbanization, de-urbanization, and re-urbanization (Van den Berg, Drewett, Klaasen, Rossi, & Vijerberg, 1982). Therefore, urban decline and vacant or abandoned land are part of a cycle in the phenomena of the process of urban birth and death; there is no end state. Along with this natural phenomenon, the formation of VAP is concurrent and intertwined with a city's history and is characterized by a progressively privatized public realm and growing socio-political and economic polarization (Foo, Martin, Wool, & Polsky, 2013). U.S. cities have also undergone various significant incremental changes. Post-World War II shifts population to the outside of urban areas, it caused concentration on VAP outside of urban areas as well. By the 1970's, economic recession and massive job losses that resulted in massive out-migration from the urban core increased the amount of VAP in urban areas. Since the 1980s, the construction of

highways and the expansion of suburban infrastructure have led to larger suburban populations. During the 1990s, many cities intentionally created VAP by razing dilapidated structures while continuously building new housing stock in suburban and exurban environs, expanding urban areas across the entire United States (Accordino & Johnson, 2000). With these changes, governmental agencies have highlighted strategic and effective planning for urban renewal (Jackson, 1985; Accordino & Johnson, 2000). Due to this phenomenon, VAP can be found in diverse sites and tends to fluctuate with local policy, expansion, and population/land use migrations.

Many shrinking cities[1] in the U.S. have faced daunting economic, social, and physical challenges, population and job losses, and increased poverty (Hollander, Pallagst, Schwarz, & Popper, 2009). As a result, VAP in shrinking cities has attracted much attention from governmental agencies, urban development organizations, and planning researchers. Inversely, growing cities[2] feature population growth, the expansion of physical boundaries, and economic growth. Despite these positive characteristics, increasing amounts of VAP in growing cities can also be a critical issue. Pagano and Bowman (2000) suggested that growing cities, with their expanding size, hold larger amounts of VAP than other cities. While VAP inventories in urban areas are routinely calculated, especially in shrinking cities, relatively little effort has been made to investigate and test the effects of VAP in growing cities (Pagano & Bowman, 2000).

[1] A shrinking city is one in which the urban population is decreasing continuously. Alternatively, one in which a "compactly populated urban area with a minimum population of 10,000 residents that has faced population losses for more than two years and is undergoing an economic transformation with some symptoms of structural crisis" (Hollander, Pallagst, Schwarz, & Popper, 2009, p. 224).

[2] The growing city defined as the continuously increasing urban population and the overall population (Devas, 1993).

Furthermore, the strategies and policies of VAP regeneration tend to focus on only depopulating cities, even though VAP in inner urban areas have experienced reinvestment and regeneration over the past decades. The conditions of shrinking cities and growing cities are not the same since VAP issues in growing cities include more serious problems, and the effects of VAP and regeneration are understood very poorly. Thus, current vacant issues in inner urban areas are more noteworthy than in any other era.

However, if we maintain VAP and protect it, it can be a significant asset conducive to an attractive city and can contribute to its economic growth (Hollander & Nemeth, 2011). Also, VAP can improve a city's image and quality of life (Hollander, 2011; Popper & Popper, 2002). To determine the best approach to deal with vacant or abandoned land, many studies have been conducted to identify and validate its value (Bowman & Pagano, 2000; Carter & Polevychok, 2003; Hollander, Pallagst, Schwarz, & Popper, 2009; The United States Conference of Mayors, 2009; The Vacant Properties Research Network, 2015). Nonetheless, there are still gaps in the existing knowledge. First, existing research efforts focused on proof-of-concept studies, which shed a little light on how and why the VAP was converted and what kinds of critical factors affect the conversion. Second, many studies targeted shrinking cities only, such as Detroit and Flint in Michigan, Cleveland and Dayton in Ohio, and Buffalo in New York. There have been few studies specifically aimed at expanding cities[3] that need sound management

[3] If the urban boundaries are extending, and it appears that the territory being annexed adds more undeveloped land, these cities are expanding cities (Bowman & Pagano, 2004).

such as Ft. Worth and Austin in Texas and Sacramento in California (Kotkin, 2013). Last, previous efforts examined technical and political problems in constructing and maintaining vacant property inventories and databases.

Based on these remaining gaps regarding VAP, this research proposes that if we know what the patterns of vacant and non-vacant land (NVL) change depends on during certain periods, and if we know that what kind of factors most strongly affect the conversion of land use, especially from non-vacant to vacant; we can more properly manage vacant land and project a future VAP conversion pattern of land use.

Following this viewpoint, this research conducts an exploratory analysis of the factors influencing the conversion of NVL to vacant in an expanding city: Fort Worth, Texas. The city of Fort Worth (CFW), Texas is one of the fastest growing cities in the United States (City of Fort Worth, 2015). Moreover, through annexation from the 1980s, the amount of VAP in the city has continuously increased. To examine the impacts of vacant or abandoned land, this research suggests that, first of all, preventing abandonment is primary. Thus, analyzing the causes of abandonment and establishing preventative programs is necessary. Second, the period of abandonment and reuse should be minimized to protect the surrounding area from harmful effects. Third, abandoned properties should be reused in a positive and beneficial way for the community and neighborhood, either immediately or over the long-term. Consequently, this research will shed light on an unstudied aspect of the conversion of VAP.

2. LITERATURE REVIEW

Many professionals, researchers, and government officials have studied the issues of VAP and have established strategies that encourage its conversion. They have focused on resolving several problems of the conversion of VAP by asking the following questions empirically and theoretically: “Why is VAP a significant issue?”, “What are the critical reasons and procedures for currently generated VAP?”, “Where are existing vacant properties located?”, “How do neighborhoods, communities, cities, and governments maintain or protect VAP?”, moreover, “What are appropriate strategies and policies applicable to VAP?” Along with the challenge of these unanswered questions, VAP is a serious issue in most urban places.

Most previous studies on VAP issues have concentrated mainly on shrinking or declining cities with abandoned or under-occupied structures, overgrown empty lots, high crime rates, and income segregation with an aging and heavily minority population (Hollander, Pallagst, Schwarz, & Popper, 2009). It is hard to find a study that focuses on VAP in expanding cities. Growing cities tend to have more VAP than shrinking cities – the percentage of VAP in growing cities (19.3 percent) is much higher than that of shrinking cities (9.6 percent) (Bowman & Pagano, 2004). Newman and his colleagues (2016) confirm it through recent study that growing cities have a large amount of vacant land (17.2%) rather than shrinking cities (14.1%). Moreover, growing cities have been experiencing high levels of growth in population, revealing high levels of VAP (Pagano & Bowman, 2000). These previous studies pointed out the population growth of cities

(i.e., growing or shrinking), rather than boundary size fluctuations. Fixed boundary cities have a much higher structural abandonment than expanding boundary cities (Rusk, 1993). The elastic cities are defined as the expanding boundary cities; they can expand its boundaries through annexation. According to Rusk, elastic cities are advantageous than fixed cities which are bounded by incorporated areas on their borders (Rusk, 1993). It is difficult to use a holistic approach to understanding how to improve and reuse VAP and which critical factors determine the conversion of this land because the VAP is related to various causes and effects, and numerous characteristics.

Thus, throughout this literature review section, this research describes how different cities are addressing rising vacancies, how property abandonment has developed, and the common characteristics of blight in the United States.

2.1 Terminology

There are many terminologies related to VAP such as expanding or fixed city; shrinking or growing city; and inelastic or elastic city (Rusk, 1993; Pagano & Bowman, 2000; Bowman & Pagano, 2004). These terms are classified by population, economic, and physical boundaries. Other terms that relate to reuse of VAP strategies, policies, and programs that create more attractive urban areas and increase neighborhood economies and quality of life are urban renewal, urban redevelopment, urban regeneration, urban revitalization, and urban rehabilitation. From reviewing the literature, it is apparent that these terms can be confusing. Moreover, the meaning of all of these terms is slightly different; even though they represent similar purpose and characteristics. Based on these

issues, in this section, the terminology employed in this research will be summarized and defined.

2.1.1 Expanding City vs. Fixed City

When we define a city as expanding or fixed, this is based on the physical boundary of the city. If the urban boundaries are extending, and it appears that the territory being annexed adds more undeveloped land, these cities are expanding cities. On the other hand, if the urban boundary is contracting or staying the same size due to being bounded by other cities, these cities are defined as fixed cities (Bowman & Pagano, 2004). This research's study area, Fort Worth, Texas, is an expanding city.

2.1.2 Shrinking City vs. Growing City

When we define a city as a shrinking or growing city, the definition is based on population and economic change. The growing city is defined as the continuously increasing urban population and the overall population (Devas, 1993). A shrinking city is one in which the urban population is decreasing continuously. Alternatively, one in which a "compactly populated urban area with a minimum population of 10,000 residents that has faced population losses for more than two years and is undergoing an economic transformation with some symptoms of structural crisis" (Hollander, Pallagst, Schwarz, & Popper, 2009, p. 224). According to this definition, Fort Worth, Texas, the study area of this research is a growing city.

2.1.3 Inelastic vs. Elastic City

If a city can expand its boundaries and it can capture the population and tax base growth on its boundary, the city is considered an elastic city. David Rusk (1993) found that central city elasticity generates a metropolitan healthiness. Based on his hypothesis that metropolitan areas to which central cities have been able to expand to experienced more promising social and economic results than those in which annexation is limited (Rusk, 1993). Following his hypothesis, the most economically prosperous cities have been elastic cities. Conversely, inelastic cities tend to be older, more complacent, and more racially segregated, as well as more impoverished (Rusk, 1993). Consistent with Rusk's theory, the CFW, the study area of this research, is an elastic city.

2.1.4 Urban Renewal, Redevelopment, Regeneration, Revitalization, and Rehabilitation

Urban renewal, redevelopment, regeneration, revitalization, and rehabilitation are fairly generic terms, but there are slightly different nuances, and they each have different objectives. Though many studies use these terms, it is hard to find a clear and exact definition for them. No specific literature deals with the differentiations among these terms. Therefore, this research summarizes these terms as:

2.1.4.1 Urban Renewal

Urban renewal occurred largely as a final stage in Hoover and Vernon's neighborhoods life-cycle model (Hoover & Vernon, 1959) in the 1950s and 1960s. The neighborhood life cycle involves five stages: development, transition, downgrading,

thinning out, and renewal (Schwirian, 1983). Every neighborhood and areas have a unique and not the same characteristics, thus this model did not apply a set pattern of stages through all areas passed. An urban renewal program was to remove blight as an economic problem (The Vacant Properties Research Network, 2015), encourage the movement of suburbanites back to the city (Schwirian, 1983). From the 1960s, it became commonplace for local governments to charter special redevelopment authorities (RDAs). Establishment of the urban renewal program areas or districts required formal findings of blight and adoption of redevelopment plans. The RDAs led to the acquisition of private property for primary economic development projects (within cities and beyond) by using their eminent domain powers as authorized by state laws and local policies (The Vacant Properties Research Network, 2015, p. 27). Urban renewal, which was supposed to improve the lives of the poor, have lavished considerable investments in public facilities. However, it neglected the quality and the distribution of social services and had the overall impact of displacing poor residents (Webber, 1968).

2.1.4.2 Urban Redevelopment

After the urban renewal programs, by the late 1970s and continuing into 1980s, a new critical approach, urban development, had been created. Urban redevelopment can be defined as "the process by which large areas of derelict and industrial land and rundown housing areas are restored to become thriving communities once more" (Crager, 2012, p. 2; Science Dictionary, 2012). Thirty years ago, the urban redevelopment term generally meant bulldozing large areas of neglected inner city areas

to construct new industrial and residential areas. (BBC, 2014). In the planning process, urban redeployment can increase the quality of the living area and reestablish the sense of place by involving the community and surrounding neighborhoods. For example, using vacant or abandoned buildings and properties for a different purpose than was originally intended instead of removing the built environment (BE). This concept can also include the process of a change in land use, where the planned land use is changed to benefit the human population. Most large northeastern cities in the United States flourished from industrial and manufacturing trades, and by employing urban redevelopment for existing historic structures; they are brought back to the community and more affordable housing opportunities are created (Crager, 2012).

2.1.4.3 Urban Regeneration

Urban regeneration in this research is based on the Roberts and Sykes (2000) definition and the concept. It leads to the resolution of urban problems – especially the area where has been experienced the decline with VAP - along with a comprehensive and integrated vision. Moreover, it brings about a long-term improvement in the economic, physical, social, and environmental conditions (Roberts & Sykes, 2000). This definition contains the Lichfield's definition as well. Lichfield's (1992) has been identified the urban regeneration as the concept of a better understanding of the processes of decline (Lichfield, 1992). This definition includes the short-term, fragmented, ad hoc, and project-based without an overall strategic framework for city-wide development concept from Hausner (Roberts & Sykes, 2000; Hausner, 1993). The

definition of urban regeneration follows urban renewal's purpose that aspirations and achievements are a process of essentially physical change and the general mission of urban redevelopment. Also, urban regeneration moves toward urban revitalization and suggests the need for action and specifies a detailed method of approach. Urban regeneration points toward cities and urban areas that should be constructed with a long-term, more strategic, purpose in mind to address the problems the cities face (Roberts & Sykes, 2000). Another definition of urban regeneration by Investment Property Forum (IPF) is that cities evolved over time and are currently influenced strongly by concepts of sustainability, increasing property values, promoting entrepreneurialism as well as attracting private investment (Colantonio & Dixon, 2009; Investment Property Forum (IPF), 2009). Urban regeneration is a rebirth that is done when the purpose is to add more functions or totally change the function of space.

2.1.4.4 Urban Revitalization

The urban revitalization policy in the United States is composed of intricate interactions among the institutions, performers, and resources of both the public and private sectors. For the most part, urban revitalization strategies are place-based and have focused historically on make-overs of the BE while other urban revitalization policies have emphasized people-based strategies or human renewal (Colantonio & Dixon, 2009). Some have taken revitalization as a rebuttal of traditional urban growth theory, which predicts the decline of inner city areas as the high-income level classes move to the metropolitan fringe. Essentially, the traditional model states that rich people

can choose their housing from the entire city housing market. For a range of reasons many inner city areas are becoming more attractive (Schwirian, 1983). Urban revitalization can essentially contain two different processes: gentrification (movement of middle-class residents into old, lower-income inner city areas) and incumbent upgrading. In gentrification, white, young, middle-class professionals substantially rehabilitate declining but fundamentally sound housing. The architectural appeal of old housing greatly affects the extent to which an older area is gentrified (Laska, Seaman, & McSeveney, 1982). Incumbent upgrading involves reinvestment in moderate-income neighborhoods by their long-time residents. There are several characteristics of neighborhoods where upgrading is likely to be widespread: a strong neighborhood organization, a high percentage of homeowners, a strong sense of identification with the area, and housing stock that is basically sound though in decline (Schwirian, 1983).

Along with these urban revitalization definitions, this research is defined the urban revitalization as the parcels land use changed from vacant to non-vacant for an improvement to quality of neighborhood/community based on the place and people based strategies.

2.1.4.5 Urban Rehabilitation

The definition of urban rehabilitation is indeed a process of refreshing, of reviving the town, to be conducted over the medium or long term. It acts simultaneously on urban space as a territory and its residents. The concept of urban rehabilitation has changed considerably since the mid-1960s, to respond to our contemporaries' evolving

problems and concerns in the field of urban development. The progressive enrichment of the urban rehabilitation concept by a succession of contrasting yet complementary approaches to the strictly heritage-minded approach underlines the fundamental change in the concept of urban rehabilitation from ‘heritage protection’ in historical centers to the completion of a bona fide ‘urban project’ based on a multidisciplinary approach, integrating all urban policies. The goal of urban rehabilitation is to improve the quality of the urban territory, with special emphasis on areas which are run-down or becoming so. Particularly, in a territorial sense, integrated conservation of the cultural heritage intrinsic in the urban districts addresses the right to housing for the whole urban population, territorial cohesion or a balance between different parts of town or between town and country, and sustainable development of the city through the cautious ecological management of the environment. Also, urban rehabilitation seeks fulfillment, greater well-being, and a higher quality of life for the whole population whether living, working, or at leisure in the town. The human commitments are local development activating the economic potential of urban districts, social cohesion or balance between the different social groups, and respect for cultural diversity as the foundation of a common local identity. Thus, urban rehabilitation comes under an overall urban design and urban development plan, requiring an integrated, cross-sectoral approach to all urban policies (Roth, 2004, pp. 73-74).

A related strategy is the rehabilitation of individual abandoned properties, be they old vacant buildings, tax-delinquent homes, empty monuments, or other potentially useful properties. New Jersey, for example, passed a new rehabilitation code to facilitate

the restoration of older buildings. Such measures have led to a substantial increase in rehab investment in New Jersey cities and have been adopted by Maryland, Rhode Island, and other states (Bronin, 2006; Ewing, 2002). Other states have reformed tax foreclosure laws and initiated improved inventory and tracking systems to identify more quickly negligent owners of abandoned properties and transfer the property to new investors (Ewing, 2002).

In sum, these five concepts are commonly have a same purpose that is to improve and revival the declined community, neighborhood, and downtown areas through them. Even though they have an equal purpose, depends on the strategies established era and other conditions, the subject and concentrated aims are little bit different. Urban renewal is the oldest strategy, it remove blight as an economic problem and encourage the movement of suburbanites back to the city. Urban redevelopment is to increase the quality of the living area and reestablish the sense of place. Urban regeneration follows urban renewal's purpose that aspirations and achievements are a process of essentially physical change and add more functions or totally change the function of space. Urban revitalization emphasized people-based strategies or human renewal. Urban rehabilitation is based on a multidisciplinary approach, integrating all urban policies. Urban renew is based on the economic improvement, urban redevelopment is for the physical enhancement, urban regeneration is focus on the function of area. Urban revitalization concentrated on the human's well-being and urban rehabilitation is for the whole treatment.

2.2 The Definition of Vacant Land

The definition of VAP is a broad and ambiguous concept. In other words, there is a lack of a formal or standardized definition of VAP even though the term has connotations of many different aspects and concerns. In general, VAP commonly denotes many types of unutilized or under-utilized parcels (see Table 1). As a way to define VAP, Niedercorn and Hearle (1964), Northam (1971), and Pagano and Bowman (2000) described representative definitions, and many other researchers used them in their studies. Niedercorn and Hearle (1964) endeavored to measure the amounts of VAP and abandoned structures in U.S. cities in the early 1960s. In 1971, Northam classified vacant urban land into five types (Northam, 1971). According to Northam's definition, VAP is a small and irregular shaped parcel with a steep slope. Also, VAP can include physical limitations, corporate, or institutional reserve. In 2000, Pagano and Bowman defined VAP as all land unused or abandoned for a long period, including raw dirt, spontaneous vegetation, and emergent ecologies, land with recently razed buildings, perimeter agricultural land fallen out of cultivation, brownfields and other contaminated sites, or land that supports long-term, abandoned, derelict structures (Pagano & Bowman, 2000).

In 2004, Bowman and Pagano defined VAP broadly, as covering diverse types of non-utilized or underutilized land. They included "not only publicly-owned and privately-owned, unused or abandoned land, or land that once had structures on it, but also land that supports structures that have been abandoned, derelict, boarded up, partially destroyed, or razed (Bowman & Pagano, 2004, p. 196)." Nemeth and Langhorst (2013) expanded on

Pagano and Bowman's definition of VAP by adding that if no structure exists and humans do not currently use the property, one can consider the land vacant.

Table 1 Definitions of Vacant Land

Author(s)	Year	Definitions
Niedercorn & Hearle	1964	▪ Undeveloped and not underwater land use
Northam	1971	▪ Residue parcels, parcels with physical limitations, corporate reserve parcels, parcels held for speculation, institutional reserve parcels
Accordino & Johnson	2000	▪ A building or lot that has been vacant for two years or more
ICMA	2000	▪ No one resides at this site ▪ It would be very difficult for anyone to occupy this site without substantial repairs ▪ Only commercial and residential properties, not industrial properties ▪ Undeveloped open space or land zoned for recreational uses, agriculture, or environmentally sensitive habitats excluded from VAP
Pagano & Bowman	2000	▪ Unutilized or underutilized parcels that include brownfields, empty lots, land recently cleared of structures, somewhat paradoxically land that cannot be built on for some reason and greenfields
	2004	▪ Diverse types of non-utilized or underutilized land ▪ Includes publicly-owned, privately-owned, unused, or abandoned land or land that once had structures on it ▪ Land that supports structures that have been abandoned, derelict, boarded up, partially destroyed, or razed
Davidson & Dolnick	2004	▪ Lands or structures that are not dynamically used for any purpose - the California Planning Roundtable ▪ A lot or parcel of land on which no improvements have been constructed –Leesburg, Virginia
Bielsa et al.	2005	▪ Transformation from mixed crops and pastures to a few monocultural crops; policy aided set-aside; managed afforestation; partial abandonment of some parcels; total abandonment of agriculture and a successive conversion of an area into uncultivated land
City of New York	2010	▪ On which no lawful structure exists and which is not otherwise being used for any purpose for which it may lawfully be used
Németh & Langhorst	2013	▪ Underutilized parcels or lots that operate below their functional or capital-producing capacity ▪ When no structure exists, one can consider land vacant if humans do not currently use the property ▪ When a structure sits on the property, some contend that structure is abandoned, and its lot considered vacant when it has been unoccupied for 60 days; others use 120 days or longer
Daniel et al.	2013	▪ The portion of urban area without buildings, improvements, and public uses (road networks, recreation centers, and institutions)

On the other hand, if a structure sits on the property, some contend that structure is abandoned, and its lot considered vacant if it has been unoccupied for 60 days; others use 120 days or longer;, and VAP can be zoned residential, commercial, industrial, or some combinations thereof. However, this definition did not include underutilized parcels or lots in which operational function is below the functional or capital-producing capacity, compared with adjacent land uses (Németh & Langhorst, 2013). Furthermore, many definitions share similar characteristics, and most of the definitions consider VAP as neglected space. In this regard, the definition of VAP is still varied and unclear for researchers or government officials to promote accurate and realistic studies on VAP.

Based on these definitions, this research assumes the meaning of VAP as unused by humans or failing to be maintained and protected by humans. It means that the property cannot operate at its original given function and purpose, whether the land is developable or not, regardless of its ownership, which also includes abandoned buildings and unused structures. This research extracted key features and elements that can affect producing VAP. First, vacant lots reflect the former land use and type of industry (Niedercorn & Hearle, 1964; Schilling, 2002; Sperandelli, Dupas, & Pons, 2013) Second, there are two fundamental distinctions of VAP: ownership and developability. Ownership of the land describes whether it is publicly or privately held, which has an impact on management and consequences of VAP transformation. Third is whether the land is developable or not, regardless of ownership. The definitions also include several diverse characteristics: physical features (Northam, 1971); the presence (or absence) of legal or financial problems (City of New York, 2010); the local real estate market

(Pearsall, Lucas, & Lenhardt, 2014); and the land use plan of the city or county government (Bielsa, Pons, & Bunce, 2005). Overall, how small a size it is, how it is shaped, what the zoning or land use is, where the vacant land is located, who the owner is, what the previous land use was, and what industry the VAP was in would determine the conversion of VAP.

2.3 Classifications of Vacant Land

Vacant and abandoned properties (VAP) can be classified into many different types (see Table 2), such as dead space (Coleman, 1982), or temporary, obsolete, abandoned, or derelict sites (TOADs) (Greenberg, Popper, & West, 1990), derelict zones (Kiwell, 1993), underutilized areas (Pagano & Bowman, 2000), drosscapes (Berger, 2006), urban wastelands (Urban Wastelands Conference, 2007), and zombie property (Silverman, Yin, & Patterson, 2012). All of these describe space that is non-productive (Newman & Kim, 2013) or is contaminated; they once had structure and then were abandoned.

Dead space is disturbed space that includes exposed neglected land, wasteland, abandoned buildings, with various temporary uses such as materials dumps and existent or supposed construction sites (Coleman, 1982, p. 103). TOADs are deserted areas after the development of industrial sites and housing projects; they are the very last subjects in the land use cycle. Treatment or reclamation is needed to reuse these lands since some of them are never productively operated or structures on these lands are not occupied at all. TOADs include abandoned warehouses and plant facilities, homes, landfills, and tracts

of overgrown undeveloped land (Greenberg, Popper, & West, 1990, p. 435). The derelict land is described as a land so damaged by industrial or other development that it is incapable of beneficial use without treatment (Kiwell, 1993, pp. 150-151). Underutilized areas include outskirts agricultural or uncultivated land, recently razed land, derelict land, land with abandoned buildings and structures, brownfields, and greenfields (Pagano & Bowman, 2000, p. 1). Drosscape, a term used as a combination of dross (waste) and scaped (resurfaced and/or reprogrammed for adaptive reuse), is a sort of scavenging of the regional urbanized surface for interstitial landscape remains. Two different areas produce drosscape; one is the deindustrialization of older city areas in the city core, and the other is the rapid urbanization of newer city areas in the periphery (Berger, 2006, p. 1). Urban wastelands are defined as territories in transition, and these areas exist everywhere, such as urban landfills, post-industrial terrains, leftover zones in cities, peripheries, harbors, and dismantled military installations (Urban Wastelands Conference, 2007). According to Mathey and Rink (2010), a city has approximately 5 to 7 percent wasteland that has a high potential for the development of green space (Mathey & Rink, 2010). A zombie property is a new type of VAP, and this kind of vacancy is distinct from other types. They are produced in shrinking cities where demographic and economic decline makes abandonment an enduring fixture of the urban milieu as a particular type of abandoned structure. These structures no longer have a reason for existing in the new urban space, but they carry on as lifeless shells. Many zombie properties are boarded up, contain health hazards such as asbestos and lead, and

have extensive structural damage. For rightsizing[4] (downsizing) to take place, there is a need to remove zombie properties from the urban landscape. (Silverman, Yin, & Patterson, 2012).

Table 2 Types of Vacant Land

Types	Year	Characteristics
Dead Space	1982	▪ Bare derelict land, roughly vegetated wasteland, abandoned buildings, and various temporary uses such as materials dumps and real or supposed construction sites
TOADs (Temporarily Obsolete Abandoned Derelict sites)	1990	▪ Deserted after development of industrial sites and housing projects ▪ Scattered, random, unused parcels of land of varying sizes and shapes ▪ Some have abandoned structures; others only empty lots ▪ No longer used productively, or they never were ▪ Abandoned warehouses, plant facilities, homes, landfills, and tracts of overgrown undeveloped land ▪ Very last subject in the land use cycle ▪ Some of them need treatment or reclamation for reuse
Derelict Land	1993	▪ So damaged by industrial or other development that it is incapable of beneficial use without treatment
Underutilized Areas	2000	▪ Perimeter agricultural or uncultivated land ▪ Recently razed land; derelict land ▪ Land with abandoned buildings and structures
Drosscape	2006	▪ The deindustrialization of older city areas in the city core ▪ The rapid urbanization of newer city areas in the periphery
Urban Wasteland	2007	▪ Territory of transition - urban landfills, post-industrial terrains, left over zones in cities, and peripheries, harbors, dismantled military installations ▪ Social and environmental abuse ▪ An enigmatic ‘emptiness’ and appear to be in a waiting mode, ultimately ▪ The city has approximately 5 to 7 percent wasteland that has a high potential for the development of green space.
Zombie Property	2012	▪ A particular type of abandoned structure ▪ Found in shrinking cities where demographic and economic decline makes abandonment an enduring fixture of the urban milieu ▪ Boarded up, contain health hazards such as asbestos and lead, and have extensive structural damage ▪ Need to remove zombie properties from the urban landscape ▪ An indicator of a city in sustained decline

[4] Rightsizing is the same as downsizing; the meaning is something smaller, something better (Oswalt & Rienitz, 2006). Rightsizing a place would allow for enhanced green infrastructure, a systematic strategy of greening shrinking place would provide ecological and public health benefits to remaining residents (Schilling & Logan, 2008).

Many prior studies involve the reuse and reclamation of many ambiguous terrain types such as landfills, abandoned industrial manufacturing structures, and sites, infrastructural corridors, and abandoned or VAP. As a result, the federal government developed new policies and funding systems to promote reclamation and reuse of a broad range of contaminated and abandoned urban sites.

2.4 Causes and Effects of Vacant Land Abuse

The analysis of the causes of VAP and the establishment of programs to preserve viable buildings are apparent goals of many municipalities. The minimization of the period between abandonment and reuse is necessary to protect the resident population from any harmful effects. Also, VAP do not generate tax revenue, due to the tax revenue is an important issue. (Only VAP do not generate tax revenue. Land may be vacant and still generate taxes.) (Zhang, 2012; Greenberg, Popper, & West, 1990). Thus, converting them to non-vacant status is a revenue issue as much as a public safety issue.

Numerous previous research pointed out that depopulation is a most crucial and fundamental cause of land vacancy. There are three major causes of depopulation: 1) deindustrialization or fluctuating economic conditions (Hollander, Pallagst, Schwarz, & Popper, 2009) suburbanization that indicates a sprawling pattern of low-density commercial and residential settlement (Zipperer & Pickett, 2012), and 3) the natural economic sequence of boom and bust as a characteristic of many of cities (Frey & Alden Speare, 1992; Hollander, 2010). The results of these occurrences, as VAP, can represent

an opportunity to reflect on the pattern of land use changes (Beauregard, 2009; Hollander & Nemeth, 2011).

To make a sustainable and efficient re-urbanization, it is necessary to focus on the revitalization or reuse of VAP that has a high developable potential but not been managed very well by governments and developers. Depopulated cities lead to critical concerns about low property values and lower quality of life, such as decreased educational opportunities and fewer local services. VAP are one of the most obvious indicators of depopulation in cities since these lands reduce property values, discourage investment, produce a low quality of life, and promote further abandonment. The National Vacant Properties Campaign has associated VAP to a variety of economic and social ills including property crimes, drug trading, arson, declining property values and others (Silverman, Yin, & Patterson, 2012).

Another reason for producing VAP is the traditional development approach. Many American planning strategies focused on growth control in the 1950s and 1960s. By the 1970s and 1980s, growth management was the focus, and by the 1990s and 2000s, it was smart growth (Popper & Popper, 2010). The purpose of city planning was historically only focused on new-growth or new-development, actually increasing the amount of VAP and abandoned properties, without consideration of reuse or redevelopment. Also, the government supported the construction of highways that made access easy to the suburbs. The interstate highway program released large quantities of low-cost and slightly taxed land on the urban fringe for industrial and residential

developments (Accordino & Johnson, 2000). Traditionally, redlining[5] by insurance companies and banking sectors supported development in certain areas over others, and many federal policies including Community Development Block Grants (CDBG) focused on new infrastructure and new development rather than rehabilitation or infill development (Jackson, 1985). These redlining practices and the resulting poor condition of housing and redevelopment projects created unpleasant areas such as ghettos and transitional zones. Often race was a factor in the appearance of VAP because the lenders or insurance company deny to African-American and Latino, and minorities' loan application (Németh & Langhorst, 2014). Likewise, due to the redlining, many homeowners could not afford their mortgages in these areas. Moreover, some tax policies fostered speculation and property holding by investors and developers and others promoted abandonment as an alternative to underperformance.

Another reason for creating VAP is the broken window phenomenon which is a critical sign of the breakdown of the physical, social, and economic conditions of a neighborhood (The Vacant Properties Research Network, 2015). The broken window theory states that if a window in a structure is broken and is left unrepaired, all the remaining windows will soon be broken (Wilson & Kelling, 1989). Likewise, this theory can represent the spreading of vacancy and can be described as urban blight or urban decay that is the process of disrepair and decline of a functioning city. These vacant

[5] The term redlining derives from the stated practice by mortgage lenders and property insurers of drawing boundary lines around neighborhoods where services are to be restricted or withdrawn (Grigsby, Baratz, & lennan, 1983), include discrimination as for African-American and Latino loan applicants, discrimination as for neighborhoods of color.

buildings offer a place for criminals and illegal activity resulting in a loss of safety in the area and signal that neighborhood has deteriorated, that no one cares, and no one is in charge. Eventually, many residents leave while those who remain become accustomed to blight as the neighborhood norm (Schilling, 2002; The Vacant Properties Research Network, 2015). VAP allowed to stay in such a condition is a signal to the community that no one cares. Disorder and crime are inextricably connected with the physical environment at the community level (Schilling, 2002). Related to this broken window theory, this research explores and establishes relationships between the degrees of clustering and dispersed vacant properties and social problems and neighborhood characteristics.

Despite these negative impacts, these properties can also be potential resources to rebuild cities. VAP offers an opportunity to invest in attractive streetscapes and public enhancements, and many commercial and housing markets responded positively to this opportunity (Bowman & Pagano, 2004). Portland's Metropolitan Greenspaces program proposed to change the real estate produced labels of VAP or undeveloped land to green spaces or greenbelts through biologically defined descriptions (McClintock, Cooper, & Khandeshi, 2013). Hollander (2009) and his colleagues considered whether or not cities that are consistently losing population can sustain a high quality of life. Through the case study of Pittsburgh, they found a possible answer. Even though Pittsburgh was one of the most well-known cities for some of the worst poverty, crime, unemployment, low income, housing abandonment, and depopulation statistics (Hollander, 2009), this city is now top-ranked in quality of life and affordability (US Environmental Protection

Agency, 2006; Pallagst, 2007). Through the preservation of historic buildings, the diversification of the economy, mixed land use, pedestrian-friendly redevelopment, and regionalism, Pittsburgh achieved a high quality of life and slowed the population decline (Blanco et al., 2009). Along with the problems and opportunities, new strategies for the reduction of harmful impacts of vacancy and creative reuse of VAP and abandoned structures are needed in cities across the nation.

Through the previous studies, various causes and effects of VAP were analyzed (see Table 3). Most of the findings demonstrated negative impacts such as low property values, low income, a negative reflection of the image of the city, race (minority) segregation, low educational attainment, low population density, declining jobs, low vitality of commercial areas and lower quality of public safety and health, high crime rates, arson, drug use, and a high poverty level. In addition, industry and land use/zoning have had a substantial harmful impact on generating VAP, especially, in the old industrial cities such as rustbelt cities. Single- and multi-family housing and retail properties are the most problematic types of VAP for most cities. Furthermore, home ownership and landowner occupancy also have negative relationships with abandoned structures and VAP, while highway construction and physical features such as the size of the land, location, and political boundaries were associated with producing VAP. Moreover, disinvestment, suburbanization, annexation, access to capital, population migration, the housing crisis, the cities' land use policies and transportation causes increased VAP. As geographical conditions, the parcels which are not large enough,

located in the wrong place, the duration of the vacancy is too long, and over or under supply create more VAP (Newman, Bowman, Lee, & Kim, 2016).

Table 3 Findings of Prior Studies

Author(s)	Year	Study Area	Findings
Isakson	1997	Denver, CO	▪ Sales of large parcels of VAP are examined for grantor and grantee influences after controlling for other factors that affect land prices ▪ Other factors: size, location, date of transaction, zoning
Bowman & Pagano	2000	1990 population of 100,000 or more in the US	▪ VAP most often is linked with cities that have expanded their political boundaries ▪ The number of abandoned structures is related to a city's change in population
Accordino & Johnson	2000	200 most populous central cities in the US	▪ Negative housing, neighborhood vitality, crime prevention efforts, and commercial district vitality, overall quality of life, assessed property values, fire prevention efforts ▪ Single- and multi-family housing, merchandising properties, and VAP are the most challenging types of VAP for most cities
Schilling	2002	Portland, OR	▪ Primarily vacant single-family dwellings and duplexes in the city's older, inner-ring neighborhood
		San Diego, CA	▪ The savings and loan bailout exacerbated problems with vacant properties ▪ Especially in the city's low-income communities
		Richmond, VA	▪ A combination of high crime during the mid-1990s in consort with a deteriorating housing stock of older homes and historic buildings
Friedman	2003	Baltimore, MD	▪ A high number and widespread vacant structures and former industrial sites ▪ Tarnishes neighborhood images

Table 3 Continued`

Author(s)	Year	Study Area	Findings
			▪ resulting from the loss of residents and businesses, mainly manufacturing jobs ▪ Widespread blight depresses property values ▪ Encourages crime and grime
Carter & Polevychok	2003	Chicago, IL	▪ Inner-city residents concerned about crime and violence, diminished personal hope, public education, drug consumption, and low-income ▪ White resistance to black migration
		Washington, DC	▪ Almost ¼ of households received public assistance
		Baltimore, MD	▪ Decline in the manufacturing base and the loss of middle-income households ▪ Racial, geographic segregation ▪ Problems of crime, sanitation, drugs
		Milwaukee, WI	▪ Non-Hispanic whites, moved out of these neighborhoods, causing poverty rates to increase
		Houston, TX & Seattle, WA	▪ After highway construction: increase in crime and poverty rates ▪ Suffered from very low homeownership rates and housing values
		Atlanta, GA	▪ Job decline, static population growth, and low to moderate household incomes, majority non-white
Bowman & Pagano	2004	U.S. cities with population greater than 50,000	▪ Affects the image of a city ▪ Public support for privately developed projects ▪ VAP can offer a buffer between different social groups and income classes ▪ Through the control over the supply and quality, of VAP available for development, municipalities play a critical role in shaping the location, quality, and nature of development projects ▪ VAP should be viewed as an asset
Mallach	2004	N/A	▪ Decreasing property values ▪ Increasing public safety concerns ▪ Threatening public health ▪ Challenging municipal finances

Table 3 Continued

Author(s)	Year	Study Area	Findings
Berger	2006	N/A	▪ The rapid urbanization of the NEWER city = the periphery ▪ The deindustrialization of the OLDER city = the city core
Hollander et al.	2009	N/A	▪ Landscape beautification approach: property value is increased ▪ Prevention of illegal dumping of construction materials, tires, and other debris ▪ VAP provides opportunities for grassroots economic development, local tourism and enhanced quality of life for residents of depopulated areas ▪ Innovative temporary use projects abound
Hollander	2010	Flint, MI	▪ The inability of the city or the neighborhood association to effectively reuse or demolish abandoned buildings makes them susceptible to higher levels of criminal activity ▪ The lack of strong community organizing and low levels of homeownership may have played a role in a different outcome
Park & Ciorici	2013	Philadelphia, PA	▪ Community gardens are achievement popularity as a substitute use for vacant lots in communities that struggle to address the adverse effects of property abandonment ▪ Poverty level, educational attainment, zoning, and owner occupancy level mainly determine the conversion ▪ Ownership and topography have substantial impacts on the conversion
Garvin et al.	2013		▪ A significant net increase in residents' perceptions of safety around greened vacant lots compared with non-greened vacant lots
Kremera et al.	2013	New York City, NY	▪ Numerous vacant lots in New York City are used as community gardens, residential yards, parks, parking areas and sports fields

Table 3 Continued

Author(s)	Year	Study Area	Findings
			▪ Neighborhood income and properties vegetation are significantly related to most of the ways that VAP are used in practice ▪ In particular, lots that are unemployed (33%) tend to be placed in neighborhoods with comparatively high population density and low median household income levels
Newman et al.	2016	79 US cities	▪ Causes of increased vacant land: disinvestment, suburbanization, annexation, access to capital, deindustrialization, population migration, housing crisis, contamination, land use policies, transportation problems ▪ Causes of decreased vacant land: strong economy growth, reuse policy, population in-migration, private development, real estate tax policies

2.5 Vacant Land in American Cities

In the United States, between 1820 and 1930, only a small number of US cities lost population – large cities such as Detroit, MI, Buffalo, NY and Philadelphia, PA, and smaller cities such as Flint, MI, Gary, IN, and Youngstown, OH. After several periods, since the 1960s, trends in the distribution of VAP have significantly changed over time (Hollander, Pallagst, Schwarz, & Popper, 2009). After World War II, populations shifted to the inside of urban areas to look for employment opportunities; consequently, VAP was generated outside urban areas. In the 1970's, an economic recession caused people to lose their jobs and leave the urban core, increasing the VAP share in the urban core. In the 1980s, construction of highways and the expansion of the suburban infrastructure gave rise to a higher population in suburban areas. In the 1990s, many cities created

VAP intentionally by razing dilapidated structures while continuously building new housing stock toward suburban and exurban environs, expanding urban areas across the whole United States (Metzger, 2000; Wilson, 2009; Zhang, 2012). To address this issue, the governmental policy has underscored strategic planning for urban renewal to prevent planners and developers from avoiding constructing infill projects. Reflecting this political phenomenon, distributions of VAP shifted from inner urban to suburban. Nevertheless, it is now again moving back toward inner urban. This reversal in trends (i.e., from suburban to inner urban) is significantly affected by the people who do not have the capability to repay their mortgage or want to decrease their scope of activity to reduce economic losses and to increase social interactions (Mallach, 2008).

Common U.S. planning reactions to shrinkage over the last half-century have dealt mostly with revitalizing troubled city centers. In addition, American urban planning regularly aims at either managing urban growth or concentrating on redevelopment instead of regional approaches that include the planning of growth (Popper & Popper, 2002; Blanco et al., 2009; Pallagst & Wiechmann, 2004). How to identify at what point a city actually begins the process of shrinkage and creating VAP has not been established. In general, growth trends in disinvestment and suburbanization play a pivotal role in increasing VAP whereas economic growth and in-migration bring about a decline in VAP (Bowman & Pagano, 2004).

Although some research identified a correlation between urban expansion and amounts of VAP despite population growth, there is a still lack of effective measuring methods aimed at determining what kind of factors affected by its conversion from non-

vacant to VAP in the future. For example, how can we convert functionless parcels into functioning areas to support sustainable and infill growth patterns? Even though strategic planning for urban VAP renewal can handle both shrinking and growing, the strategy for an expanding area is more critical since physical, and jurisdiction boundaries of a city are increasing.

2.5.1 Vacant Land in Expanding Cities vs. Shrinking Cities

There are two different concepts of cities, which have experienced an urban VAP issues during recent years: 1) expanding cities in which areas have been spatially annexed; and 2) shrinking cities that have experienced depopulation whether the city has been expanded or fixed, spatially. According to the boundary flexibility, city land area that is physically increasing or decreasing can describe expanding cities or fixed cities. Depopulation is one of the key components that lead to a shrinking city, and it has a high potential to change an expanding city into a shrinking one.

Expanding cities can be an imaginative way to explain the phenomenon of sprawl, even though this phenomenon does not include the significant and concrete concept of VAP. The features of sprawl include suburban growth, decentralization, inadequate accessibility, low density, and fragmented land use. Many U.S. cities expand outward across countless parcels through urbanization. According to a previous study, most cities in the 21st century will be dominated by urbanization – the rate of increase in urban populations is faster than that of the total population – and it will be kept on the move by expanding cities (Genske & Ruff, 2006). Many studies on the spatial impact of

annexation and population migration in expanding cities show that annexation plays a significant role in the outcome of VAP (Bowman & Pagano, 2004). The amount of VAP in expanding cities increases more rapidly than in non-expanding cities; especially where the boundary of the urban area is expanding, but the population is getting smaller (Newman, 2012).

In expanding cities, VAP is crucial for carrying out the vision of a city by providing a supply of potentially developable open space (Pagano & Bowman, 2000). Cities with the largest elasticity had vacant peripheral city land to develop and the political and legal tools to annex new land. Elastic cities, especially in the southern and western regions, tend to be much younger in their development cycle, and their sizes are fixed through growth boundaries, natural borders, or some political mechanism. On the contrary, inelastic cities are typically older and had been built out at higher densities during the industrial age. They are either unable or unwilling to expand their city boundaries through annexation or other political processes. The cities in the Northeast and Midwest are inelastic (Rusk, 1993). This trend has revealed that the amount of VAP; the elastic cities have a half times (23%) greater than the inelastic cities (8%), in 2000 (Pagano & Bowman, 2000). However, in 2010, the elastic cities' amount of VAP reduced (19%), and the inelastic cities' amount of VAP increased (11.7%) (Newman, Bowman, Lee, & Kim, 2016).

Shrinking cities also have been affected by suburban expansion – which happens when the population of a city shrinks, but not the size of the spatial boundary. The geographic area can stay the same or grow larger, but because of decline, the blighted

structures are removed and empty areas spread (Stoner, 2013). As a strategy for shrinking cities, smart decline is one of the best solutions for urban decline or shrinkage and ranges from the institutional to the physical, from the creation of a publicly owned land bank to managing abandoned properties of entire neighborhoods or cities (Hollander, 2011). Popper and Popper define a smart decline as ‘‘planning for less—fewer people, fewer buildings, fewer land uses” (Popper & Popper, 2002, p. 23). Smart decline means that after people leave, the city has to establish a plan for the remaining people through the assumptions of growth and its appropriate alternatives. Until now, the purpose of urban planning in the United States has been toward development or growth. As is frequently pointed out, smart decline strategies underscore the fact that qualitative changes could provide higher quality and efficient services to depopulated communities and cities compared to the traditionally planned quantitative changes only that do not improve the quality of life in communities. According to Hollander and Nemeth (2011), there are many benefits to a smart decline. The most important one is that rightsizing neighborhoods improve the green infrastructure, which that is a systematic strategy of greening a shrinking place to provide ecological and public health benefits to the remaining residents (Schilling & Logan, 2008). Rightsizing scales can strike a better balance between a city’s remaining population and its support for the shrinking city. Second, the systematic management of abandoned buildings and VAP offers guidance to provide a well-managed depopulation strategy. Shrinking cities approach their problems with an assumption about which places have a higher potential to lose population and

which areas show a possibility for ensuring a high quality of life and enhanced social values (Johnson & Hollander, 2012).

Comparing the smart decline theory and traditional redevelopment, traditional redevelopment seems to be more fitted for economic and physical improvement and supports literal growth. Moreover, the purpose of redevelopment seems to be to bring people back to an area. On the other hand, smart decline focuses on the entire aspect of a city –social, economic, environmental, and quality of life. The strategies for shrinking cities cannot be applied to expanding cities. For this reason, expanding cities also need an approach that considers the broken window concept and annexation issues. That is why this research focuses predominantly on performing an analysis of VAP in expanding cities rather than shrinking cities.

2.5.2 Amount of Vacant Land in American Cities

Abandoned properties are found in every city in the United States, even in the nation's fastest growing cities. Since the early 1960s, many researchers have tried to measure the amounts of VAP and abandoned structures in urban areas. Among them, analyses conducted by Neidercorn and Hearle in 1964, Northam in 1971, Bowman and Pagano in 2000 and 2004, and Newman and his colleagues in 2016 were the most representative studies (see Table 4). According to their main findings, on average, there was 20.7% vacant urban land in 48 American cities in the 1960's (Niedercorn & Hearle, 1964). At this time, the overall amount of VAP was declining in large cities since the population was moving toward cities to find jobs. In the 1970s, through a survey of 86 cities, Northam pointed out that, on average, there was 19.7% VAP within cities with a

population over 100,000 and 37.9% VAP within cities with a population less than 50,000 (Northam, 1971).

Table 4 Amounts of Vacant Land in U.S.

Author(s)	Year	No. Case City	Findings
Niedercorn & Hearle	1964	48	▪ On average, 20.7% VAP in urban areas ▪ The overall amount of VAP was rapidly declining in large cities ▪ Unless a significant amount of VAP exists within the city boundaries, the average large city seems to have nearly reached its upper limits of population and employment in commerce and manufacturing
Northam	1971	86	▪ On average, 24.5% of VAP was within cities with a population over 100,000 (1.5 million acres) ▪ 37.9% VAP was within cities with a population less than 50,000 ▪ Buildable VAP in 86 cities with populations over 100,000 amounts to over 1 million acres ▪ The amount of VAP has a reverse relationship with population
Bowman & Pagano	2000	70	▪ On average, cities contain15% VAP ▪ Sunbelt cities: experiencing high levels of growth in population and land area (high levels of VAP) ▪ Growing cities (southern cities): more VAP than declining cities (northeastern cities) ▪ A small proportion of cities with VAP have a high number of abandoned structures
	2004	48	▪ On average, there is 15.4% VAP within cities with a population over 100,000 ▪ Compared to the result of the 1960's study of 48 large cities, there was a decrease in VAP ▪ Cities with large amounts of VAP have small numbers of abandoned structures ▪ Cities with rapid population growth and boundary expansion have significant amounts of VAP ▪ The amounts of VAP is wide-ranging by region, but most of all vacant parcels were relatively small, odd shape, and were located in inconvenient places ▪ These conditions restricted the potential of VAP redevelopment
Newman et al.	2016	124	▪ Nationally, an average 16.7% of large US cities' land area is considered vacant ▪ Approximately 4% of city addresses unoccupied ▪ The ratio of VAP to city size has increased by 1.3 percentage points since 1998 ▪ Most vacant parcels are small, odd shaped, and disconnected, making them difficult to regenerate ▪ Disinvestment, suburbanization, and annexation are the primary causes of increases in VAP supply

These results indicate that the amount of VAP has a reverse relationship with population; as populations increased, the amount of VAP decreased. Another survey performed by Bowman and Pagano (2004) found that there was 15.4% VAP within 48 cities with a population over 100,000. That is, compared to the analysis of the results by Niedercorn and Hearle's 48 large cities in the 1960's (20.7%), the total amount of VAP decreased. In addition, they discovered that cities with a more amount of VAP had relatively small quantities of abandoned structures.

Based on the survey of Pagano and Bowman's (2000) results analyzed by census region, the highest proportional amount of VAP was in the south (19.3%). The proportions of VAP in western cities were similar to the survey average (14.8%). The number of cities that had a higher proportion of VAP than the survey average was 25. Among them, a total of 21 cities (84%) were located in the south or west, and the Midwestern cities (12.2%) had less VAP compared to the southern and western regions. In contrast, the northeastern cities had the lowest proportional amount of VAP (9.6%), which is less than the survey average. Nevertheless, they had the highest number of abandoned structures. It means that amount of VAP and number of abandoned structures indicate different results. The proportionately VAP in median western cities was less than in the other census regions. The amount of VAP was wide-ranging by region, but most vacant parcels were relatively small and odd-shaped as well as being located in inconvenient places. These conditions impeded the potential redevelopment of VAP.

Newman and his colleagues (2016) conducted the survey via 124 cities. They discovered that south has a highest VAP (23.5%), next is the Midwest (21.2%), west is

the third (12.2%), and north-east has a smallest VAP (9.3%). Compared the overall 124 cities VAP (16.7%), south and Midwest are contained much higher VAP.

Urbanization following the early period after World War II had a significant impact on the Rustbelt cities and the Midwestern regions that had built their prosperity on manufacturing and ports; these had lost approximately 60% of their population, collectively (Beauregard, 2009). Depopulation in these areas is associated with the migration of people and businesses to the Sunbelt (Napton & Loveland, 2004). Due to the amount of VAP, cities in the northeast and south have suffered more from a decline in the overall quality of life compared to other areas. In addition, northeastern, southern, and Midwestern cities have experienced significantly negative effects on city vitality, compared to western cities (Accordino & Johnson, 2000). Since the 1970's, many developing cities have gained population supported by improved financial and business services, tourism, healthcare, education, and immigration. Taking a closer look at population distribution, it was noted that many residents are moving from inner cities to suburbs where there is a greater likelihood of benefits from public safety, better quality schools, a healthier environment, better quality housing, and less congestion despite higher housing prices (Mallach, 2012; Carter & Polevychok, 2003). One in four cities with more than 100,000 residents had population losses before the 2007 American subprime mortgage crisis and the late 2008 international economic strike (Oswalt & Rieniets, 2007; Blanco et al., 2009). Because of these phenomena, central cities lost population, whereas suburbs continuously gained population. However, this is not typical of all cities; some showed opposite phenomena where the decline of the suburbs

was faster than the decline in central cities, especially in small-scale Northeastern and Midwestern cities. These suburban cities are the representatives of shrinking cities, having a population less than 10,000 per city (Lucy & Phillips, 2001).

2.6 Urban Vacant Land Reuse

Urban VAP reuse is a comprehensive and integrated vision, and its actions lead to the resolution of urban problems and seek to bring about a long-lasting enhancement in the economic, physical, social, and environmental circumstances of an area that has been subject to change (Roberts & Sykes, 1999). Reuse of VAP emerged throughout many kinds of infill projects incorporated into the smart growth theory. Most studies indicated that the cities could earn benefits through regeneration of the VAP. Over time, urban reuse evolved into a policy based less on demolition and more on restoration and investment, and today is a fundamental part of many local governments, often combining with small and large business incentives. Urban reuse is more than just upgrading the physical environment of an area to spark private investment (Rashid, Rosly, & Shamsuddin, 2013).

According to a vacant properties regeneration guidebook from Eppig and Brachman (2014), there are three options for regeneration strategies: renovation, adaptive reuse, and conversion land use. Renovation can be an effective strategy for regeneration and reuse, as long as the land use demand exists for the occupant. Many different circumstances can determine the range of property renovation, such as how it is to be used, whether there is an existing building or not, the condition of the structure, the

design guidelines, and codes of the location or development. Thus, the range of property renovation can be from notable change to widespread improvements. Adaptive reuse mostly applies to land that includes older structures. As a transformative process, adaptive reuse can be started with an understanding of the unique characteristics of the structure and property (Eppig & Brachman, 2014). This research is focused on land conversion. The following subsections described the land conversion.

2.6.1 Land Conversion

There have been numerous studies on parcel land conversion and city/urban community comprehensive plans for VAP conversion projects. It has been a pressing need for planners, researchers, and policymakers to understand how parcel conversion has subsequently affected vacant parcel redevelopment patterns. By understanding the factors that help to explain parcel conversion and its ability to encourage vacant parcel regeneration, planners, researchers, and policymakers can manage and refine how urban VAP functions (Wilson, 2009). For this reason, many researchers studied parcel data on land conversion related to sprawl, open space, sustainability, waterfront park development, the development of greenways used as bike or pedestrian paths along railroads or abandoned industrial sites, the creation of a city gateway, and livable residential areas (Kremer, Hamstead, & McPhearson, 2013). Nevertheless, the studies on the regeneration of VAP and parcel conversion are still not sufficient, especially the understanding of parcel conversion. The following subsections describe overall conversion parcel cases.

New development, through the conversion of VAP, mostly occurs along the periphery of the city near major transportation routes and far away from the city center (Pham, Yamaguchi, & Bui, 2011). This rapid development pattern around a city led to an increase in the size of the urban area and a large number of VAP in the inner city. Cities which include large amounts of VAP need to create strategies to encourage clever investment and reinvestment. In the past few years, planners and scholars have begun to address the gap between theory and practice by suggesting a smart decline solution in which the vital principle of the conversion of VAP, underused buildings, and are put to other uses (Tighe & Ganning, 2014). Mallach (2008) suggested that as strategies to increase neighborhood stability, the conversion of multifamily rental housing to cooperative or condominium ownership should be promoted (Mallach, 2008).

According to Irwin and Bockstael (2004), smart growth policies significantly influence land conversion – reuse already-development land, repair existing infrastructure, and engage the community (Smart Growth America, 2016). Residential land conversion influences the development and management of urban growth and preserves open space (Irwin & Bockstael, 2004). Gardiner and colleagues (2014) examined how the conversion of VAP to urban green spaces such as urban gardens and farms influenced the community. They found that the agricultural conversion of VAP could provide a significant impact on the sustainable production of food in cities. The conversion of a small proportion of VAP to urban gardens, and maintaining or enhancing the quality of these lands, can produce a high-quality urban landscape and improve the function of urban ecosystems (Gardiner, Prajzner, Burkman, Albro, &

Grewal, 2014). Also, Park and Ciorici (2013) identified the factors of vacant lot conversion into community gardens. According to their findings, poverty level, educational attainment, zoning, ownership and topography mainly affected the conversion (Park & Ciorici, 2013). Even though residents desire urban green space or parks, municipal governments endorse the conversion of vacant lots into tax-revenue generating development. To manage these challenging VAP, Pearsall and others provided a VAP redevelopment framework, using a Multi-Objective Land Allocation (MOLA). According to their results, vacant parcels that are highly suitable for two or more objectives can find the most appropriate reuse of each vacant parcel by employing a MOLA (Pearsall, Lucas, & Lenhardt, 2014).

Traditional planning strategies and regulatory tools such as industrial zone designations reduce conversion opportunities. Most old industrial cities have been facing eras of declining industrial jobs and enormous inventories of industrial land. Vacant industrial properties do not create revenue and reduce the potential for high-density development in urban areas. Lester et al. showed factors that can describe the conversion of industrial land to other uses and how various industrial maintenance policies are effective in limiting conversion. Industrial conversion is much more sensitive to neighboring residential real estate concerns; for example, the conversion of industrial land and residential gentrification have a strong connection (Lester, Kaza, & Kirk, 2013).

Many cities encourage VAP conversion for a variety of reasons: 1) to increase employment; 2) to encourage neighborhood or community development, and 3) to

promote city revenue collections. However, most cities promote VAP conversion for the benefit of the investor city – especially city-owned properties - with property taxing authority that has a financial incentive to reuse VAP parcels. The successful conversion of VAP increases the adjacent parcels' values, and the city receives more benefits. Therefore, the city encourages the conversion of VAP parcels (Bowman & Pagano, 2004). Planners and scholars need enhanced information about the conversion of vacant parcels and an assessment of the effectiveness of protection policies (see Table 5).

Table 5 Strategies Comparisons

	Strategies
Traditional Redevelopment	• More focused on only economic and physical improvement, and it supports toward literal growth • Bring back people into town and it is for large amount of people
Smart Growth Revitalization	• Reuse already-developed land: As opportunities, not problems • Repair existing infrastructure • Engage the community
Smart Decline	• Focus on the entire aspect of neighborhood – such as social, economic, environmental, and quality of life • For the remaining people and toward more beauty • Remaining people deserve a place to live better environmental condition and quality

2.6.2 Effective Urban Vacant Land and Abandoned Properties Reuse Cases

2.6.2.1 Youngstown, Ohio: 2010 Plan

Youngstown, Ohio, which has experienced a loss of half of its population since 1950, adopted a smart decline approach. The new master plan of Youngstown concentrated on improving the quality of life for remaining residents rather than endeavoring to grow the city (City of Youngstown, 2005; Hollander, Pallagst, Schwarz,

& Popper, 2009). In 1950, Youngstown was the 57th largest American city with a population of 170,000. Located roughly midway between Cleveland and Pittsburgh, the city's main industry is steel. After suburbanization, the steel mills began to close in 1977, leaving a population of only 82,000 in 2000. The city appeared to have significantly declining neighborhoods with vacant properties and abandoned buildings, high crime, and an elderly and seriously minority population, like many other shrinking cities (Hollander, Pallagst, Schwarz, & Popper, 2009). The Youngstown agreed to take the decline of the city scale based on the proposed plans aimed at depopulation and deurbanization while improving the quality of the remaining buildings, infrastructure, and their services (Blanco et al., 2009).

2.6.2.2 Baltimore, Maryland: Project 5000

The various approaches to the vacancy problem in Baltimore included: (1) demolition and rehabilitation, (2) brownfield initiatives, (3) historic preservation and smart growth tax incentives, and (4) infill development and adaptive reuse (Friedman, 2003). Among these approaches, historic preservation and smart growth tax incentives involved the essential concept of recycling land as a valuable resource. State and local tax incentive programs are supported both the rehabilitation of historic buildings, properties and the adaptive reuse of abandoned constructions in historic districts (Freece, 2003). In addition, Project 5000 in Baltimore included housing rehabilitation initiatives in Patterson Park, the revitalization of Belvedere Square and Façade, and infrastructure enhancements in neighborhoods throughout the city. The CDBG, Community Legacy

grants, and the Neighborhood Business Development Loan Program supported these smart growth projects with funds. In addition, when compared with other strategic approaches, the strategy of infill development and adaptive reuse is potentially an inclusive approach that could incorporate many of the anti-blight strategies. Baltimore has become famous for its revitalization of the Inner Harbor, a three-decade plan that carries on today with residential and commercial development along the waterfront in Canton, Fells Point, and Locust Point. Infill development for operating the abandoned shipping piers and adaptive reuse for converting old buildings such as unused power plants into office and retail space has employed Inner Harbor Revitalization (Kromer, 2002). Greatly successful redevelopment in Baltimore has revolved around the natural amenity of its harbor, and the Westside revitalization is a case of the preservation and incorporation of historic architecture in the renewal plan. The most considerable limitation to adaptive reuse of vacant properties is the lack of a committed source of funding and scarce general funds for redevelopment.

2.6.2.3 Chicago, Illinois: Comprehensive Strategy to Address Troubled and Vacant Buildings

The city of Chicago has recognized the impact of vacant buildings throughout the city and neighborhoods. The city has worked to prevent foreclosures and abandoned properties, ensure that owners maintain existing vacant properties and return vacant properties to be used as viable housing stock instead of watching them fall into disrepair (The United States Conference of Mayors, 2009).

To prevent foreclosure, the city provided financial counseling to more than 12,000 homeowners and reclaimed more than 550 vacant and abandoned buildings under the Homeownership Preservation Initiative (HOPI). To maintain existing vacant properties, the city created more stringent security standards, the city's Vacant Building Ordinance in 2008, harsher penalties for irresponsible building owners, and increased occasions for the city to inspect VAP and abandoned buildings. All VAP and abandoned buildings must be registered with the city and owners must pay a registration fee every six months. Also, the city has aggressively targeted enforcement against negligent owners and is currently pursuing over 2,100 buildings in demolition court and more than 1,800 in its Fast Track Demolition program. In 2008, the city demolished more than 200 vacant, abandoned buildings and secured another 200 to increase public safety. For productive reuse of vacant properties, the city set up two programs - Troubled Buildings Initiative (TBI) and Neighborhood Stabilization Program (NSP). Through the TBI, nearly 6,800 abandoned units repurposed as affordable housing. The purpose of this program is to maintain homes while they are under court-ordered receivership and assist private developers with financing to rehabilitate the properties for sale as affordable homes. The city will use its NSP funds to put up to 2,500 vacant and foreclosed properties into reuse over the next three to five years by facilitating the transfer of vacant properties owned by financial organizations to approved redevelopment partners. The strategy of the city is to facilitate targeted revitalization efforts by identifying blocks where it can have the largest impact and build upon recent investments and community anchors (The United States Conference of Mayors, 2009).

2.6.2.4 Louisville, Kentucky: Vacant Property Prevention and Re-Use Strategy

The latest and effective tools for dealing with property issues, including the Abandoned Urban Property Tax and the Louisville/Jefferson County Landbank Authority were put into place by the Metro government, which are remaining vacant or abandoned properties via acquiring. The Louisville/Jefferson County Landbank Authority, Inc., clears the title and works with a suitable buyer to deliver an affordable housing opportunity for someone in need, when a vacant structure is acquired, through tax foreclosures and donations. Owners of vacant properties can be tax delinquent or active, and unresolved code enforcement cases are required to pay much higher property taxes, generally three times the normal tax rate. Abandoned Urban Property Tax and the Metro government work aggressively with non-compliant property owners to correct property neglect. Community development block grants and HOME funds are prioritized to support the Vacant Properties Program, which, funds maintenance of challenging vacant properties, rehabilitation efforts, new construction, streetscaping, and other projects designed to eliminate vacant properties, consecutively. The Affordable Housing Trust Fund creates new housing and preserves existing housing units, and disciplines have participated in planning sessions and leaders from all areas. Neighborhood groups have formal processes in place to present their top problem properties to the Mayor's staff for review and action (The United States Conference of Mayors, 2008).

2.6.2.5 Dallas, Texas: Urban Landbank Demonstration Program

The purpose of the Urban Landbank Demonstration Program is to improve a substantial amount of affordable single-family homes, vacant, and tax-delinquent properties in Dallas neighborhoods. The objective of the program is to acquire unproductive vacant and developable lots in the inner city area which are banked for affordable housing development. They can provide housing for nearly 2,000 low and moderate income homeowners. This is accomplished through foreclosures on tax delinquent vacant properties. The program increases the communities' quality of life, reverses the trend toward underutilized neighborhood schools; addresses the shortage of affordable workforce housing; stimulates community investment and growth, creates jobs, provides retail and commercial services for neighborhood residents; reduces local government expenditures to maintain unproductive properties; and increases local government property taxes, sales taxes and fee revenues (The United States Conference of Mayors, 2008).

With the cooperation and assistance of the Dallas taxing entities, the first step of this program is to identify the target properties. After identifying the tax status, the properties may be foreclosed and sold to the Landbank, which sells the properties to developers for development and sale to home buyers. Until 2008, 1,391 properties were referred by the Landbank for tax lawsuit; 782 lawsuits have been registered; 231 parcels have been purchased; 43 properties have been sold, and 58 sales to the Community Housing Development Organizations for the development of affordable houses are pending. Twenty-two homes have been completed and sold to qualifying families. The

goal of the Landbank is to become self-sustaining after five years (The United States Conference of Mayors, 2008).

2.6.2.6 Summary

All of the cities in the above section have experienced an urban decline due to VAP. However, each city established its own strategies to solve the problems caused by VAP (see Table 6). In the case of Youngstown, Ohio, the city adopted smart decline strategies to improve the quality of life for the remaining residents. This city is a representative shrinking city, and a significant issue caused by VAP is depopulation. Thus, Youngstown concentrated on the enhancement of the remaining environments to prevent the loss of the remaining population. Baltimore is one of the deindustrialized shrinking cities that applied smart growth strategies through historical preservation, tax incentives, infill development and adaptive reuse. Nevertheless, the lack of financial sources limited the strategies. On the other hand, the approaches to VAP reuse in Chicago is more comprehensive. The city provided education and financial counseling and enhanced the security standards for the inspection of VAP. To handle VAP, the most important thing is prevention before it develops too far. For example, the strategies in Louisville is prevention and reuse. Through the tax foreclosures and donations, the city produced more affordable housing by reusing VAP. Even though Dallas is one of the growing Sunbelt cities similar to Fort Worth, Dallas also provided affordable housing through tax delinquent.

Table 6 Urban VAP Reuse Cases

City	Strategy	Approaches
Youngstown OH	2010 Plan Smart Decline	• Improving the quality of the remaining buildings, infrastructure, and their services for remaining people
Baltimore MD	Project 5000 Smart Growth	• Historic preservation • Smart growth tax incentives • Infill development • Adaptive reuse • Limitation to adaptive reuse of vacant properties is the lack of a committed source of funding and scarce general funds for redevelopment
Chicago IL	Comprehensive Strategy	• Provided financial counseling • Created more stringent security standards • Affordable housing
Louisville KY	Prevention & Re-Use Strategy	• VAP acquiring via tax foreclosures and donations • Affordable Housing
Dallas TX	Landbank Demonstration Program	• VAP acquiring via foreclosures on tax delinquent • Affordable Housing

2.7 Gaps in Previous Studies

This research found several significant gaps remaining in the previous studies.

First, the majority of prior studies use different definitions of VAP. Their concepts of VAP are similar in that they include unused and underutilized areas, whether or not the area was contaminated or not or whether the area had abandoned structures or not. However, most of them did not define the periods of vacancy or apply different periods of vacancy. For example, Accordino and Johnson (2000) defined vacancy as two years or more, whereas Németh & Langhorst (2013) defined vacancy as 60 days or more. Also, some researchers considered greenfields and brownfields as VAP together; others

separated them. Second, regarding research on the amount of VAP, a rough survey method was used. It is still difficult to collect a sufficient and a validated set of VAP data. Nor have they thoroughly considered abandoned and VAP status changes. Third, most of the case study areas are representative of shrinking cities or legacy[6] cities or old industrial cities that were once vibrant hubs for business and industry, education, culture, and city life, but face significant challenges due to decline, loss of population, and increasing poverty (The American Assembly, 2013). Fourth, several studies have inadequately analyzed the distribution of VAP patterns and locations regarding the distribution of VAP and its effect on the urban core. Only a few studies found that the rapid urbanization of the newer city has more land that is vacant in the periphery of the city. Moreover, previous studies have not examined VAP longitudinally or patterns of vacancy. Fifth, not many previous studies considered the distance from the CBD, vacant units duration, and spatial clustering patterns of VAP as an effective factor for conversion. From the survey in Pagano and Bowman's study (2000), cities reported the distance from the CBD as the main reason for creating vacancies. Sixth, many of the previous studies focused only on one single land use type, almost always a residential vacancy. Last, the majority of prior studies used a cross-sectional approach in order to estimate the characteristics of VAP at one specific point in time. This approach could only describe the static relationship between VAP and other features, which means that

[6] A legacy city is defined as a city that has suffered population loss, job loss, and increasing poverty. They were once industrial powerhouses and hubs of business, retail, and services scattered across New England, the Mid-Atlantic, and the Midwest. Since the mid-twentieth century, these cities face daunting economic, social, physical, and operational challenges (Mallach & Brachman, , 2013).

this approach misses the direction of causality among the studied variables. In other words, without considering the direction of causality, it is difficult to capture the unique characteristics of the conversion of VAP.

In sum, many types of research and studies focused on what makes VAP. From an urban regeneration aspect, research is needed on what makes NVL convert to VAP. These studies applied the most recent quasi-experimental approach to consider the increased amount of VAP. In other words, they observed the differentials in levels and trends of pre- and post- the amount of VAP. The most noticeable gap from prior studies is that most of them did not consider why and how the transformation of VAP conversion is made. Therefore, this research would estimate influential elements affecting the conversion of VAP by applying their quasi-experimental research design in order to determine the causal direction of VAP and conversion activity.

To address these gaps, this research conducts a two-part analysis: 1) descriptive spatial analysis and 2) using a discrete-time hazard model that aims to analyze the variables that have impacts on the conversion of VAP. It is expected that key findings of the transformation of VAP resulting from a research methodology that uses the proposed two-stage analysis could shed light on resolving questions about what elements effect the conversion of VAP.

3. RESEARCH DESIGN

The purpose of this research is to provide policymakers and researchers who are concerned about the VAP with solid directions for regeneration of this land to achieve a better consequences via conversion and contribute to the in-depth understanding of the effects of VAP conversion in expanding cities. To achieve these aims, this research establishes two research questions and several hypotheses that support the research questions.

3.1 Definition of Vacant Land in This Study

In the literature review section, this research already summarized many different definitions of VAP. Based on this summary and consideration of the study area, the definition of VAP follows the definition of VAP in the CFW and the NCTCOG (North Central Texas Council of Governments) data. The CFW separates VAP into three different categories – brownfields, vacant housing units, and vacant and agricultural. VAP is included under brownfields when it is vacant, underutilized, obsolete, or structurally deteriorated industrial or commercial property where improvements are hindered by real or perceived contamination. Under the vacant housing unit, the VAP includes houses, apartments, mobile homes or other units, occupied or vacant but intended for occupancy as separate living quarters. The category of Vacant and Agricultural is one residential unit per structure on a one or more acre lot with no city

water or sewer service or land with no existing buildings, except for those related to mining, crops, or grazing (City of Fort Worth, 2015).

Even though the CFW, Texas, mentioned VAP several times in different land uses, it is not enough to use for the analysis. Thus, the definition of VAP in this research is based on the NCTCOG land use code (see table on p.59). That is, if a property's land use was NVL (i.e. residential, commercial, and industrial) of any type in 1990 but changed to VAP of any type in the following year and remained vacant until the end of the study period (2010), this non-vacant property was deemed to be vacant or abandoned.

3.2 Research Question

Vacant and abandoned properties (VAP) is a ubiquitous occurrence, but its amount, spatial distribution, and characteristics change based on multiple elements. Although some researchers have studied VAP in American cities, a few studies have taken to measuring amounts of VAP based on a broad and rough survey method. However, there is still a lack of studies that aim to verify statistically the critical factors affecting the re-activation of VAP in a holistic manner. As well, there is the difficulty that is having a random probability distribution or pattern that may be analyzed statistically but may not be predicted precisely. To achieve this primary goal, this study involves two different methods: 1) longitudinal patterns of VAP using GIS spatial analysis, and 2) identification of the elements affecting the conversion of VAP using a discrete-time hazard model incorporated with the results of the descriptive spatial

analyses. The specific causal variables involved in the conversion of vacant spaces are examined in the two different research subjects – VAP distribution patterns and analysis of the effects of elements for the conversion of VAP.

The analytic strategy evaluates spatial characteristics and descriptive statistics of VAP patterns on a city scale, and the assessment of quantities and clustering of VAP. In addition, these evaluated results of descriptive analyses are applied to the discrete-time hazard model to evaluate the causality of variables that affect the conversion of these spaces based on the inventory above classification system. The following are key questions to fill out the gaps in existing knowledge and to achieve the final goal of this study.

- How have vacant and abandoned properties and non-vacant land patterns been distributed through time?
- What factors affect the conversion of NVL to vacant overall and for different land use types – residential, commercial, and industrial?

3.3 Research Hypotheses

To answer the research questions in a systematic and scientific way, this research includes the following hypotheses.

Hypothesis 1 (H1). *The urban core will have more vacant or abandoned properties compared to peripheral areas of the city in the year 2010 is larger than in the year 1990 and 2000 because of annexation*

Hypotheses 1 will be tested using GIS spatial analysis and existing plans and projects in the CFW, Texas and the policy that concerns the creation of conservation and reclamation districts. This research expects that the target areas where the CFW applied the conservation and reclamation policy, the re-development projects, show a decrease in the amount of VAP.

Hypothesis 2 (H2). *Significant clustering of vacant or abandoned properties will result in increased vacancies or abandonment of adjacent or nearby parcels.*

This hypothesis is based on the broken window theory, and it will be tested using spatial analysis. The expected results of this hypothesis are that overall concentrations of VAP will create larger proportions of future VAP than dispersed ones. As well, concentrations of VAP from residential, commercial, and industrial areas will create significant proportions of future VAP than dispersed ones.

Hypothesis 3 (H3). *Variables influencing conversion of VAP will vary by land use type.*

This hypothesis will be tested using discrete-time hazard analysis. The expected results of this hypothesis are that overall VAP will have a more significant relationship with socioeconomic status (SES)/built environment (BE) characteristics than will small parcel size and longer distance from the central business district (CBD). Also, VAP from residential areas will have a more significant relationship with SES/BE characteristics than small parcel size and a longer distance from the CBD. Indeed, VAP from commercial and industrial areas will have a more significant relationship with neighborhood SES/BE characteristics than will larger parcel size and a closer distance to

the CBD. Also, depending on the different land use type, the factors that influence the conversion of land use will be different.

Hypothesis 4 (H4). SES *variables will have a stronger influence on residential vacancies while BE variables will have a stronger influence on commercial and industrial vacancies.*

This hypothesis will be tested using a discrete-time hazard analysis. The expected results of this hypothesis are that vacant/abandoned properties from residential areas will have a most significant relationship with household race, median household income, and ownership. On the other hand, VAP from commercial areas will have a significant relationship with the size of the parcel, the distance from the CBD, and the units in the structures. Alternatively, VAP from industrial areas will have a most significant relationship with the size of the parcel, the distance from the CBD, and the age of the parcel.

Hypothesis 5 (H5). *A further distance from the CBD will increase the chance that property becomes vacant or abandoned.*

This hypothesis will be tested using spatial analysis and a discrete-time hazard analysis. The expected results of this hypothesis are that overall VAP located further away from the CBD have a high probability of conversion to vacancy than do closer properties, due to the annexation. The VAP from residential areas which are located further away from the CBD have a greater probability of conversion to vacancy over time than do closer properties. The vacant/abandoned properties from commercial and

industrial areas which are located closer to the CBD have a higher probability of conversion to vacancy over time than do properties further away.

Hypothesis 6 (H6). *Small size parcels will increase the chance that property becomes vacant or abandoned.*

This hypothesis will be tested using spatial analysis and a discrete-time hazard analysis. The expected results of this hypothesis are that overall VAP that has a small size have a high probability of conversion to vacancy than do larger size VAP.

3.4 Data and Variables

A rich set of data for the city of Forth Worth in Texas between 1990 and 2010 in 10-year increments was collected to analyze the conversion of VAP. The unit of analysis for this research was a parcel-level data. The conversion of VAP is determined by the results of the descriptive spatial analysis. Therefore, spatial analysis data was drawn from the CFW and Tarrant County, and, land use data and annexation data is from NCTCOG and Tiger GIS data. The NCTCOG land use inventory was collected by the Department of Research and Information Services in NCTCOG and it covers the Metropolitan Planning Area (MAP), including Ellis, Erath, Hood, Hunt, Johnson, Kaufman, Navarro, Palo Pinto, Parker, Rockwall, Somervell, Tarrant, and Wise Counties, as the Dallas-Fort Worth MAP. The land use data is classified into 34 categories, and it proves the structure and relationships of land uses, and also points toward the changes and trends taking place in the region's growth. The coordinate

system for NCTCOG GIS data is NAD 1983, State Plane, Texas, North Central zone, feet (Regional Data Center, 2014).

Table 7 Land Use Data Categories from NCTCOG

Land Use	Category	Examples of Uses
Residential	Single family	▪ Single family detached units and duplexes
	Multi-family	▪ Apartments, condominiums, residential hotels, converted apartments and townhouses (single family attached)
	Mobile home	▪ Mobile homes inside mobile home parks and free-standing units outside parks
	Residential acreage	▪ Land that is mostly undeveloped, yet includes a residence, either house or mobile home, as a minor part of the use
Commercial	Commercial	▪ Unspecified office or retail uses or a combination of office and retail uses excludes office and retail uses when residential use is present
	Office	▪ Includes any administration functions include corporate and government offices, banks
	Retail	▪ Retail trade and services, such as department stores, repair shops, supermarkets, restaurants
	Institutional	▪ Churches, governmental facilities and offices, museums, education, hospitals, medical clinics, libraries and military bases
	Hotel/motel	▪ Hotels and motels
	Parking garage	▪ Parking garages
	Large stadium	▪ Large venue for organized events
	Mixed use	▪ Areas that contain both commercial (office and retail) and residential uses either in the same facility or in very distance
	Parking CBD	▪ Parking in CBDs
	Expanded parking	▪ Parking areas adjacent to or near large event venues and other large parking lots
	Improved acreage	▪ Open land that has a non-residential structure
	Parking	▪ Paved areas dedicated to vehicle parking, includes parking structures
Industrial	Industrial	▪ Manufacturing plants, warehouses, office showrooms
	Utilities	▪ Sewage treatment and power plants, power line easements, pump stations, water treatment plants and water systems
	Communication	▪ Radio and television communications stations
	Landfill	▪ Sanitary landfills, land applications, and similar waste management facilities
Vacant	Vacant	▪ Undeveloped land can be either urban or rural (excluded Ranchland, Timberland, and Farmland)

Based on the NCTCOG GIS land use data, this research categorizes land use as residential, commercial, industrial, and VAP. Residential land use includes Single-family, multi-family, mobile home, and residential acreage. Commercial land use contains commercial, office, retail, institutional, hotel/motel, parking garage, large stadium, mixed use, parking in the CBD, expanded parking, improved acreage, and parking. Industrial land use includes industrial, utilities, communications, and landfills. VAP use excludes ranchland, timberland, farmland, cemeteries, and land under construction (see Table 7). Based on these different land use categories, this research analyzes conversions for each type of land use (residential, commercial, and industrial) as well as overall conversion separately.

As a statistical research using the discrete-time hazard model, the dependent variable of this research is parcel land use status in 2010; the independent variables are categorized as SES characteristics, BE characteristics, and geographical (GEO) characteristics (see Table 8). All independent variables are in the year 1990 data; the SES and the BE characteristics were collected at the block-group level. The overall number of independent variables is 25, and they are categorized specifically. The SES and the BE variables data were collected from the US Census Bureau. The geographical variables – Hotspot z-scores, local Moran's I z-score, the parcel size, and the distance from the CBD data were calculated in GIS. The SES variable categories include population, gender, race, educational level, income, automobile, employment, and family type. The BE variable categories include housing unit, ownership, vacant purpose, vacant duration, building type and structure, housing value, land value, parcel

age, and structure count. The GEO variable categories include spatial z-scores, distance from the CBD, and parcel size.

Table 8 Data Descriptions and Sources

Dependent variable	Land use status 2010 (Non-vacant or Vacant)	
Independent Variable		
Socioeconomic Status	Population	Total Population (100Person)
	Gender	Male Population (%)
	Race	Non-White (%)
	Education	Less than 9th Grade (%)
	Income	Households Median Income ($1000)
	Automobile	Vehicle (%)
	Employment	Unemployed (%)
	Family Type	With Children (%)
Built Environment	Housing Unit	Total Housing Unit
		Occupied Units (%)
	Ownership	Ownership (%)
	Vacant Purpose	Vacant Units for sale only (%)
	Vacant Duration	Less than 2months (%)
		2 up to 6 months (%)
		More than 6months (%)
	Building Type & Structure	Multi-housing (%)
		Mobile Home or trailer (%)
	Housing Value	Median Housing Value ($1000)
	Land Value	Land Value($1000)
	Parcel Age	Parcel Age (2015-Parcel year)
	Structure Count	Structure Count
Geographical Characteristics	Spatial	Hotspot z-score
		Local Moran's I z-score
	Distance	Distance from CBD (1000feet)
	Size	Parcel Size (100sqft)

Independent Variables		Previous Study
Socioeconomic Status	Population	• Bowman & Pagano (2000, 2004) • Hollander (2009, 2010)
	Race	• Carter & Polevychok (2003) • Bowman & Pagano (2000, 2004)

Table 8 Continued

Socioeconomic Status	Gender	• N/A
	Education	• Carter & Polevychok (2003) • Park & Ciorici (2013)
	Income	• Schilling (2002) • Carter & Polevychok (2003) • Bowman & Pagano (2000, 2004) • Park & Ciorici (2013)
	Automobile	• Newman at al. (2016)
	Employment	• Friedman (2003) • Carter & Polevychok (2003) • Berger (2006) • Hollander (2009, 2010)
	Family Type	• N/A
Built Environment	Housing Unit	• Schilling (2002)
	Ownership	• Carter & Polevychok (2003) • Hollander (2009, 2010) • Park & Ciorici (2013)
	Vacant Purpose	• Isakson (1997) • Accordino & Johnson (2000) • Friedman (2003) • Carter & Polevychok (2003)
	Vacant Duration	• Accordino & Johnson (2000) • Németh & Langhorst (2013) • Newman at al. (2016)
	Building Type & Structure	• Accordino & Johnson (2000) • Schilling (2002)
	Housing Value	• Accordino & Johnson (2000) • Carter & Polevychok (2003)
	Land Value	• Isakson (1997) • Accordino & Johnson (2000) • Friedman (2003) • Mallach (2004) • Hollander (2009, 2010)
	Parcel Age	• Isakson (1997) and Schilling (2002)
	Structure Count	• Bowman & Pagano (2000, 2004) • Schilling (2002) and Friedman (2003)
Geographical Characteristics	Spatial	• Bowman & Pagano (2000, 2004) • Schilling (2002) • Carter & Polevychok (2003) • Berger (2006)
	Distance	• Isakson (1997) • Bowman & Pagano (2000, 2004)
	Size	• Isakson (1997) • Bowman & Pagano (2000, 2004) • Newman at al. (2016)

3.5 Conceptual Model

This research consists of two analyses by different land use status (see Figure1). First part of the analyses discover the spatial distribution and clustering pattern of vacant land and different land use. Second part of the analyses highlight the conversion condition of VAP.

In detail, as the preliminary stage, the descriptive spatial analysis aims to identify location-based trends in the existing VAP; whether the VAP that exists in urban areas would shift toward the outside of urban areas as time goes on (or vice versa). Moreover, clustering trends based on the parcel size; whether the small or large parcels are clustered or not, and where and how depends on the different land use type. This analysis is performed based on the distance of VAP from the CBD and parcel size. In this analysis, GIS is used, and five different tools are used with parcel data: mean center, directional distribution, hotspot analysis, clustering analysis, and pattern analysis. Second, in the discrete-time hazard analysis, the ultimate aim is to analyze the effecting elements for conversion of VAP use, using the most widely used statistical analysis tools, STATA. The descriptive spatial analysis is to figure out the phenomenon of the spatial situation in a case study area. Moreover, it will show how the VAP pattern and distribution have changed from 1990 to 2010.

These results may not be enough to say which variables affect the conversion of VAP. Therefore, using a discrete-time hazard analysis, this research explains which variables are effects to the conversion of VAP comprehensively, based on the results of analyses part one. To reach the goal, this research set up categories as four different

types of land use status (see Figure 1) – residential, commercial, industrial, and overall. In this analysis, the explanatory variables include SES, BE, and GEO characteristics. Each variable consists of sub-variables, which are designated throughout the literature review. For GEO characteristics variables, the size of a parcel, the distance from the CBD, and spatial variables were chosen at a parcel level. SES variables include population, gender, race, educational level, income, poverty level, automobile, employment and family type at a block-group level. BE variables consist of housing units, ownership, the purpose of vacant units, vacancy duration, building detachment, housing values, land values, parcel age, and structure count at the block-group level.

Throughout the descriptive spatial analysis, this research analyzed the geographical concentration of each land use type with the mean center tool. It shows that where is the most attentiveness area of each land use. Also, it analyzed the geographically dispersed direction, trend, and tendency of each land use type using the directional distribution tool. It represents that each land uses distribution pattern and historical location trend. Based on the parcel's size and the number of parcels in a block group, an analysis of the clustering patterns of each land use type was made using the spatial autocorrelation tool. Based on the results of the spatial autocorrelation, an analysis was done on the hot or cold spot for each land use type. These analyses indicate where is the most significant area of each land use and how they changed from 1990 to 2010. After these analyses, this research compared each land use type based on the different year (1990, 2000, and 2010) to determine the pattern of land use change.

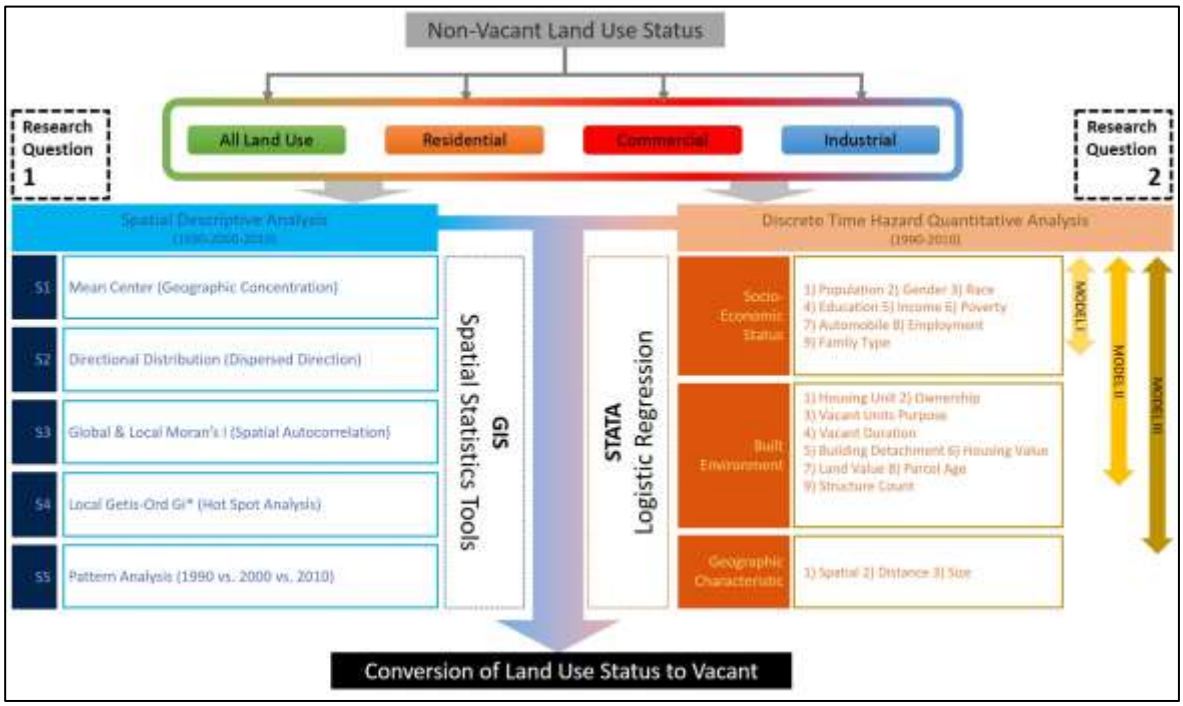


Figure 1 Conceptual Model

Throughout the discrete time hazard model analysis, this research analyzed the relationships between the VAP conversion of land use and each group of variables. First, only the SES variables were used, then the BE variables were added. Finally, GEO variables were added so this research could examine the relationships between these variables and VAP conversion.

4. RESEARCH METHODOLOGY

In this research, two different methodologies were used to answer the following research questions in this research: 1) How have the patterns of non-vacant and VAP changed from 1990 to 2010? and 2) What factors affect the conversion of NVL to vacant overall and for different land use types – residential, commercial, and industrial? The first is for descriptive spatial analysis and the second is for statistical analysis. In the descriptive spatial analysis, this research determined the geographic distributions trends, clustering, and land use patterns using a geographical information system (GIS). This method is for the research question 1. In the statistical analysis, this research found the most significant factors that affect each land use conversion using a discrete time hazard model (STATA). This method is for the research question 2. Through these two different methodologies, this research expects various meaningful results.

4.1 Spatial Descriptive Analysis

In this section, the way land parcels have fluctuated or altered between vacant and NVL is examined using several different GIS spatial analysis tools. Specifically, it will describe the transformation of land parcels every ten-years from 1990 to 2010. That includes the patterns of VAP as a time series, using ratios, typologies, amounts of VAP change, annexation, distance from the CBD, and an analysis of the clustering or dispersion of VAP patterns. Analysis of the VAP patterns in Fort Worth is not only needed to understand the density of VAP but also how they are spatially distributed.

Based on the density of VAP spatial distribution, spatial statistical models can be processed to realize whether or not they are randomly distributed and if the land clusters are high density or low density. Density measured as the intensity of activity was the most widely used variable to quantify compactness or dispersion in an area. The degree of clustering was identified as whether the VAP was clustered with or dispersed from other VAP or whether they were randomly distributed (Guo, 2008). Additionally, the distance from the CBD to the VAP can show the relationship between annexation impacts and urban core vacancy. Since this study examines the spatial distribution of the unit change of VAP over time, a longitudinal analysis is necessary. First, using several different geographic distribution measuring tools, the mean center of the VAP and each land use type, and the directional distribution of VAP and each land use type as a time series were analyzed.

The mean center of VAP and NVL were represented by the change of the mean center of the VAP and NVL. The distribution pattern of VAP and NVL as a time-series was examined through a directional distribution analysis. Then, Global Moran's I and Anselin Local Moran's I and Hotspot analysis were applied to analyze the patterns and identify the clustering of VAP (Newman & Kim, 2014; Anselin, 1992). The results of the annexation analysis explain how the boundary of Fort Worth, Texas, has changed and how much the area has increased related to annexed areas. One of the purposes of this analysis is to explain the VAP distance from the CBD, in other words, the inner city vs. boundary of the city. This is based on that VAP most often is linked with cities that have expanded their political boundaries (Bowman & Pagano, 2004). The results of the

directional distribution of VAP as a time series showed how the VAP has been distributed. Global Moran's I and Anselin Local Moran's I results illustrated the degree of clustering of VAP. The results of the Hotspot analysis explained which VAP areas have significantly decreased or increased. This research also generated different patterns for converted land based on land use status for 25 years ago (1990), 15 years ago (2000), and 5 years ago (2010). These results show how the status of parcels have changed.

4.1.1 Mean Center and Directional Distribution

As a spatial statistics tool, this research uses a mean center analysis and a directional distribution analysis. The mean center analysis identifies the geographic center or the center of concentration. Directional distribution analysis summarizes the spatial characteristics of geographic features, central tendencies, and dispersion and directional trends (Esri, 2015). In this research, each land use parcel in each year – 1990, 2000, and 2010 – was analyzed.

4.1.2 Spatial Pattern and Autocorrelation

To determine spatial clustering pattern and autocorrelation, Global and Local Moran's I were applied. Spatial clustering happens both at the global level and at the local level where features may cluster in one part of an area and disperse in another (Guo, 2008). In this research, a clustering pattern of VAP focuses on a global and local level together. Global Moran's I measures the degree of clustering, using the value between -1 to +1. If a Global Moran's I has a high positive value, it indicates a strong

clustering pattern on the VAP. When a Global Moran's I value is close to 0, it indicates that developments were randomly distributed. In addition, if a Global Moran's I value was -1, a strongly dispersed pattern is implied.

Local Moran's I is used to capture local clusters where similar values are concentrated or spatial outliers where values are distinct from neighboring clusters. A positive value indicates that the feature is surrounded by features with similar values (either high-high or low-low). On the other hand, a negative value points out that the feature is surrounded by features with dissimilar values (either high-low or low-high). For the Z-score, a high positive score larger than +1.96 indicates that the surrounding features have similar values (either high-high or low-low), whereas a low or negative Z-score of less than -1.96 indicates that the surrounding features have dissimilar values (either low-high or high-low). If the Z-score shows within the range of -1.96 to +1.96, it means that there is no clustering (Wang, 2010).

In this research, based on a number of the parcel and the parcel size, Global Moran's I was analyzed first. Then, following the results of Global Moran's I, Local Moran's I was applied. Also, the parcel size Z-scores in the Local Moran's I results was one of the variables for geographic characteristics.

4.1.3 Local Getis-Ord Gi (Hotspot Analysis)*

Hotspot analysis (Local Getis-Ord Gi*) identifies the locations of a local hot spot or cold spot, and local clusters with statistically significant high or low attribute values. The hot spot analysis index discovers and maps where high values or low values cluster

in a study area. A hot spot indicates when a Gi value is high, and the surrounding features have high values. Oppositely, a cold spot indicates when a Gi value is low, and the surrounding features have low values. For the Z-score, if statistically significant, a positive Z-score that is higher than +1.96 indicates a high clustering of high-value features, while a negative Z-score less than -1.96 indicates a strong clustering of low-value features. If the Z score is between -1.96 and +1.96, it means that there is no clustering (Wang, 2010). In this research, the same as in the spatial pattern and autocorrelation analysis, based on the number of the parcel and the parcel size, and following the results of the Global and Local Moran's I, hot spot analysis was applied. Also, the parcel size Z-scores in hot spot analysis results were one of the variables for geographic characteristics. Using this methodology, this research explores the hypothesis 1: The urban core will have more vacant or abandoned properties compared to peripheral areas of the city in the year 2010 is larger than in the year 1990 and 2000 because of annexation and the hypothesis 2: significant clustering of vacant or abandoned properties will result in increased vacancies or abandonment of adjacent or nearby parcels.

4.2 Regression Analyses

In this section, the factors that have the most significant effects on conversion from NVL to VAP are examined using quantitative data and methods. Quantitative analysis of the conversion of non-vacant to VAP is relatively rare. This statistical analysis is essential for conducting a conversion analysis to gather qualitative information about the study area in order to best understand the area and what is needed

for a successful revitalization strategy. Moreover, the advantages of the quantitative land use conversion variables are many, diverse, and comprehensive. They categorized as three different characteristics as SES, BE, and GEO, and covered all-inclusive conditions. Throughout the quantitative analyses, this research tested and validated already constructed theories and founded results from previous studies about how and why the land use conversion occur. Moreover, using the collected and generated data, this research tested and confirmed the established hypotheses. Based on these hypotheses results, this research explains and answers the research questions; and suggest better strategies to prevent, maintain, and regenerate the VAP.

4.2.1 Discrete-Time Hazard Model Analysis

The discrete-time hazard model (Singer & B.Willett, 2003) is a suitable longitudinal method to study the occurrence of property vacancy and abandonment over time. A hazard event occurs when a parcel changes from its normal stage, non-vacant – residential, commercial, or industrial – to vacant (Zhang, 2012). Because the parcel land-use data was only collected once a year (i.e., discrete time), the non-vacant parcel's transition to a vacant parcel can be conceptualized as a discrete-time hazard event (Zhang, 2012). The probability of a hazard event (conversion from non-vacant to vacant) occurring in any given time period, h(tij), is defined as the following:

$$h(tij) = Pr\ (Ti = j \mid Ti >= j, \text{ and } Xij) \ldots\ldots\ldots\ldots (1)$$

Logit is the most commonly used transformation for estimating the discrete-time hazard model (Cox, 1972). The serial correlation between observations from 1990 to 2010 should not be a problem for the estimation because the hazard function, by definition, describes the conditional probability of event occurrence given each individual parcel's characteristics for each time period and the fact that it survived until this time period. Therefore, all observations are conditionally serial independent (Singer and Willett, 2003). To identify the determinants of a non-vacant parcel becoming vacant or abandoned, as well as the temporal pattern of vacancy and abandonment, the discrete-time hazard model specified by equation is estimated as

$$\text{logit h}(t_{ij}) = (\beta_1 X_{1ij} + \beta_2 X_{2ij} + \cdots + \beta_n X_{nij}) + u \text{……..…..(2)}$$

For each predictor, both the maximum likelihood estimate of its coefficient and the fitted odds ratio are reported. In this research, a discrete-time hazard model will be applied to each land use that is overall, residential, commercial, or industrial. In the overall, it will show the most significant factor that affects general land use conversion from non-vacant to vacant. After that, specifically, this approach will be applied to each land use that is residential, commercial, or industrial.

5. STUDY AREA

5.1 Fort Worth, Texas

The study area of this research is Fort Worth, Texas, which is used as a representative case for expanding cities that typically report higher ratios of VAP than non-expanding cities. Fort Worth is located in North Central Texas and is the fifth largest city in the state of Texas, occupying nearly 350 square miles (City of Fort Worth, 2015). In addition, Fort Worth is located in Denton, Parker, Tarrant, and Wise Counties. Most of the area is in Tarrant County. The city experienced the fastest growth in the United States from 2000 to 2010. According to the CFW, the population in Fort Worth is over 812,000. Over 40 percent are White, almost 35 percent are Hispanic, and nearly 20 percent are African American[7] (see Figure 2).

The CFW classifies VAP under the three different categories – brownfields, vacant housing units, and vacant and agricultural. VAP included under brownfields is vacant, underutilized, obsolete, or structurally deteriorated industrial or commercial property where real or perceived contamination hinders enhancements. Under the vacant housing unit, VAP includes houses, apartments, mobile homes, or other units, occupied or vacant, but proposed for occupancy as separate living quarters. The category of vacant and agricultural is one residential unit per structure on a one or more acre lot with no city water or sewer service or land with no existing buildings, except for those related to

[7] The population of Fort Worth, TX is 812,553 in 2014. White is 42%, Hispanic is 34%, and African American is 18% (City of Fort Worth, 2015).

mining, crops, or grazing (City of Fort Worth, 2015). The CFW has been experiencing rapid development since the 1980s, still the issue of VAP remains as an important issue. It makes this area an ideal case study area that demands a longitudinal approach.

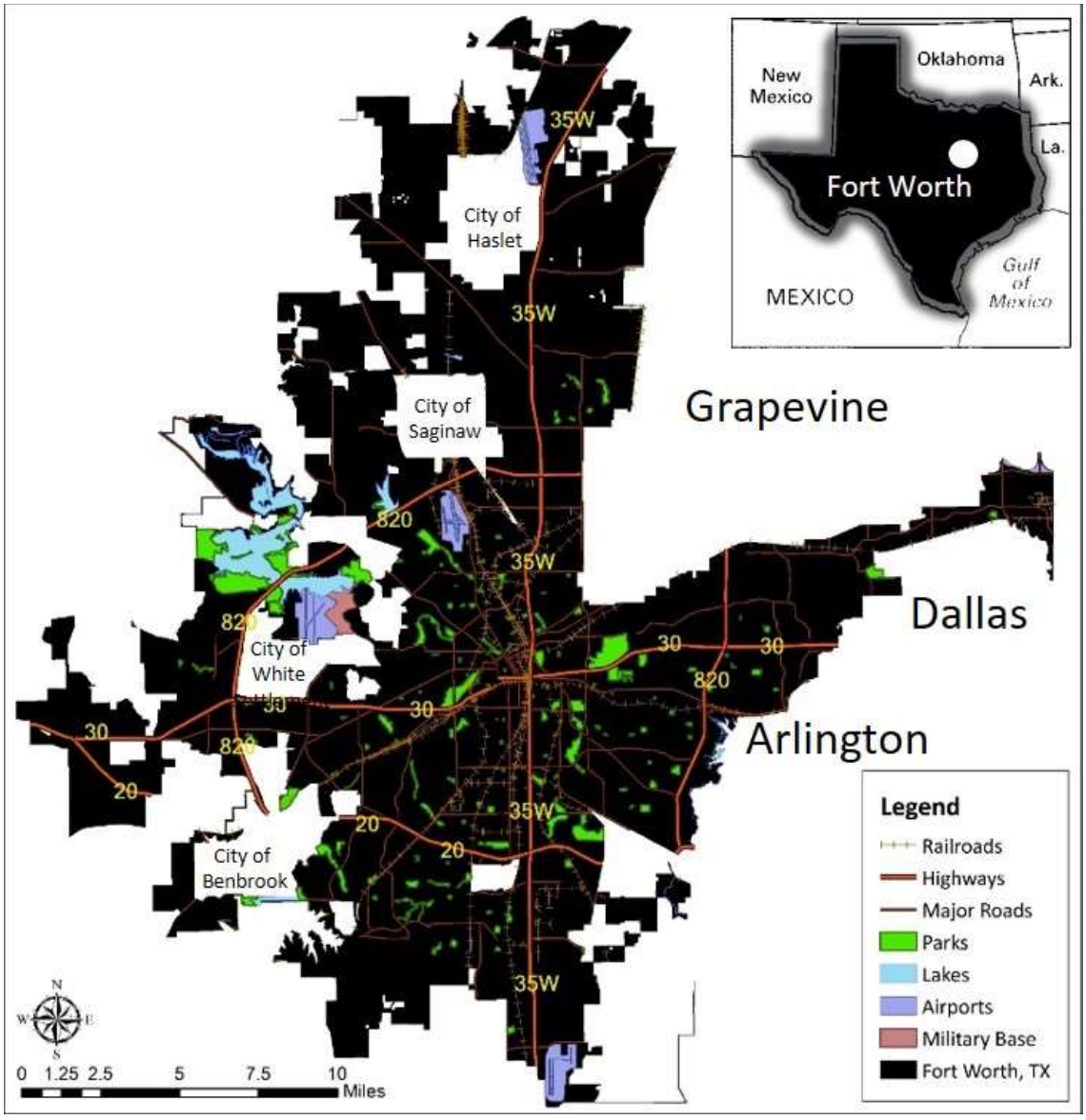


Figure 2 City of Fort Worth (CFW)

5.2 The Present Spatial Condition

5.2.1 Annexation in City of Fort Worth

The city has annexed over 40,000 acres from 1983 to 2012, due to massive population migrations to the periphery. In the early 1990's and mid-2000's, substantial annexation occurred in the city, producing large amounts of VAP in the urban area (Newman, 2012). This occurrence supports the idea that one of the major reasons for the formation of VAP is annexation (Bowman & Pagano, 2004). While new development on the urban edge actually decreased VAP amounts from 1990 to 2012, the number of vacant parcels increased.

In 1990, the physical size of the CFW was 287.44 square miles; in 2000, the size was 299.43 square miles (a 4.2 percent increase); and in 2010, the size was 347.98 square miles (a 16.2 percent increase). The physical size of the city is increasing continuously; the city size increased over 20 percent between 1990 and 2010, especially, when the north and west sides of the city were annexed (see Figure 3).

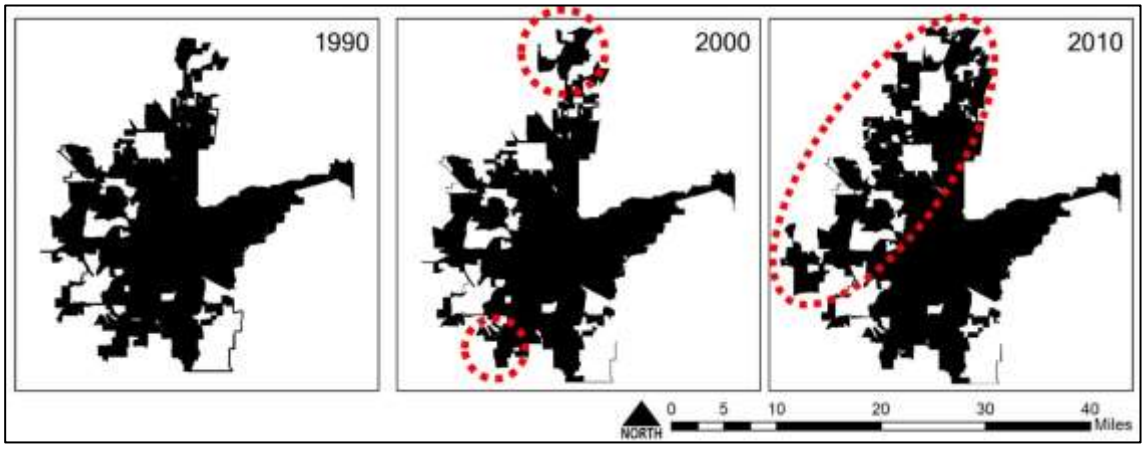


Figure 3 Annexation in CFW from 1990 to 2010

Also, the boundary of the city was not stable during the study period. Thus, this research assumes that there was no boundary change during the study period and will use the 1990's city boundary consistently.

5.2.2 Land Use Change from 1990 to 2010

Currently, Fort Worth incorporates 350 square miles; 27 percent is vacant which holds floodplains, steep slopes, or other development constraints limiting its development perspective (City of Fort Worth, 2015). Along with annexation, land use has also changed dramatically. Using the NCTCOG land use code, this research determined how the land use changed from 1990 to 2010.

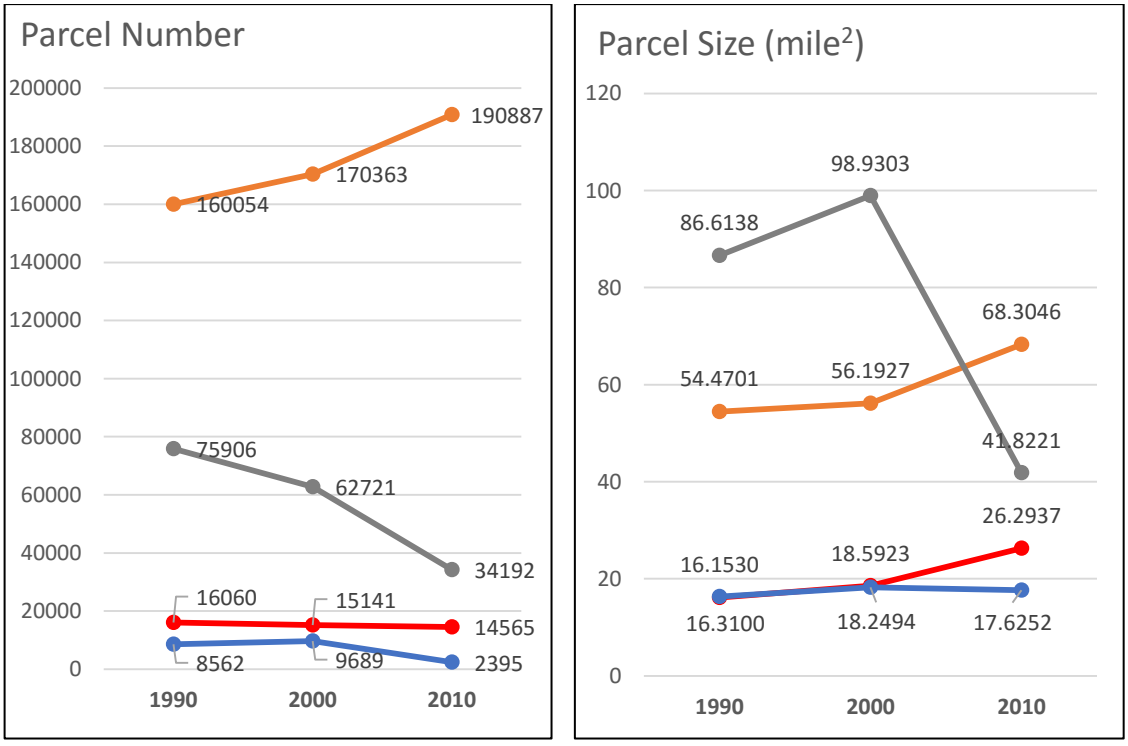


Figure 4 Number of Parcels Change and Average Parcel Size Change

First, the number of commercial and vacant parcels continuously decreased, while the residential amount of parcels increased from 1990 to 2010. In fact, the amount of residential and vacant parcels show opposite trends from 1990 to 2010 (see Figure 4). The average vacant and industrial parcel size are decreased from 2000 to 2010 while the average residential and commercial parcel size are increased from 2000 to 2010 (see Figure 4).

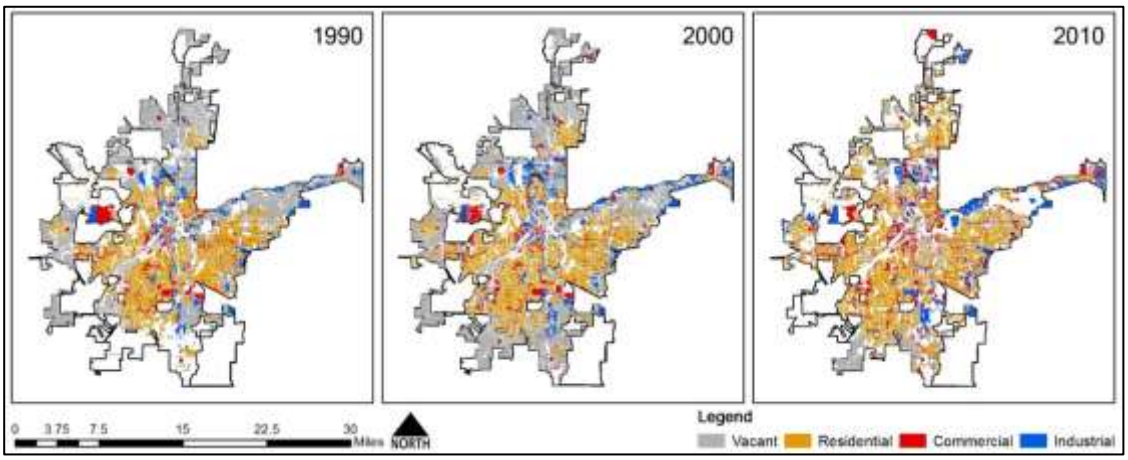


Figure 5 Land Use Change from 1990 to 2010

The north and south regions of the city increased in VAP between 1990 and 2000. From 2000 to 2010, vacant parcels in the peripheral area in the city mostly disappeared (see Figure 5). Residential land use occupies the highest amount of developed land area in Fort Worth.

5.3 Current Policy and Development Plan

In this section, this research summarizes the recommended policies, strategies, programs, and projects of the comprehensive plan for the CFW, especially related to the VAP conversion. This plan will help the city to achieve its mission of focusing on the future to create strong neighborhoods, develop a sound economy, and provide a safe community while revitalizing the central city (City of Fort Worth, 2015).

5.3.1 Annexation

The definition of annexation is a legal process by which a city extends its boundaries. A city may annex property only within its extraterritorial jurisdiction unless the city owns the area (City of Fort Worth, 2015). Some studies mention that an annexation is essentially the same as elasticity or sprawl that is movement outward from the city center without the creation of new political jurisdictions (Transportation Research Board, 1998). Rusk (1993) claims that cities with high lists of elasticity are superior to those with low lists of elasticity, such as income distribution, racial integration, population growth, and economic development (Rusk, 1993). On the other hands, many previous studies indicate that an annexation is a reason for an increasing amount of VAP (Bontje, 2001; Bowman & Pagano, 2004; Kremer, Hamstead, & McPhearson, 2013; Newman, Lee, & Berke, 2016).

Well-planned annexation can produce a more consistent land development pattern with population growth and economic development opportunities while protecting existing and future land uses. Therefore, annexation can be used as a growth

management tool by promoting orderly development patterns. Furthermore, it can minimize urban sprawl and enhance the quality of life via the efficient supply of services and infrastructure necessary to develop raw land and consequently the tax base for the city, the region, and the state (City of Fort Worth, 2015). As well, local annexation policies should emphasize environment protection plans and regulations (Duerksen, 1997).

Through well-maintained and planed annexation process, Fort Worth promotes economic growth, manages and regulates development on the fringes of the city as an extended range, protects future development, fosters intergovernmental cooperation, and creates a policy concerning utility districts (City of Fort Worth, 2015, p. 237). In 2005, the CFW adopted an annexation policy that calls for the annual preparation of a five-year annexation program as part of the Comprehensive Plan and provides more specific guidance for making annexation decisions. It is more proactive in identifying annexation areas and promotes more meaningful citizen participation during the annexation process (City of Fort Worth, 2015).

5.3.2 Revitalizing the Central City

In line with the Fort Worth Comprehensive Plan, a total of 45 projects is now ongoing in Fort Worth. These plans address significant policy issues for targeted districts or the city as a whole (see Appendix A). Among them, the CFW is devoted to revitalizing its central city, which is the area within Loop 820, consisting of low and moderate income neighborhoods (see Table 9). Beginning in 2002, the city created

conceptual redevelopment plans for urban villages along priority commercial corridors targeted for reinvestment, for a total of sixteen urban villages. The strategies for central city revitalization are to develop compact, pedestrian-oriented mixed use improvement centers; using by developing mixed-use urban villages revitalize distressed commercial corridors; and develop a rail transit system that connects the improvement centers and urban villages and promotes transit-oriented development (TOD).

Table 9 Revitalizing Central City Projects (City of Fort Worth, 2015)

Project	Strategies
Lancaster Avenue from I-35W to Henderson Street	▪ Redeveloped into an attractive, pedestrian-oriented street with residential, retail, and office uses ▪ The I-30 and I-35W interchange were relocated to the south of the Union Pacific railroad lines ▪ The Lancaster Avenue construction began in 2005 and was completed in June 2008 ▪ Public art was installed in the median in 2009 ▪ Construction will begin in 2012 on a new mixed-use development on Lancaster between Monroe and Throckmorton that will include retail, office, and residential units
Berry Street Corridor (from Evans Avenue west to University Drive)	▪ Revitalize the corridor, stimulate new economic development, and promote pedestrian activity ▪ As part of its urban village program, the city has secured approximately $4.2 million in federal and local funds for pedestrian and streetscape improvements on Berry Street ▪ Construction of phase one began in November 2005 and was completed in the spring of 2007 ▪ Phase two construction will start in 2012
North Main Street Corridor (from the Tarrant County Courthouse to the Historic Stockyards)	▪ Creates an attractive, safe, and pedestrian-oriented environment that will improve tourism and stimulate economic activity ▪ Two districts for improvements: the Stockyards district, between 23rd and 28th Street; and the Historic Marine retail and restaurant district, between the railroad and 23rd Street ▪ Pedestrian and Streetscape improvements in the Historic Marine District were completed in September 2006

To achieve these goals, the following policies and strategies were developed. Policies were put in place to promote neighborhood stability through a comprehensive and coordinated strategy that addresses housing, neighborhood economic development, infrastructure, parks, cultural programs, safety improvements, and human services; and the Neighborhood Empowerment Zone program was used to promote the development of designated urban villages, Model Blocks, and other targeted redevelopment areas. Strategies were implemented to enhance the city's existing preservation incentives and develop new towns; and support redevelopment, community development, and nonprofit organizations' efforts to spur the revitalization of central city business districts where investment is not occurring but that have redevelopment potential (City of Fort Worth, 2015).

5.3.3 Conservation and Reclamation Districts

The purpose of the policies of conservation and reclamation districts is to carry out and encourage quality development, to enforce proper land use and development regulations, provide for the construction of infrastructure, and provide notification to residents of the district that the city may annex the district at some future time. This policy can address several related issues. Among them, some are related to annexation. Annexation can occur if the district contains sufficient acreage to assure the economic viability of the district but no more acreage than can feasibly be annexed at one time. No district includes land in more than one city's extraterritorial jurisdiction (ETJ). No land within the district shall be allowed, at any time in the future, to incorporate, join in an

incorporation, or be annexed into any incorporated city other than the CFW (City of Fort Worth, 2015).

5.4 Historical Land Use Change

Regarding the validity of the vacancy data and confirm the conversion of VAP in city of Fort Worth, this research illustrates the change of land use during the study period using Google Earth. Using data in this research is 1990, 2000, and 2010 land use data from NCTCOG, unfortunately, Google Earth provides available data from 1995, but there is no exact data for 2000 and 2010. Thus, this research compared the same location for three different areas on Google Earth in January 1995, February 2001, and December 2009 (see Figure 6).

Case	1995	2001	2009
1			
2			
3			

Figure 6 Google Earth Case

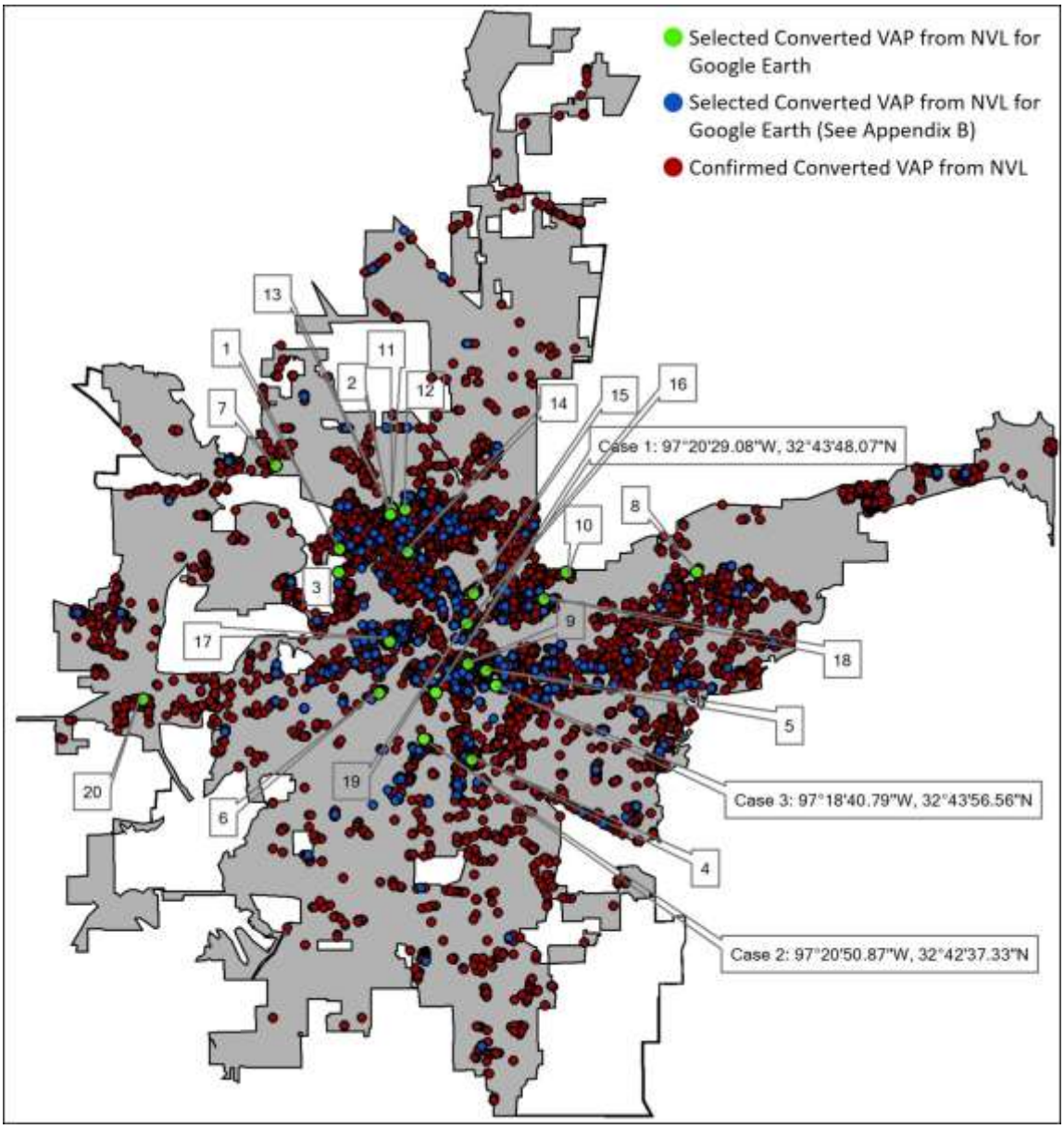


Figure 7 Cases Location and Validation

The green dots are the case locations. The first spot is bordered by W. Magnolia Ave., W. Morphy St., Fairmount Ave., and 7th Ave. The second spot is bordered by W. Cantey St., Gordon Ave., W. Lowden St., and Livingston Ave. The last spot is bordered

by E. Rosedale St., Fabons St., Verbena St., and Troost St. (see Figure 7). Another twenty land use changed locations show the land use transformations in the Appendix B. This research confirmed that the data which is used in this research is validated.

6. ANALYSIS AND RESULTS

A multi-scale analysis of VAP can indicate a change in its functions associated with spatial scales such as local/neighborhood, urban, and city/regional. Among these various scales, the role of VAP needs to be understood within the relationships between a parcel of land and the wide-ranging GEO characteristics, SES, and BE systems to which it belongs. In other words, an analysis of the conversion of VAP makes evident an in-depth and comprehensive understanding of how VAP are perceived and function in a city (Pierce, Martin, & Murphy, 2011). Therefore, this longitudinal research studied the CFW, Texas, as a case study city, in ten-year increments from 1990, 2000, and 2010. A complete account of data and methodologies are explained in Chapters 3, 4 and 5.

This research analysis is divided into land use type based on the NCTCOG land use code. First, this research explores vacant and overall NVL use. The meaning of overall NVL use includes residential, commercial, and industrial. More specifically, defined by each land use type, residential, commercial, and industrial, this research examined the conversion from each land use to VAP. To explain the conversion of land from non-vacant to vacant, this research employed a discrete time hazard analysis model. This model consists of three models of analyses. According to the previous studies, this research confirms that the SES, BE, and GEO characteristics variables influenced the conversion VAP from NVL. The model I only uses the SES data as the independent variable. In model II, the BE data is added; and the physical characteristics data is added in model III.

Using the only Model I which including only SES variables, it is difficult to analyze the VAP conversion impact. To more reliable and accurate analysis of the conversion of VAP from NVL, this research adds to the BE variable in Model II and add the GEO variable in Model III. Moreover, to avoid biased results of the impact variable for conversion VAP from NVL; and to find significance with considering of the critical variables, this research used three different models of analysis.

After each land uses analysis using descriptive spatial analysis and discrete time hazard model analysis, they are compared with each other by study time period, 1990, 2000, and 2010, and by land use type, vacant, residential, commercial, and industrial. This research examined how each land use is dispersed for each year and changes in the inner city area and suburban areas compared to the expansion of the city boundary based on annexation. Moreover, using different characteristics variables, the kinds of factors linked with VAP conversion for each land use were identified.

6.1 Vacant Land

6.1.1 Descriptive Spatial Analysis

In this section, the overall VAP in the CFW, Texas, is spatially analyzed. The conversion to VAP from the NVL is the dependent variable in the statistical analysis in this research. This means that a statistical analysis of the VAP is impossible. Thus, this research conducted only a descriptive spatial analysis of VAP.

The total vacant parcel count per block group – count ratio – was explored, using a quantile classification. From 1990 to 2010, the count ratio of vacant parcels showed

that the area near the center of the city was increasing. However, particularly on the eastern side of the city, the count ratio of vacant parcels was decreasing as time went by.

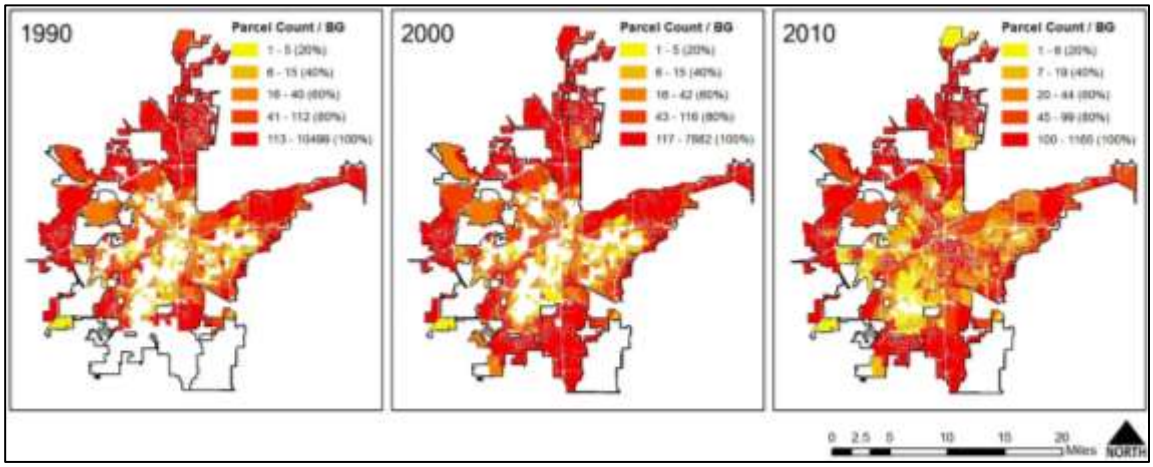


Figure 8 The Number of Non-Vacant Parcels per Block Group by Quantile

The red section is the top 20 percent, from 81 percent to 100 percent, which is toward the central area of the city. The lowest quantile each year showed a similar count ratio of vacant parcels for each year, in 1990 and 2000 it was 1 to 5 and in 2010, it was 1 to 6. Moreover, the highest quantile each year showed that the count ratio of vacant parcels decreased dramatically, in 1990 it was 113 to 10499, in 2000 it was 117 to 7882, and in 2010 it was 100 to 1165 (see figure 8).

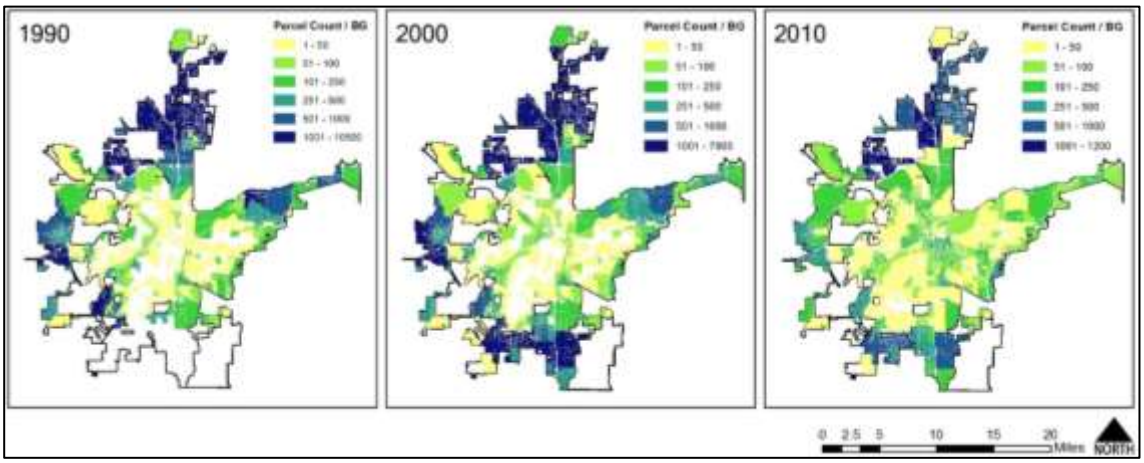


Figure 9 The Count of Vacant Parcels per Block Group

For a more precise examination, this research classified a number of vacant parcels casually. The results illustrated more clearly that the high count ratio of vacant parcels on the periphery of the city had decreased while the count ratio of the vacant parcels around the city center had increased (see Figure 9).

To determine the area ratio of the vacant parcels, which is gauged per block group, the number of all of the vacant parcels in the block group were totaled, and the total was then divided by the block group's size in square miles using the same interval classification. In the 1990s, the city's block groups on the edge of the city had a large portion of vacant parcels, which continued until 2000. By 2010 almost all the block groups that included a large vacant parcel area ratio had disappeared. The explanation for this is that the conversion from vacant to NVL, such as for development or reuse, occurred on the edge of the city (see Figure 10).

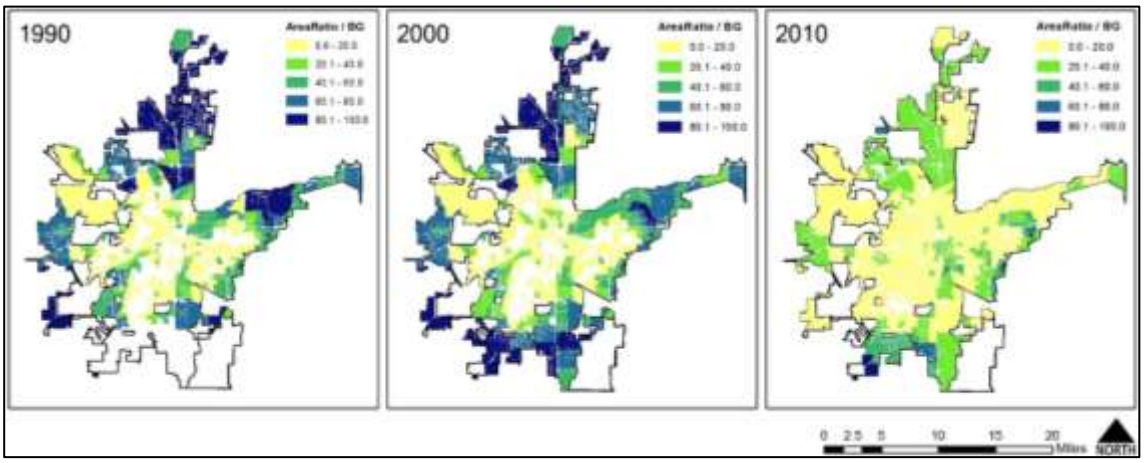


Figure 10 The Area Ratio of Vacant Parcels per Block Group by the Same Interval

According to the results of the mean center and directional distribution of vacant parcels from 1990 to 2010, the outcomes indicated that the tendency of vacant parcels was continuously moving toward the CBD starting in 1990. Also, the directional distribution of VAP showed a concentrated trend toward the center of the city. The directional distribution circle for the year 2000 was the largest one, meaning that the distribution and dissension of VAP covered almost all of the city. Moreover, 2010's directional distribution circle represents that the distribution pattern circle size decreases, it concentrates to the center city as well (see Figure 11). It indicates that in 1990, the VAP existed around of the city boundary rather than the area of the CBD. However, as time goes by, the distribution of the VAP concentrated around the CBD area rather than the boundary of the city. It represents that more VAP are occurred in the inner-city area rather than the outskirt of the city, despite the annexation. Besides, this finding explains that due to the annexation, people tend to move to the suburban, it produces more VAP in the inner-city area.

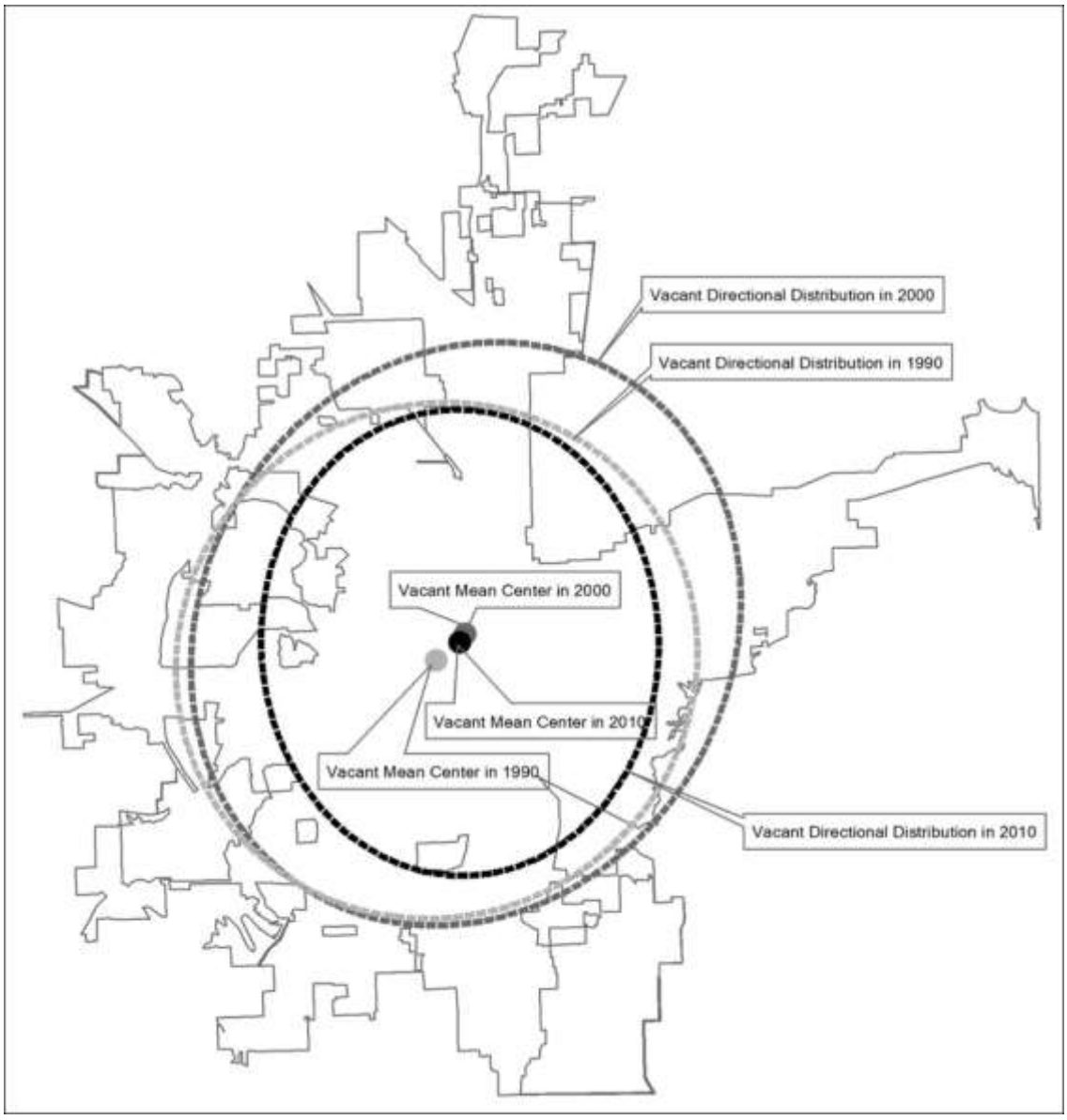


Figure 11 The Mean Center and Directional Distribution of Vacant Parcels

To examine the clustering pattern of the vacant parcels in the CFW, a spatial autocorrelation and hotspot analysis of the vacant parcels was done, using the parcel area ratio and parcel count ratio. First, the spatial pattern of overall non-vacant parcels was analyzed to determine if the dispersion of the parcels was random or clustered using the

Global Moran's I tool. All of the parcel area ratios and parcel count ratios of the overall non-vacant parcels indicated a clustered pattern. Based on all the given z-scores, there is a less than 1 percent likelihood that this clustered pattern could be the result of random chance (see Appendix B).

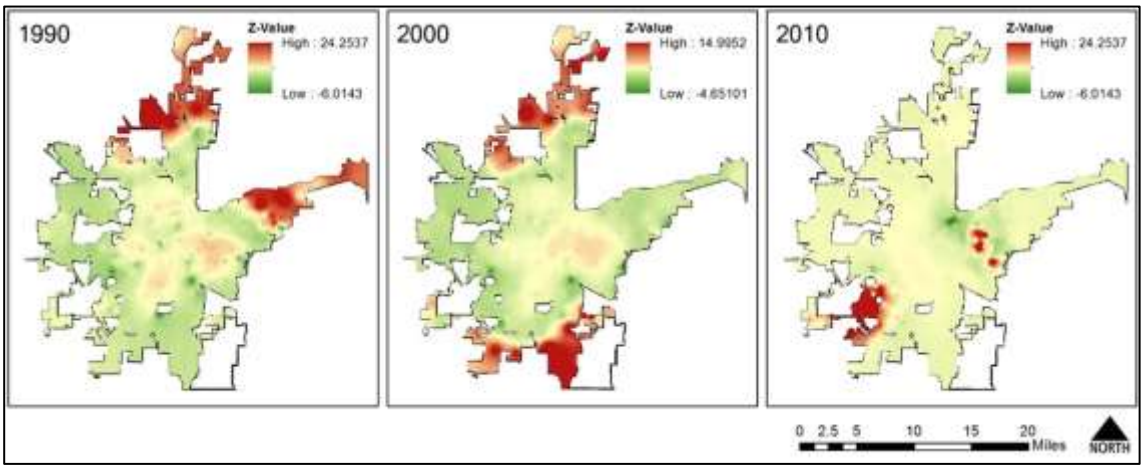


Figure 12 The Moran's I Result for the Count of Vacant Parcels

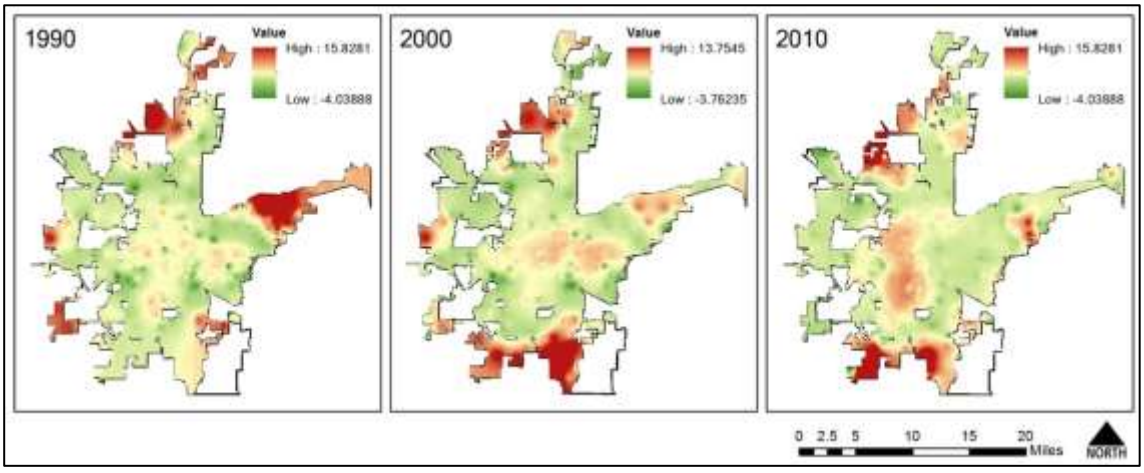


Figure 13 The Local Moran's I Result for the Area of Vacant Parcels

Based on the Global Moran's I results, what kind of characteristics and how the vacant parcels clustered was discovered, using the Local Moran's I tool. The Local Moran's I results of vacant parcels showed that the red section is a clustered area, and the green section is a dispersed area. The count ratios of the vacant parcels indicated that the edge of the city had strong clustered vacant parcels until 2000, and the strongly clustered parcels at the edge of the city disappeared in 2010. However, a large portion of the vacant parcels is still located on the edge of the city. Also, it was found that a large percentage of the clustering VAP gradually occurred in the center of the city, parts of the red sections have been replaced as can be seen in Figure 13 (see Figures 12 and 13).

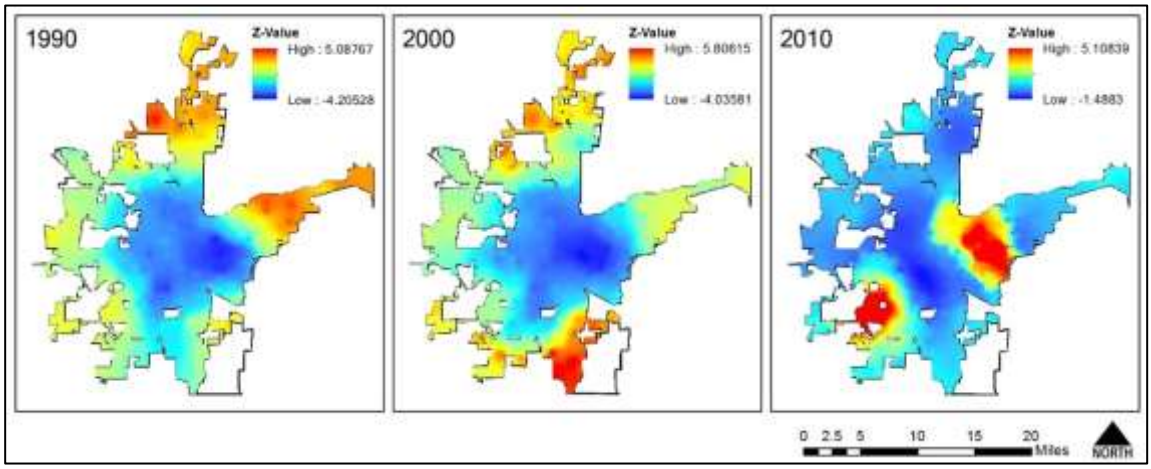


Figure 14 The Count of Vacant Parcels Hotspot Results

Using the results of the Local Moran's I, the clustered area's characteristics were explored using the Hotspot analysis tool. The red area is a hotspot and has a high value, which means that a large number and a large size of vacant parcels are clustered in that

area. The blue area is a cold spot with low value, and this means that a small number of vacant parcels are clustered there (see Figure 14).

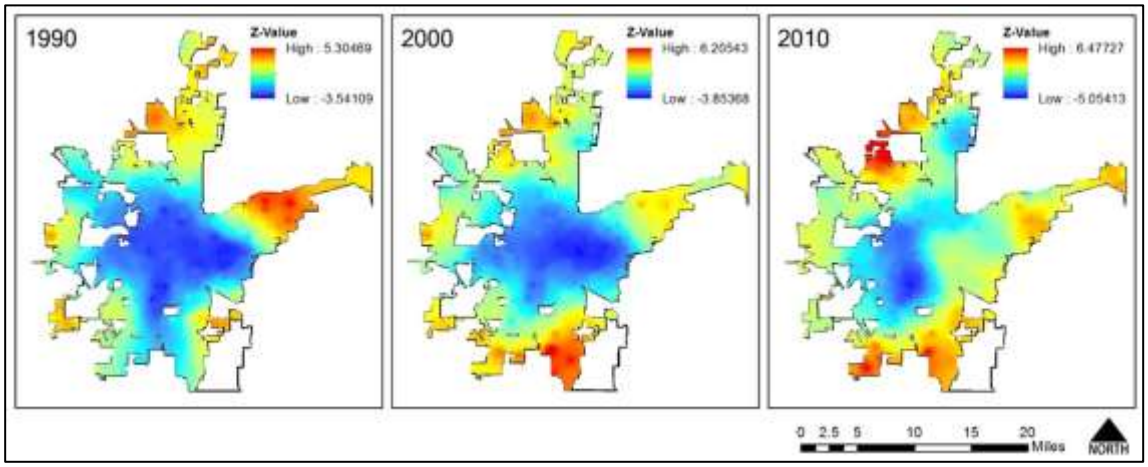


Figure 15 The Area of Vacant Parcels Hotspot Results

The results of the hotspot analysis of the count of vacant parcels showed that the small number of clustered vacant parcels in the center area of the city was stronger in 2010 than in 1990. Also, the results of the hotspot analysis of the area of vacant parcels illustrated that the small size of clustered vacant parcels in the center of the city area was weaker in 2010 than 1990 (see Figure 15). The reason of the clustering shift to a different part of city over the decades seems to because of the annexation and new-development near in the Benbrook city and other small cities.

6.1.2 Findings

Through the descriptive spatial analysis of the VAP in the CFW, this research found that the number of the VAP parcels had decreased continuously from 1990 to

2010 (see Table 10). The VAP parcels were mostly located at the edge of the city in the 1990s, after which they moved toward the center of the city and concentrated in the CBD. Moreover, the VAP parcels have no special distribution direction. A large number of VAP parcels and parcels of large size are clustered at the edge of the city while a small number of parcels and parcels of small size are clustered in the center of the city.

These findings confirmed that even the city is growing by population, economically, and geographically, the amount of the VAP is continuously increased, especially in the inner city area. These phenomena can bring the declining of the CBD and boost to create blight area in the inner city area.

Table 10 Vacant Land Spatial Analysis Findings

- Amount of the VAP parcels decreased from 1990 to 2010
- In 1990, almost all VAP located at the edge of the city
- VAP are moving toward and concentrated in the CBD
- Relatively, large size VAP are located of the city
- Many small size VAP are located in the center of the city; large portion of the VAP produced

6.2 Overall Non-Vacant Land (NVL) to Vacant and Abandoned Properties (VAP)

6.2.1 Descriptive Spatial Analysis

In this section, this research analyzes the overall non-vacant number of parcel counts per block group, using a quantile classification. From 1990 to 2010, the number per block group of overall NVL use showed a dispersed pattern. The red section is the top 20 percent, from 81 percent to 100 percent, which dispersed toward the peripheral of

the city. Moreover, in 1990, the center of the city and CBD area showed a very small number of non-vacant parcels per block group. However, in 2000 and 2010, this area showed a much denser and a high number of non-vacant parcels per block group. The lowest quantile class in each year show a similar number of non-vacant parcels per block group: in 1990 it was 1 to 123, in 2000 it was 1 to 170, and in 2010 it was 1 to 144. However, the highest quantile class in each year show some non-vacant parcels per block group: in 1990 was 440 to 1170, in 2000 it was 524 to 3013, and in 2010 it was 446 to 9587. This indicates that as time went by, the number of non-vacant parcels per block group increased (see Figure 16).

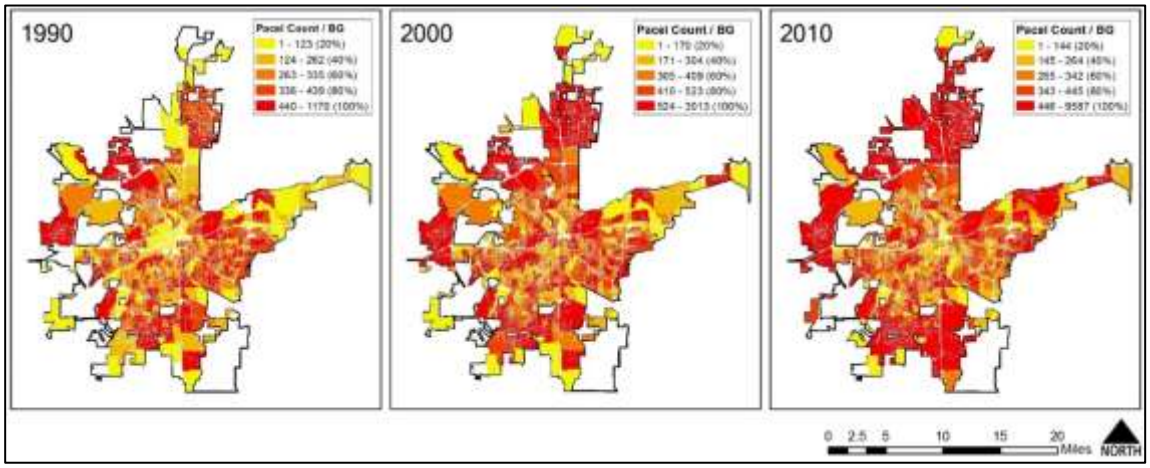


Figure 16 The Number of Non-Vacant Parcels per Block Group by Quantile

The results of the number of non-vacant parcels per block group used the same interval classification. This result shows more clearly the dispersal pattern of the number of non-vacant parcels per block group. The blue section indicates areas with the highest number of non-vacant parcels per block group–more than 1001 non-vacant parcels. On

the other hand, around the CBD area, the results showed that from 1990 to 2000, there was an increased number of non-vacant parcels per block group, and most of the CBD area turned from yellow to green. However, from 2000 to 2010, there was a decrease in the number of non-vacant parcels per block group, and the area around the CBD turned from green to yellow. Thus, from 1990 to 2000, there were many developments in the CBD area while from 2000 to 2010, the development parcels have become vacant parcels again (see figure 17).

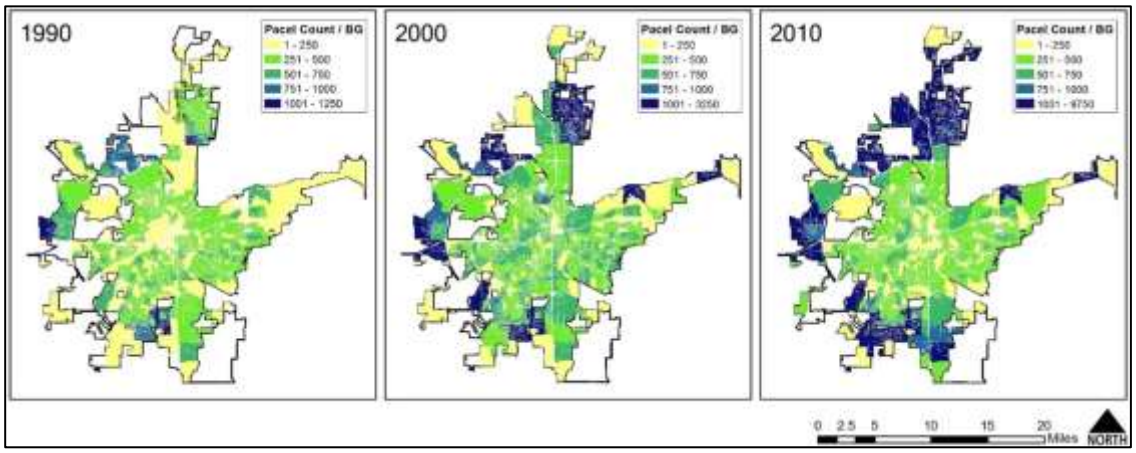


Figure 17 The Count of Non-Vacant Parcels per Block Group

As well, the ratio of overall non-vacant parcels per block group was calculated. This is the sum of the area of all non-vacant parcels divided by the block group area. The result of this analysis showed that overall NVL development had proceeded from 1990 to 2010. In 1990, almost all block groups located on the edge of the city and around the CBD area showed little development. The overall non-vacant parcel area ratio is very low, less than 20 percent. However, in 2000, the overall non-vacant parcels per block

group are dispersed, the dark green sections illustrate the increase and spread. Moreover, in 2010, the green and dark green sections are more dispersed toward the periphery of the city (see Figure 18).

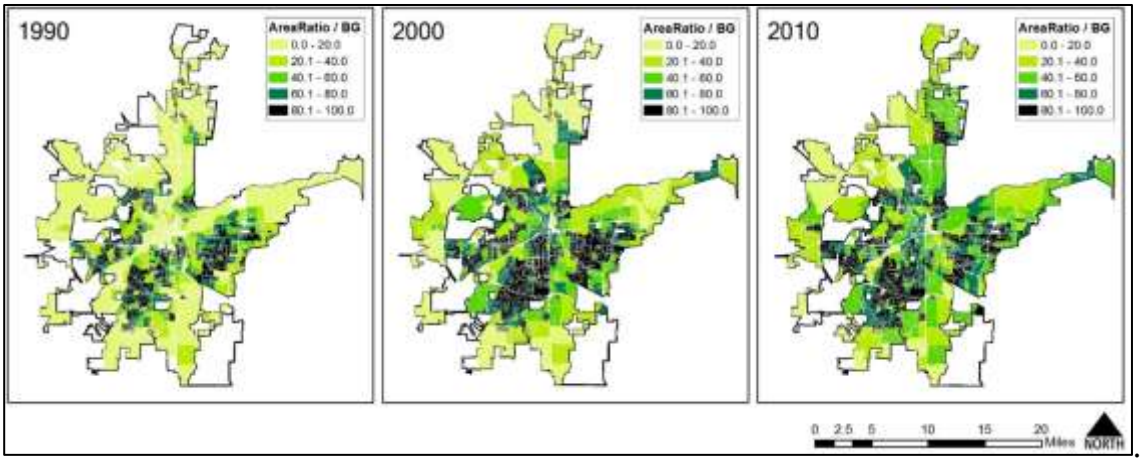


Figure 18 The Area Ratio of NVL per Block Group by the Same Interval

Along with these results, the mean center analysis and directional distribution analysis results showed comparable results (see Figure 19). The centers of the overall non-vacant parcels are moving toward the CBD (small black dot). Especially, compared to the mean center in 2000 and 2010, there is a huge movement. Also, the directional distribution results illustrate that the distribution of the overall non-vacant parcels in each year is dispersing, and the circles are getting larger. The results were the same for the mean center. There was a huge dispersion and spreading between 2000 and 2010, especially in the north-south direction.

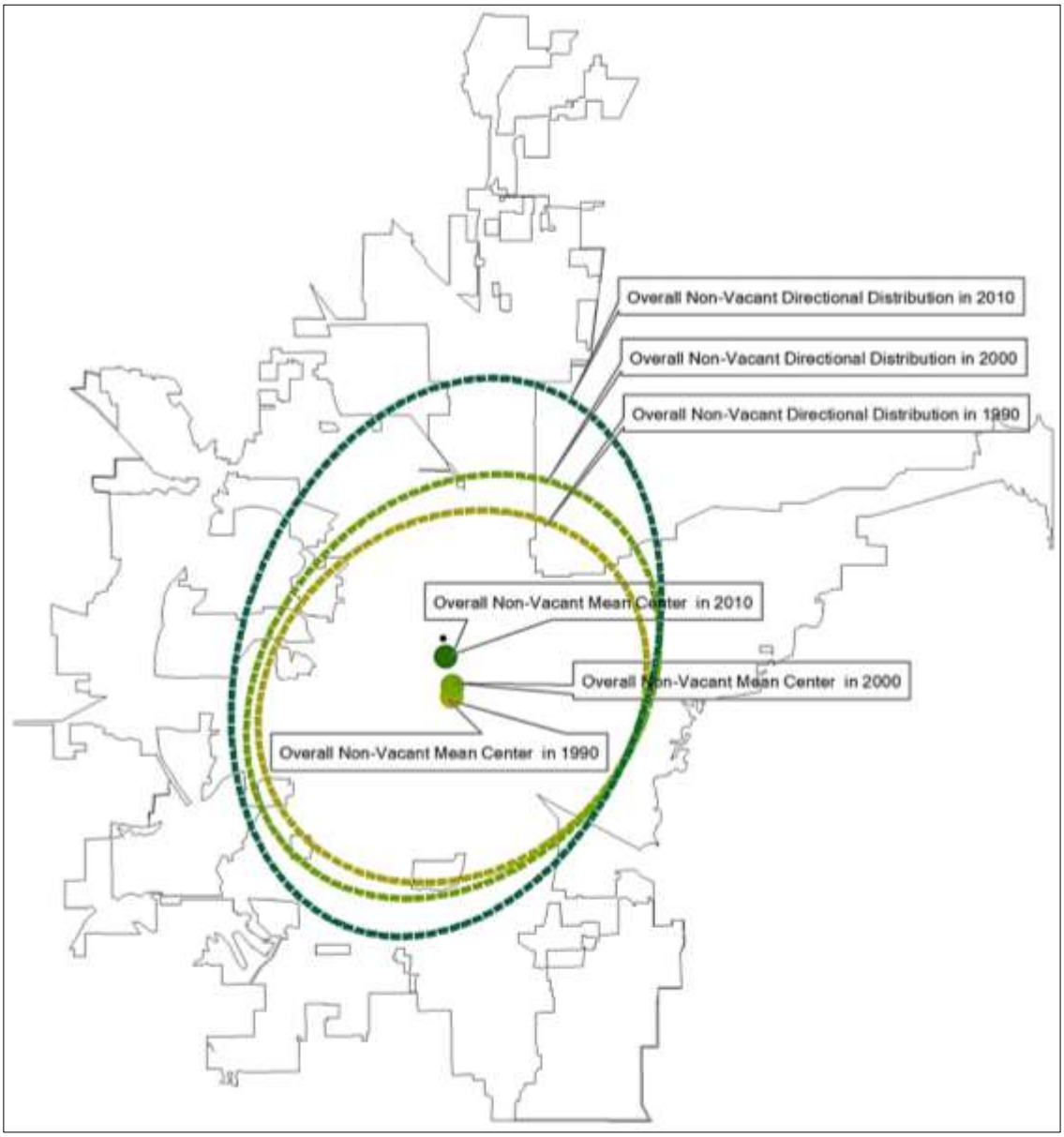


Figure 19 The Mean Center and Directional Distribution of Overall NVL

To examine the clustering pattern, this research employed a spatial autocorrelation and hotspot analysis of the overall non-vacant parcels, using the parcel area ratio and parcel count ratio. First, analyzed the spatial pattern of the overall non-

vacant parcels to determine if the dispersion was random or clustered, using the Global Moran's I tool. The parcel area ratios and the parcel count ratios of the overall non-vacant parcels indicated clustered patterns. Based on the given z-scores, there is a less than 1 percent likelihood that this clustered pattern could be the result of random chance (see Appendix B).

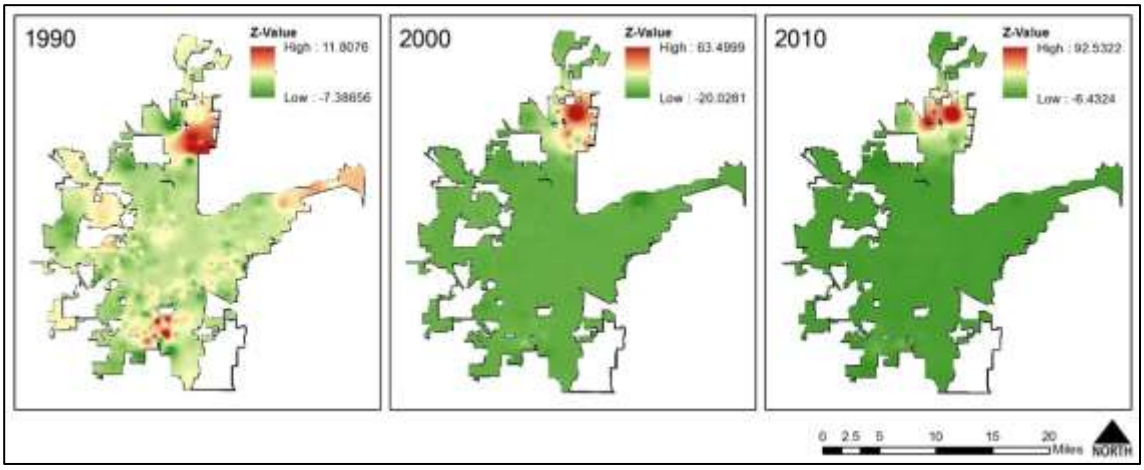


Figure 20 Local Moran's I Results of the Count of Non-Vacant Parcels

Based on the Global Moran's I results, this research discovered how they clustered, using the Local Moran's I tool. The count ratio of non-vacant parcels in the CFW showed that many non-vacant parcels were clustered on the north side of the city only. Also, the large size non-vacant parcels were clustered in the outskirts of the city and irregularly inside the city in 1990 and 2000, while in 2000, the clustered large sized non-vacant parcels were gone from the fringe of the city (See Figures 20 and 21).

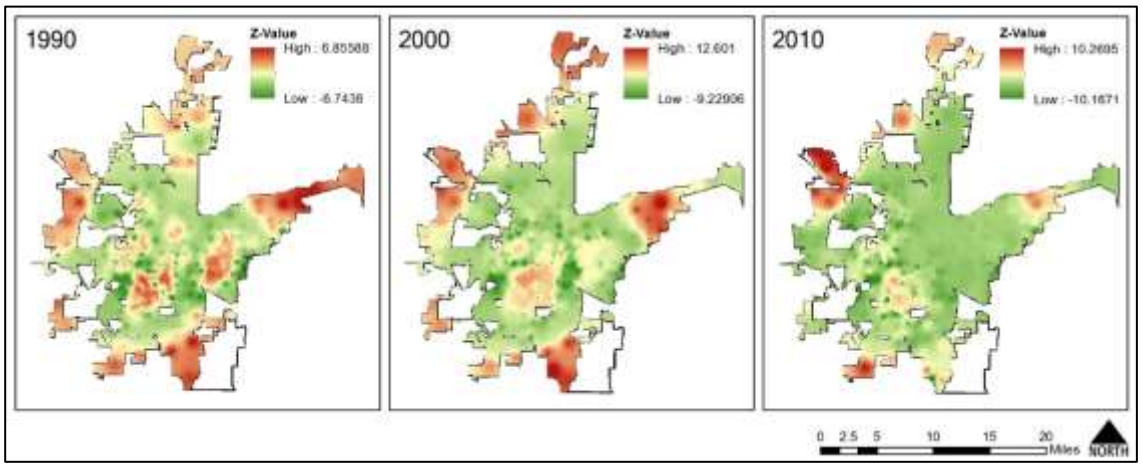


Figure 21 Local Moran's I Results of the Area of Non-Vacant Parcels

As the hotspot analysis results of the non-vacant parcels showed, a high number of overall non-vacant parcels were clustered on the north side of the city in 1990, 2000 and 2010. However, a large number of non-vacant clustered parcels on the south side of the city vanished. On the other hand, there was a large number of non-vacant parcels clustered near the center of the city. Indeed, they increased from 1990 to 2000 but decreased between 2000 and 2010. From these results, it is seen that there were a large number of non-vacant parcels on the periphery of the city and relatively few parcels are clustered (see Figures 22 and 23).

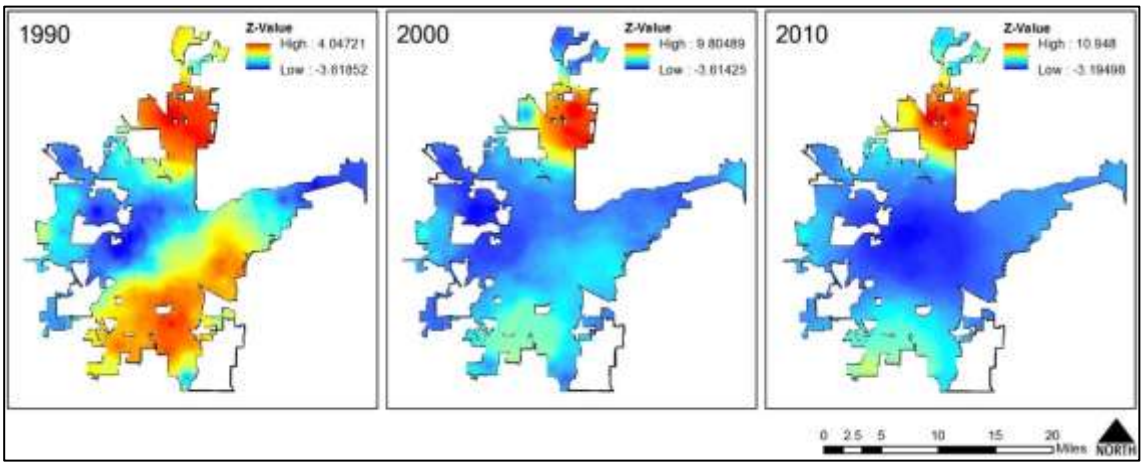


Figure 22 The Hotspot Results of the Count of Non-Vacant Parcels

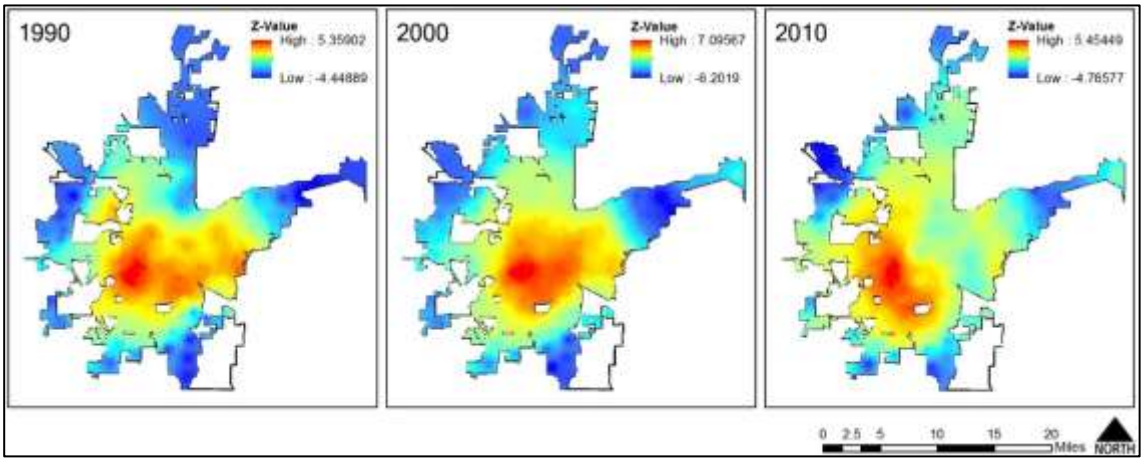


Figure 23 The Hotspot Results of the Area of Non-Vacant Parcels

6.2.2 Findings

Through the overall NVL descriptive spatial analysis of the CFW, this research discovered that the number of overall NVL parcels increased continuously from 1990 to 2010 (see Table 11). It indicated that there was continuous development in the CFW. The number of overall NVL parcels in the center of the city was small in the 1990s while

the amount of overall NVL increased and spread to the entire city area. Thus, the entire CFW was urbanized from1990 to 2010. Moreover, the overall NVL parcels had a relatively regular spatial distribution direction in a north-south direction. Many overall NVL use parcels were clustered at the edge of the city while large sized overall NVL parcels were clustered in the center of the city. These findings improved that the CFW is the growing city; the development and urbanization occurred in the suburban area rather than inner city area.

Table 11 Non-Vacant Land Spatial Analysis Findings

- Amount of the NVL parcels increased from 1990 to 2010
- Continuously urbanization occurred, especially in a north-south direction in CFW
- Relatively, NVL is located on the edge of the city

6.2.3 Discrete-Time Hazard Quantitative Analysis

The occurrence of vacant and abandoned and overall non-vacant properties over the study period is depicted in Figure 24. Among 116,994 overall non-vacant parcels, 16,069 (13.7%) converted to vacant from 1990 to 2010. Mostly, the conversion from overall non-cant to vacant occurrences were city-wide. Using the discrete time hazard analysis, the factors that had a significant relationship with the conversion from NVL to vacant were identified (see Table 12). The dependent variable is the overall non-vacant parcel's usage status. The explanatory variables included those identified in the literature review.

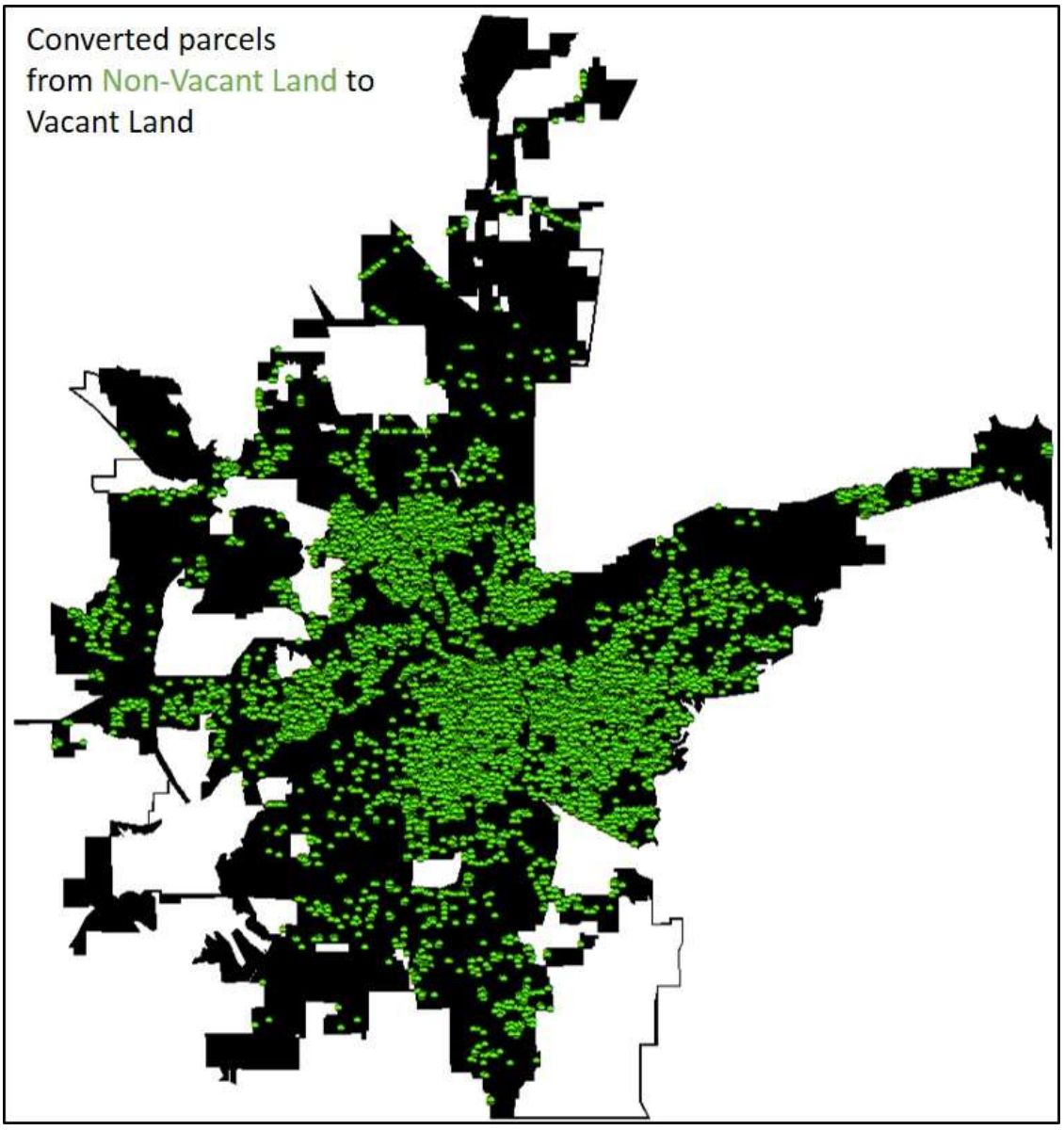


Figure 24 The Occurrence of VL from Overall NVL from 1990 to 2010

The SES characteristics were measured using the block group level data from the 1990 census. Specifically, eight variables were selected including population, gender, race, income, automobile, employment, and family type.

Table 12 The Overall Non-Vacant Data Description

Variable			Overall (Obs. 116994)			
			Mean	Std. Dev.	Min	Max
SES (8)	Population	Total Population (100Person)	10.00	5.81	0.00	34.98
	Gender	Male Population (%)	48.82	6.00	0.00	100.00
	Race	Non-White (%)	47.66	33.30	0.00	100.00
	Education	Less than 9th Grade (%)	14.70	14.43	0.00	64.56
	Income	Households Median Income ($1000)	40.10	16.62	0.00	92.14
	Automobile	Vehicle (%)	83.92	66.31	0.00	523.60
	Employment	Unemployed (%)	4.49	5.63	0.00	103.33
	Family Type	With Children (%)	33.83	51.83	0.00	352.38
BE (13)	Housing Unit	Total Housing Unit	429.22	218.98	0.00	1764.00
		Occupied Units (%)	84.75	12.80	0.00	100.00
	Ownership	Ownership (%)	53.74	31.31	0.00	100.00
	Vacant Purpose	Vacant Units for sale only (%)	0.26	0.33	0.00	1.00
	Vacant Duration	Less than 2months (%)	13.62	28.40	0.00	621.43
		2 up to 6 months (%)	21.18	24.46	0.00	436.36
		More than 6months (%)	42.08	60.85	0.00	1036.00
	Building Type & Structure	Multihousing (%)	0.24	0.22	0.00	1.00
		Mobile Home or trailer (%)	0.10	0.18	0.00	1.00
	Housing Value	Median Housing Value ($1000)	67.68	56.68	0.00	500.00
	Land Value	Land Value($1000)	58.65	358.49	0.00	33000.00
	Parcel Age	Parcel Age (2015-Parcel year)	46.10	28.77	0.00	191.00
	Structure Count	Structure Count	0.81	0.45	0.00	6.00
GEO (4)	Spatial	Hotspot	-1.49	8.25	-15.88	28.81
		Local MoransI	1.15	11.67	-414.61	982.24
	Distance	Distance from CBD (1000feet)	25.34	12.90	0.02	97.00
	Size	Parcel Size (100sqft)	74.30	117.48	0.00	6772.58

The BE characteristics were identified using block group level data from the 1990 census as well. Thirteen variables were selected including housing unit, ownership, the purpose of vacancy, duration of vacancy, building type and structure, housing value,

land value, parcel age, and structure count. The GEO characteristics were generated using the NCTCOG land use data in 1990 at the parcel level, and four variables were selected: hotspot z-scores, Local Moran's z-scores, distance from the CBD, and the parcel size.

The hotspot and Local Moran's I z-scores were generated using the parcel's size. The distance from the CBD was measured from the CBD to a parcel's centroid point. For each predictor, the coefficient[8] and the fitted odds ratio are reported (see Table 13).

The Model I includes only the SES variables. The results indicated that a large population, low educational level, low household median income, and the family with children produced fewer vacancies while male, non-white, and high unemployment produced more vacancies. The estimated odds ratio for an overall non-vacant property becoming vacant or abandoned are nearly 5 percent lower when the population of city increases by 100 people. The estimated odds are about 10 percent higher when the male population in city increases by 10 percent. Similarly, the estimated odds ratio for an overall NVL changing to VAP is nearly 20 percent higher when the non-white population in the city increases by 10 percent. Moreover, the estimated odds are 9 percent higher when the unemployment rate increases by 10 percent. On the other hand, when the lower education level population increases by 10 percent, the estimated odds ratio for an overall NVL conversion to vacant are 2 percent lower. The estimated odds ratio for conversion from non-vacant to vacant is 0.9 percent when the median

[8] The coefficient (β_i) represents the estimated logit change given a one unit difference in a predictor. The odds ratio can then be estimated as $\exp(\beta_i)$.

household income increases by $1000. Also, when the family with children rate increases by 10 percent, the estimated odds for overall non-vacant conversion to vacant are 3 percent lower (see Table 13).

Model II adds the BE characteristics to the model. Due to the added variables, the estimated odds of the socioeconomic variables showed different results. The results point out that a large total population, big male population, high household median income, high vehicle ownership, high occupied units, and units vacant more than two months, high land value, old parcel age, and many structures produced fewer vacancies. While, a high non-white population, lower education level, high unemployment, the family with children, house ownership, units vacant less than two months, and high median housing values produced more vacancies. Compared with Model I, the male population (more to less), educational level (less to more), and the family type (less to more) showed an opposite relationship with overall non-vacant conversion to vacant in Model II; and vehicle ownership showed a negative relationship with the conversion. Total housing units, the purpose of vacancy, and housing type and structure had no relationship with the overall non-vacant conversion to VAP.

The estimated odds ratio for an overall non-vacant property becoming vacant or abandoned are nearly 2 percent lower when the population in the city increases by 100 people.

Table 13 The Overall NVL Use Conversion Results of the DTHM Analysis

Variable			Model 1 COEF (OR)	Model 2 COEF (OR)	Model 3 COEF (OR)
SES	Population	Total Population (100Person)	-0.0553*** (0.946)	-0.0230*** (0.9773)	-0.0288*** (0.9716)
	Gender	Male Population (%)	0.0102*** (1.010)	-0.0143*** (0.9858)	-0.0137*** (0.9864)
	Race	Non-White (%)	0.0181*** (1.018)	0.0128*** (1.0129)	0.0144*** (1.0145)
	Education	Less than 9th Grade (%)	-0.0019*** (0.998)	0.0076*** (1.0076)	0.0081*** (1.0081)
	Income	Households Median Income ($1000)	-0.0088*** (0.991)	-0.0049*** (0.9951)	-0.0057*** (0.9943)
	Automobile	Vehicle (%)		-0.0008** (0.9992)	-0.0008** (0.9992)
	Employment	Unemployed (%)	0.0086*** (1.009)	0.0077*** (1.0077)	
	Family Type	With Children (%)	-0.0034*** (0.997)	0.0015*** (1.0015)	0.0010** (1.0010)
BE	Housing Unit	Total Housing Unit			0.0003** (1.0003)
		Occupied Units (%)		-0.0060*** (0.9940)	-0.0063*** (0.9937)
	Ownership	Ownership (%)		0.0086*** (1.0086)	0.0084*** (1.0084)
	Vacant Purpose	Vacant Units for sale only (%)			
	Vacant Duration	Less than 2months (%)		0.0029*** (1.0029)	0.0021*** (1.0021)
		2 up to 6 months (%)		-0.0023*** (0.9977)	-0.0027*** (0.9973)
		More than 6months (%)		-0.0028*** (0.9972)	-0.0029*** (0.9971)
	Building Type & Structure	Multihousing (%)			0.2085** (1.2319)
		Mobile Home or trailer (%)			
	Housing Value	Median Housing Value ($1000)		0.0027*** (1.0027)	0.0024*** (1.0024)
	Land Value	Land Value ($1000)		-0.0014*** (0.9986)	-0.0014*** (0.9986)
	Parcel Age	Parcel Age (2015-Parcel year)		-0.0776*** (0.9253)	-0.0772*** (0.9257)
	Structure Count	Structure Count		-4.1841*** (0.0152)	-4.2339*** (0.0145)
GEO	Spatial	Hotspot			
		Local MoransI			
	Distance	Distance from CBD (1000feet)			0.0119*** (1.0120)
	Size	Parcel Size (100sqft)			
		R2	0.0873	0.7502	0.7508

n = 116994, number of events = 16069
*p < 10%, ** p < 5%, *** p < 1%

Compared with Model I, the estimated odds ratio is decreased. If the male population, vehicle ownership, occupied units, and units vacant more than 2 months variables each increases by 10 percent in a city, the estimated odds decrease by about 14 percent for male population, about 0.8 percent of vehicle ownership, 6 percent for occupied units, about 2 percent of the units vacant 2 up to 6 months, and 3 percent for the units vacant more than 6 months.

Also, if median household income increases by $1000, the estimated odds ratio for an overall non-vacant conversion are 0.5 percent lower. If the land value increases by $1000, the estimated odds ratio are 0.1 percent lower also. Model II also suggests that older properties in the study area are less likely to become vacant. The estimated odds of an overall non-vacant parcel becoming vacant are nearly 7.5 percent lower for each year it ages. Along with this, the many structures in the CFW are less likely to become vacant. The estimated odds of an overall non-vacant parcel becoming vacant are 98 percent lower, when for each the structure count increase.

When the non-white population increases by 10 percent, the estimated odds ratio for an overall NVL conversion to vacant is 12 percent higher. The estimated odds ratio for conversion from non-vacant to vacant is 7 percent when the low educational population rate increases 10 percent. Also, when the unemployment rate increases by 10 percent, the estimated odds for overall non-vacant conversion to vacant are 8 percent higher. When a family with children increases by 10 percent, the estimated odds ratio is 0.1 percent higher. This research assumes that the family type and the overall non-vacant conversion has a relationship, but the degree is not strong enough to measure. Moreover,

as ownership increases 10 percent, the estimated odds are 8 percent higher. As the unit vacancy rate of less than two months increases by 10 percent, the estimated odd are 3 percent higher as well. Model II also indicated that a higher median housing value in the study area is more likely to become vacant. The estimated odds of an overall non-vacant conversion are nearly 0.3 percent (see Table 13).

Model III is the full model. It adds the GEO characteristics variables, especially the variables measuring the distance from the CBD and parcel size. The substantive findings on the SES remain similar, except unemployment. Unemployment in Model III changed, and the result has no relationship with the overall NVL conversion to vacant. The essential findings on the BE continue to show parallel results, except total housing unit and multi-housing. The total housing unit and multi-housing changed from not significant to more vacancy. When the total housing unit increases by 10 unit, the estimated odds are 0.3 percent higher; and when multi-housing increases by 1 percent, the estimated odds are 23 percent higher.

The added GEO characteristics, the overall non-vacant z-scores of the hotspot and Local Moran's I, and the parcel size had no relationship with land use conversion. Nevertheless, the estimated odds ratio for an overall non-vacant property becoming vacant or abandoned are nearly 1.2 percent higher when the distance from the CBD increases by 1000 feet (see Table 13). From this result, it was found that the further distance that properties are from the CBD they had a significant relationship with the conversion of overall NVL to vacant; and more VAP conversion is created at a further distance from the CBD than closer.

In the Model I, only consider the SES variables, the R-square value is a fairly small (0.0873). It represents that the SES variables have a significant relationship with the conversion from NVL to VAP, it is difficult to explain this phenomenon with only SES variables. In the Model II, when the BE variables added, the R-square value is increased as 0.7502. It means the BE variables are clearly the most important influenced factors rather than SES and GEO variables.

6.2.4 Findings

From the results of the discrete time hazard quantitative analysis of the overall NVL use conversion to VAP in the CFW, consistent with the literature, it was found that a large population created fewer vacancies. When only considering the SES, a non-white population had the most significant relationship with the conversion to VAP, while a large population had the most significant relationship with the creation of less VAP. Within the SES and BE variable, many non-vacant structures had a significant relationship with the formation of less VAP, while a non-white population had a significant relationship with the conversion to VAP once more. In the full model, containing SES, BE, and GEO characteristics, similar to the results of Model II, many non-vacant structures had a significant relationship with the formation of less VAP. On the other hand, multi-housing had a significant relationship with the conversion to VAP in the full model. Besides, the further the distance from the CBD a parcel is had a significant relationship with the production of more VAP (see Table 14).

Table 14 Non-Vacant Land DTHM Analysis Findings (From NVL to VAP)

	More	Fewer
SES	• Non-white population • Low educational attainment • The family with children	• Large population • Male population • High median income • Many vehicle owners
BE	• Many housing units • Large ownership • Less than two months vacant duration • Multihousing unit • High housing price	• Many occupied units • More than two months vacant duration • Lower land value • Old parcel • Many structure count
GEO	• Further distance from CBD	

According to the findings of the results to conversion VAP from NVL implicate several important influences. First of all, as a growing city, population growth, especially well-educated, high income, and employed population create a fewer VAP. Moreover, the access from the CBD – close distance - and arterial road via vehicle also create a fewer VAP. Relatively, long duration of the vacancy and the old parcel including the structure, and low land value produce a fewer VAP. Oppositely, people prefer to live a single family house, racial segregation; high housing price generates a more VAP. Based on these finding, they implicate that the affordable housing price, better public transportation, preserve the historical area, reuse or revitalization of the existing structure are needed to prevent making a VAP.

6.3. Residential Land to Vacant Land

The residential land use in CFW and the conversion from residential to VAP, this research expects that the concentrated residential land use area will be located on the edge

of the city; and the residential land use in the inner-city area will be decreased. Moreover, the significant impact variables to create more VAP from the residential land use will be the population, race, education, income, family type and automobile from the SES variables; housing unit, ownership, building type and structure, housing value, land value, parcel age, and structure count from the BE variables; and the distance from CBD and parcel size from the GEO variables.

6.3.1 Descriptive Spatial Analysis

In this section, the residential parcels in the CFW are analyzed. The number of parcel counts per block group was employed, using a quantile classification. From 1990 to 2010, the amount of residential land per block group showed that the center of the city's residential count ratio decreased as time went by. The results for 2010 are illustrated in yellow for comparison with the 1990 results. Moreover, during the study period, the high residential count ratio emerges continuously at the edge of the city (see Figure 25).

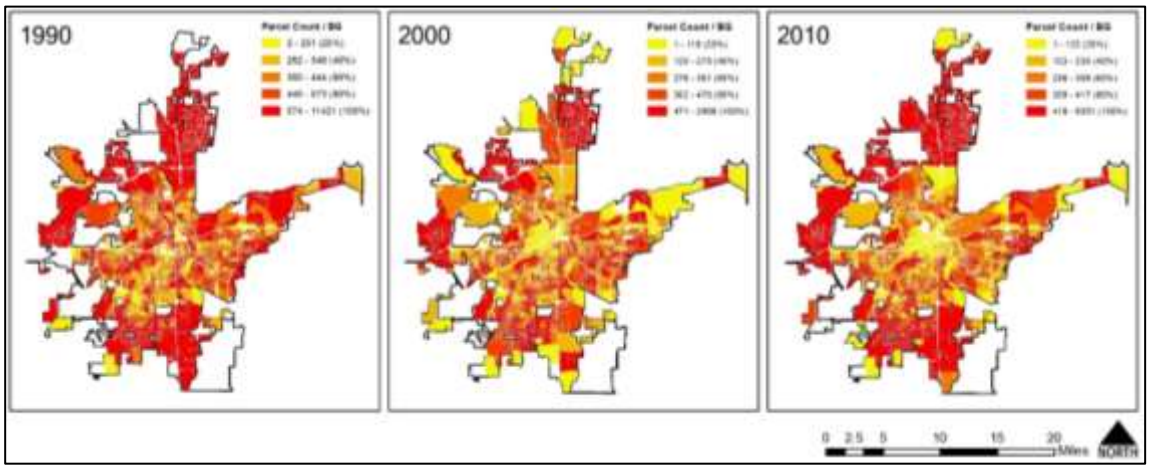


Figure 25 The Number of Residential Parcels per Block Group by Quantile

For a more vibrant pattern analysis, the results of the number of residential parcels per block group are identified using a convinced category classification. Based on the quantile results of the residential count ratio, the parcel count per block group was separated into four different intervals. This result shows more clearly the residential parcel count ratio pattern. The blue section has the highest number of residential parcels per block group, and this block group includes more than 1001 residential parcels. They are located almost completely on the edge of the city. The results showed that from 1990 to 2010, the area around the CBD had a decreased number residential parcels per block group, which turns the area from green to yellow for most all of the CBD and surrounding area. Thus, this means that from 1990 to 2010 many residents in the center of the city left their homes, or the land use was changed to another land use (see Figure 26).

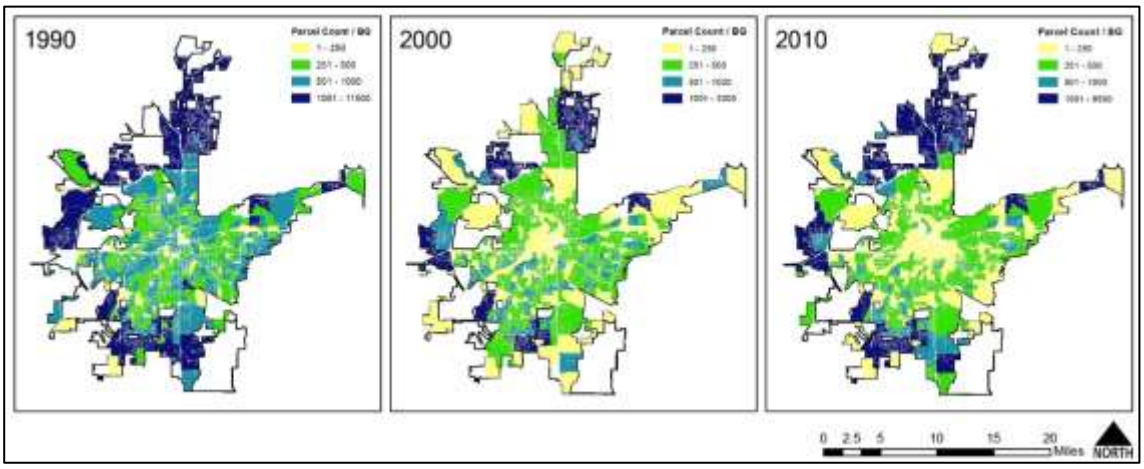


Figure 26 The Count of Residential Parcels per Block Group

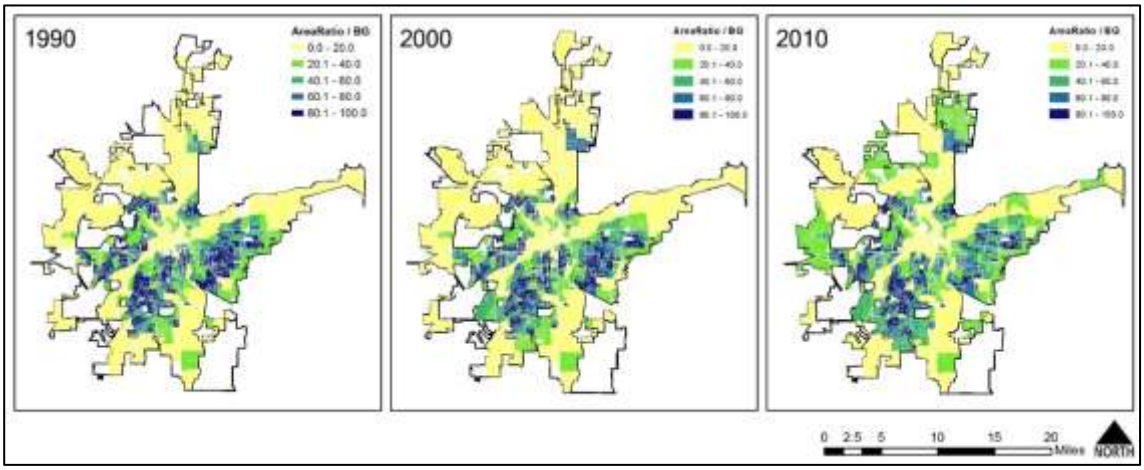


Figure 27 The Area Ratio of Residential per Block Group by the Same Interval

At this time, the ratio of residential parcels per block group was calculated using the sum of all the area of the residential parcels divided by the block group area. The results of this analysis showed that a large portion –over 80 percent – of the residential land use was dispersed toward the outskirts of the city from 1990 to 2010. Moreover, the yellow section, which is less than 20 percent of residential land use, turns to green,

particularly at the fringes of the city area. This means that the residential land use shifted toward the outskirts of the city (see Figure 27).

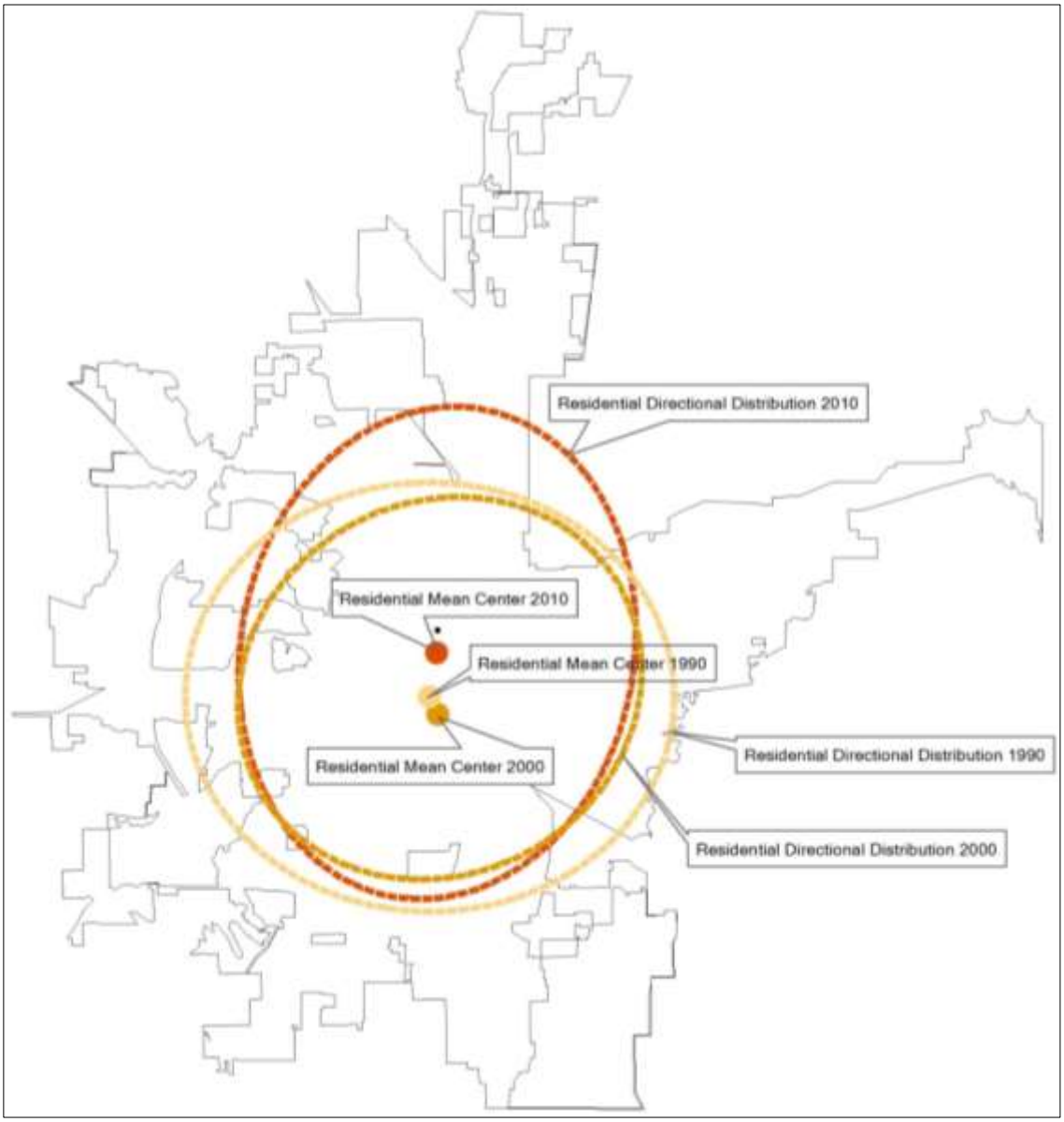


Figure 28 The Mean Center and Directional Distribution of Residential Parcels

Along with these ratio results, the residential parcel's mean center analysis and directional distribution analysis results showed coincident results. The mean center of the residential parcels are moving toward the CBD; the small black dot is the center of the city. Compared with the mean center in 2000, the mean center in 2010 shows huge movement. Also, the directional distribution results illustrate that the distribution of residential parcels in each year was very irregular. This research found that the residential parcels had no distribution and land use patterns (see Figure 28).

To examine the residential land use clustering pattern, a spatial autocorrelation and hotspot analysis of the residential parcels was employed using the parcel area ratio and parcel count ratio. First, the spatial pattern of residential parcels was analyzed using the Global Moran's I tool to determine if the dispersion was random or clustered. All of the parcel area ratios and parcel count ratios of the residential parcels indicated clustered patterns. Based on all the given z-scores; there is a less than 1 percent likelihood that this clustered pattern could be the result of random chance (see Appendix B).

Based on the Global Moran's I results, this research discovered how residential parcels were clustered, using the Local Moran's I tool. The count ratio of residential parcels in the CFW showed that residential parcels were mostly clustered on the eastern side of the city in 1990. In 2000, many clustered residential parcels were located in the north and south ends of the city. Then, the clustered residential parcels moved to the northwestern side in 2010. Similar to the directional distribution, there was no consistent pattern in the count ratios of residential land use (see Figure 29).

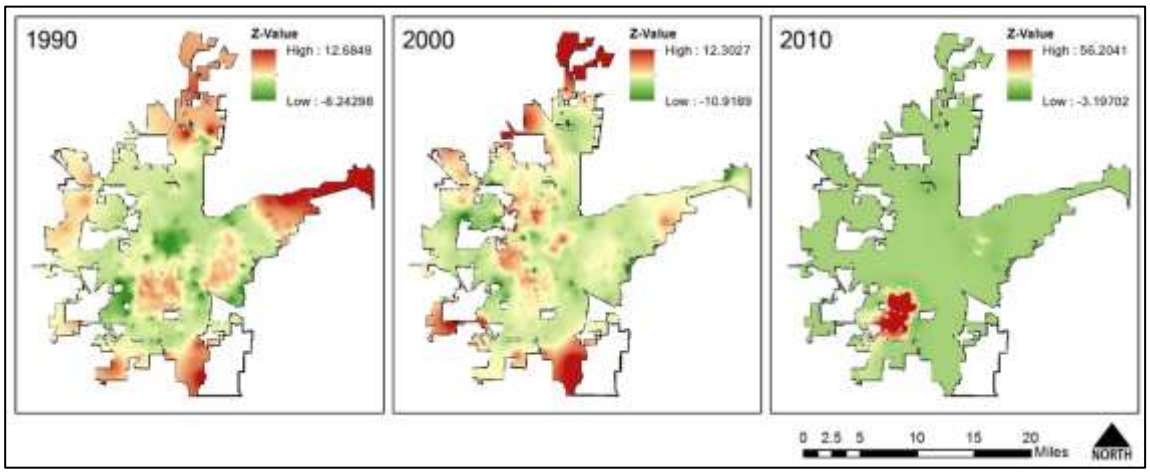


Figure 29 Local Moran's I Results for the Count of Residential Parcels

Also, the area ratios of residential parcels were irregularly clustered on the east and west outskirts of the city and inside of the city in 1990. However, the residential parcels clustered on the eastern side were gone in 2000, while, in 2010, the area ratios of clustered residential parcels were concentrated in the center of the city (see Figure 30).

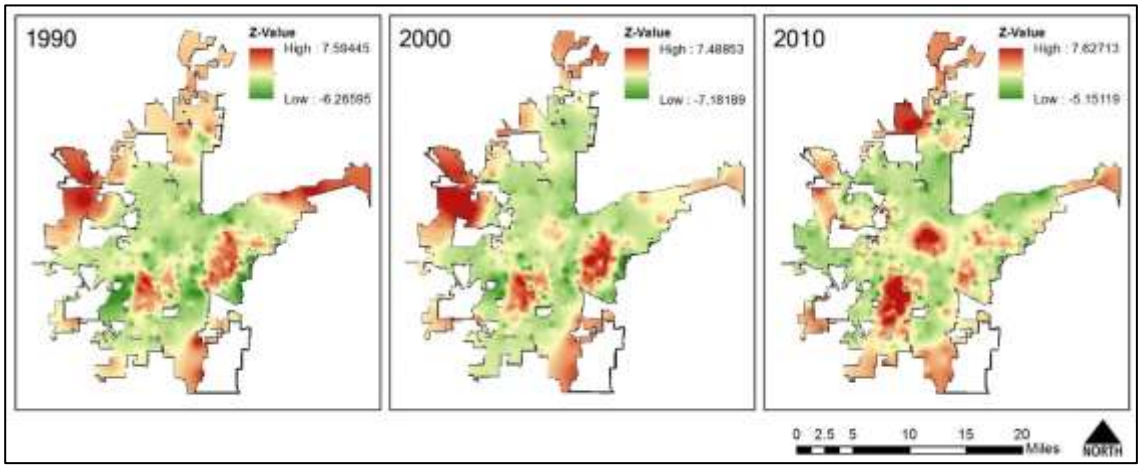


Figure 30 Local Moran's I Results for the Area of Residential Parcels

From the hotspot analysis results, the count of residential parcels results showed that a high number of residential parcels were clustered in the center of the city in 1990 and 2000. Compared with the results of the Local Moran's I, this research found that a small number of residential parcels were clustered on the east side of the city in 1990; and in the ends of the north and south parts of the city in 2000, while a large number of residential parcels were strongly clustered in the northwestern area of the city in 2010 (see Figure 31).

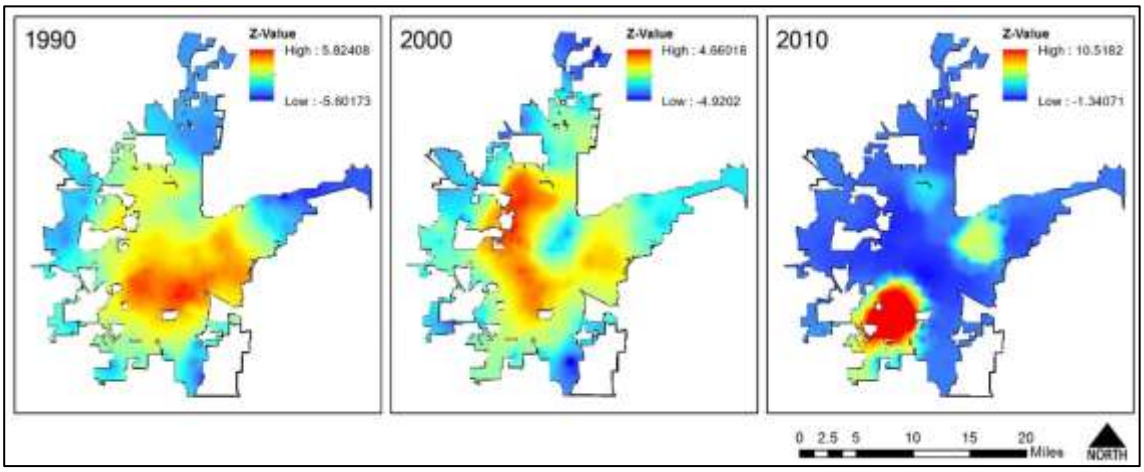


Figure 31 Hotspot Results of the Count of Residential Parcels

Related to parcel size, the large sized residential parcels were clustered in the center of the city in 1990, and they were separated into two parts in 2000 and 2010. Compared with the results of the Local Moran's I, small sized residential parcels were clustered in the periphery of the city (see Figure 32).

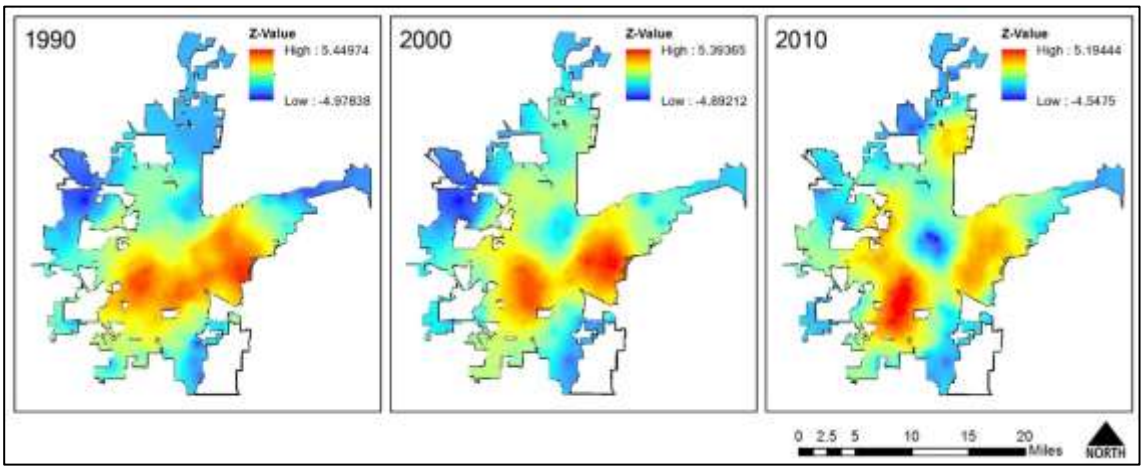


Figure 32 Hotspot Results of the Area of Residential Parcels

6.3.2 Findings

Through the descriptive spatial analysis of the residential land use in the CFW, this research found that the number of the residential land parcels decreased continuously from 1990 to 2010. The residential land parcels were mostly located in the area east of the city center in the 1990s, and they were large sized. They moved toward to the western side of the city in 2000 and were concentrated on the northwestern edge of the city in 2010. Moreover, the residential land parcels had no special distribution directions. These findings implicated that due to the annexation and the City of Arlington, the residential land use development in CFW tent to connection with the City of Arlington as a metropolitan area (Dallas-Arlington-Fort Worth) in 1990. In 2000, the CFW established many downtown revitalization and residential redevelopment policies and strategies (see Appendix A). Due to this effort, the CFW residential land use in the CFW inner-city are increased from 2000. Nevertheless, more recently in 2010, another small city – Grapevine and Benbrook - which have an attractive settlement environment

such as a lake, low land/housing price, low density, and close distance from the CFW developing and growing. Following this phenomenon, the CFW residential land use occurred the near of the Grapevine and Benbrook, north-south edge of the city (see Table 15).

Table 15 Residential Land Use Spatial Analysis Findings

• Many residential land use parcels are located on the edge of the city, suburban area • According to the annexation, large single family residential are development on the edge of the city
• In 1990, relatively, the development of the residential land use linked with Arlington; but in 2010, the development of the residential land uses linked with Grapevine and Benbrook • In 2000, the CFW had many redevelopment and revitalization strategies for the inner city – the distribution of residential land use concentered in the inner city in 2000

6.3.3 Discrete-Time Hazard Quantitative Analysis

The occurrence of vacant and abandoned residential properties over the study period is depicted in Figure 33. The conversion from residential to vacant occurred mostly in the inner city area rather than the edge of the city, except on the western edge of the city. Using a discrete-time hazard analysis, the factors that have a significant relationship with the conversion from the residential land to vacant was determined. The residential land observation number was 107803, among them, 13,237 (12.3%) converted to vacant from 1990 to 2010 (see table on p.123). The dependent variable is the usage status of the residential parcels. The explanatory variables included those

identified by the literature review. The SES characteristics were measured using block group level data from the 1990 census.

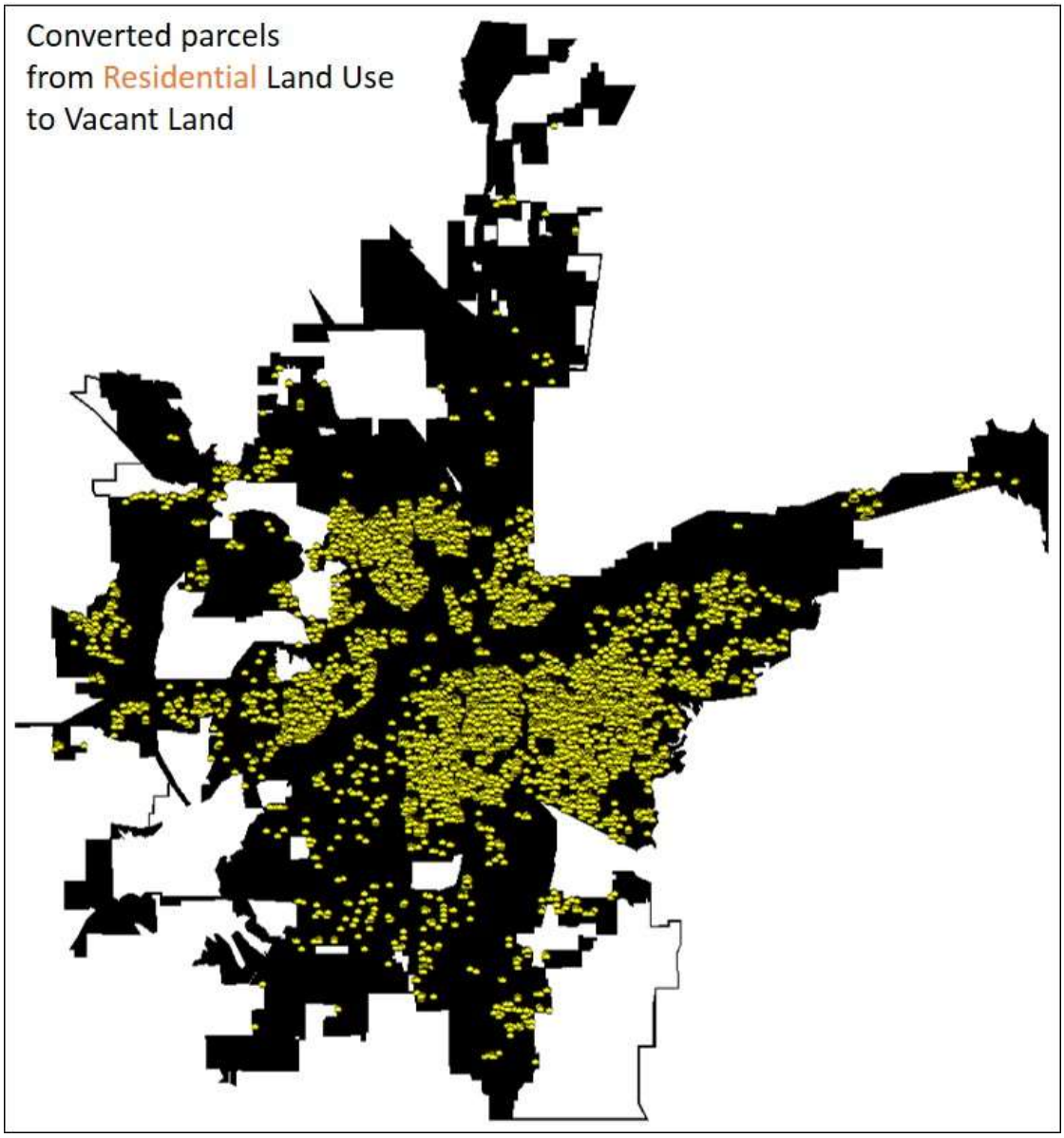


Figure 33 The Occurrence of VL from Residential Properties from 1990 to 2010

Specifically, eight variables were selected including population, gender, race, income, automobile, employment, and family type. The BE characteristics were identified using block group level data from the 1990 census, as well. Specifically, thirteen variables were selected including housing unit, ownership, the purpose of vacancy, duration of vacancy, building type and structure, housing value, land value, parcel age, and structure count.

The GEO characteristics were generated using the NCTCOG land use data from 1990 at the parcel level. Especially, four variables were selected: Hotspot z-score, Local Moran's z-score, distance from the CBD, and the parcel size. The Hotspot and Local Moran's I z-scores were generated using the size of the parcel. The distance from the CBD was measured from the CBD to the parcel's centroid point (see Table 16).

Model I includes only the SES variables. Model I results showed similar results of residential conversion with the overall non-vacant conversion. This indicates that a large population, low educational level, low household median income, and a family with children produced fewer vacancies. While male, non-white, and high unemployment produced more vacancies. Vehicle ownership had no relationship with the residential conversion. The estimated odds ratio for a residential property becoming vacant or abandoned are nearly 8 percent lower when the population in the city increases by 100 people. The estimated odds are about 10 percent higher when the male population in city increases by 10 percent.

Table 16 Residential Data Description

Variable			Residential (Obs. 107803) Mean	Std. Dev.	Min	Max
SES (8)	Population	Total Population (100Person)	10.14	5.77	0.00	34.98
	Gender	Male Population (%)	48.59	5.18	0.00	100.00
	Race	Non-White (%)	47.68	33.78	0.00	100.01
	Education	Less than 9th Grade (%)	14.52	14.16	0.00	64.56
	Income	Households Median Income ($1000)	40.32	16.46	0.00	92.14
	Automobile	Vehicle (%)	84.72	68.11	0.00	523.60
	Employment	Unemployed (%)	4.39	5.01	0.00	103.33
	Family Type	With Children (%)	35.13	52.65	0.00	352.38
BE (13)	Housing Unit	Total Housing Unit	430.12	220.73	0.00	1727.00
		Occupied Units (%)	84.82	12.70	0.00	100.00
	Ownership	Ownership (%)	54.95	31.24	0.00	100.00
	Vacant Purpose	Vacant Units for sale only (%)	22.57	23.09	1.00	64.00
	Vacant Duration	Less than 2months (%)	12.61	17.14	0.00	94.44
		2 up to 6 months (%)	20.80	20.68	0.00	100.00
		More than 6months (%)	31.93	29.45	0.00	100.00
	Building Type & Structure	Multihousing (%)	0.35	0.36	0.00	1.00
		Mobile Home or trailer (%)	0.11	0.18	0.00	0.98
	Housing Value	Median Housing Value ($1000)	73.45	55.34	0.00	500.00
	Land Value	Land Value($1000)	34.22	181.51	0.00	23000.00
	Parcel Age	Parcel Age (2015-Parcel year)	47.86	28.15	0.00	191.00
	Structure Count	Structure Count	0.88	0.39	0.00	6.00
GEO (4)	Spatial	Hotspot	-1.56	8.54	-15.88	27.95
		Local MoransI	1.16	10.36	-414.61	923.80
	Distance	Distance from CBD (1000feet)	25.84	12.35	0.02	91.43
	Size	Parcel Size (100sqft)	80.63	120.28	0.00	6772.58

Similarly, the estimated odds ratio for a residential land changing to VAP is nearly 20 percent higher when the non-white population in the city increases by 10 percent. Moreover, the estimated odds are 4 percent higher when the unemployment rate increases by 10 percent. On the other hand, when the lower education level population increases by 10 percent, the estimated odds ratio for a residential land conversion to vacant are 1 percent lower. The estimated odds ratio for conversion from residential to vacant is 0.6 percent when the household median income increases by $1000. Also, when the family with children rate increases by 10 percent, the estimated odds for overall non-vacant conversion to vacant are 3 percent lower (see table on p.126).

Model II adds the BE characteristics to the model. Model II results emphasized that a large population, high household median income, a unit vacant less than 2 months, a unit vacant more than 6 months, mobile home or trailer, high median housing value, high land value, the age of the parcel, and a large structure count produce fewer vacancies. While only three variables which are a large non-white population, a low educational level population, and a family with children produced more vacancies. Compared with Model I, the male population (more to no relationship), low educational level (less to more), and the family type (less to more) showed an opposite relationship or lost relationship with residential conversion to vacant in Model II. Total population, vehicle ownership, unemployment rate, total housing units, occupied units, ownership, the purpose of vacancy, a unit vacant 2 up to 6 months, and multihousing had no relationship with residential land conversion to VAP.

The estimated odds ratio for a residential property becoming vacant or abandoned are nearly 4.5 percent lower when the population in the city increases by 100 people. Compared with Model I, the estimated odds ratio decreased. Also, when the median household income increases by $1000, the estimated odds ratio for a residential land use conversion are 0.3 percent lower. When a unit less than 2 months vacant or more than 6 months vacant increases by 10 percent, the estimated odds of a residential parcel becoming vacant are nearly 5 percent lower. When the mobile home or trailer rate in the city increases by 1 percent, the estimated odds ratio are 43 percent lower also. This result suggests that the mobile home or trailer had an extremely significant relationship with the conversion of residential land to vacant, much more than the other variables. Moreover, the estimated odds ratio for a residential property becoming vacant are nearly 0.2 percent lower when the median housing value and land value increases by $1000 for each variable. Model II also suggested that older properties in the study area were less likely to become vacant. The estimated odds of a residential parcel becoming vacant are nearly 6 percent lower for each year it ages. Along with this, the many structures in the CFW are less likely to become vacant. The estimated odds of a residential parcel becoming vacant are 99 percent lower for one increase in each structure. From Model II, this research found that a large number of structures in the residential land has a strong relationship with a conversion from residential land to vacant.

Table 17 The Residential Land Use Conversion Results of the DTHM Analysis

Variable			Model 1 COEF (OR)	Model 2 COEF (OR)	Model 3 COEF (OR)
SES	Population	Total Population (100Person)	-0.0802*** (0.923)	-0.0458*** (0.9553)	-0.0620*** (0.9399)
	Gender	Male Population (%)	0.0133*** (1.013)		
	Race	Non-White (%)	0.0207*** (1.021)	0.0139*** (1.0140)	0.0161*** (1.0163)
	Education	Less than 9th Grade (%)	-0.0014* (0.999)	0.0130*** (1.0131)	0.0158*** (1.0160)
	Income	Households Median Income ($1000)	-0.0065*** (0.994)	-0.0033** (0.9968)	-0.0042*** (0.9958)
	Automobile	Vehicle (%)			-0.0007* (0.9993)
	Employment	Unemployed (%)	0.0042** (1.004)		-0.0116*** (0.9885)
	Family Type	With Children (%)	-0.0031*** (0.997)	0.0019** (1.0019)	0.0026*** (1.0026)
BE	Housing Unit	Total Housing Unit			0.0002* (1.0002)
		Occupied Units (%)			
	Ownership	Ownership (%)			
	Vacant Purpose	Vacant Units for sale only (%)			
	Vacant Duration	Less than 2months (%)		-0.0049*** (0.9951)	-0.0085*** (0.9916)
		2 up to 6 months (%)			
		More than months (%)		-0.0054*** (0.9947)	-0.0074*** (0.9927)
	Building Type & Structure	Multihousing (%)			
		Mobile Home or trailer (%)		-0.5632*** (0.5694)	-0.6509*** (0.5216)
	Housing Value	Median Housing Value ($1000)		-0.0024*** (0.9976)	-0.0027*** (0.9973)
	Land Value	Land Value ($1000)		-0.0015*** (0.9985)	-0.0014*** (0.9986)
	Parcel Age	Parcel Age (2015-Parcel year)		-0.0631*** (0.9389)	-0.0618*** (0.9400)
	Structure Count	Structure Count		-4.7578*** (0.0086)	-4.8501*** (0.0078)
GEO	Spatial	Hotspot			
		Local MoransI			
	Distance	Distance from CBD (1000feet)			0.0234*** (1.0237)
	Size	Parcel Size (100sqft)			-0.0007*** (0.9993)
		R2	0.107	0.8091	0.8105

n = 107803, number of events = 13237
*p < 10%, ** p < 5%, *** p < 1%

On the other hand, when the non-white population increases by 10 percent, the estimated odds ratio for a residential land conversion to vacant are 14 percent higher. The estimated odds ratio for conversion from residential to vacant is 13 percent when the low educational population rate increases by 10 percent. Also, when the family with children increases by 10 percent, the estimated odds ratio are 2 percent higher (see Table 17).

Model III is the full model which adds the GEO characteristics variables, especially the variables measuring the distance from the CBD and parcel size. The substantive findings on the SES remain similar, except for vehicle ownership and unemployment. The vehicle ownership and unemployment variables in Model III changed. The results showed that when vehicle ownership increases by 10 percent, the estimated odds for a residential property becoming vacant or abandoned are 0.7 lower. When the unemployment increases by 10 percent, the estimated odds are 12 percent lower. The essential findings on the BE also continue to show similar results, except for the total population variable. The total population results changed from no significant to more vacancy. When the total population increases by 10 percent, the estimated odds are 0.3 percent higher. Even though the total population result changed after adding the GEO characteristics, the degree of the impact is pretty small.

Among the added GEO characteristics, the residential z-scores of the hotspots and Local Moran's I have no relationship with the residential land use conversion. Nevertheless, the estimated odds ratio for a residential property becoming vacant or abandoned are nearly 2.4 percent higher when the distance from the CBD increases by

1000 feet. From this result, this research proved that the further residential properties are from the CBD had a significant relationship with the conversion to VAP; and the further residential properties are from the CBD created more VAP conversion than closer properties. Also, when the parcel size increases by 100 square feet, the estimated odds are 0.07 percent higher (see Table 17).

In the Model I, only consider the SES variables, the R-square value is a fairly small (0.107). It represents that the SES variables have a significant relationship with the conversion from residential to VAP, it is difficult to explain this phenomenon with only SES variables. In the Model II, when the BE variables added, the R-square value is increased as 0.8091. It means the BE variables are clearly the most important influenced factors rather than SES variables.

6.3.4 Findings

From the results of the discrete time hazard quantitative analysis of the residential land conversion to VAP in the CFW, this research found that a large population creates fewer vacancies corresponding with the literature. Another finding of this research is that the high household median income is associated with vacancies in the residential land (see Table 18). Considering SES, the non-white population had a significant relationship with the conversion to VAP, while a large population had a significant relationship with the production of fewer VAP. This result is the same as the overall non-vacant outcome. Within the SES and BE variables, many residential structures had a significant relationship with less vacancy creation, while a non-white

population had a significant relationship with the conversion to VAP again. In the full model, including SES, BE, and GEO characteristics, the results are the same as the results in Model II, many residential structures had a significant relationship with the fewer vacant conversion. On the other hand, multi-housing had a significant relationship with the conversion to VAP in the full model. Besides, the further the distance a parcel is from the CBD had a significant relationship with producing more VAP. Conversely, the large sized parcel had a significant relationship with fewer vacancies.

Table 18 Residential DTHM Analysis Findings (From Residential to VAP)

	More	Fewer
SES	• Non-white population • Low educational attainment • The family with children	• Large population • High median income • Many vehicle owners • High unemployment
BE	• Many housing units	• Mobile home or tailor • High housing price • High land value • Old parcel age • Many structure count
GEO	• Further distance from CBD	• Large parcel size

According to the findings of the results to conversion VAP from residential land use implicate several important encouragements. First of all, as a growing city, population growth, especially well-educated, high income, and employed population create a fewer VAP from the residential land use. Moreover, the access from the CBD – close distance - and arterial road via vehicle, and large size parcel also create a fewer VAP. Relatively, the old parcel including the structure produces a fewer VAP.

Moreover, the mobile home or tailor, high housing, and land value create a fewer VAP from residential land use. This is interesting finding from this research; because the mobile home or tailor, high housing, and high land value usually related with a creating more VAP, from the previous study. According to this finding, this research assumes the reason of this finding that the CFW is the representative Southern and Sunbelt cities like LA, Miami, Atlanta, Las Vegas, and Phoenix, etc. These cities have a warm and sunny climate with economic opportunities. These characters make an influx of people who is seeking a comfortable retirement life, especially from baby boomers generation. Thus, this research accepts that the CFW residential land use has a relationship with an influx and immigration who want to make a settlement for remaining lifetime in the Sunbelt cities, it influenced mobile home or tailor, high housing and high land value. Oppositely, people prefer to live a single family house with their children; racial segregation generates a more VAP from residential land use. This is a representative motivation for the smart growth strategies, diversity and mixed racial and income community.

6.4 Commercial Land to Vacant Land

The commercial land use in CFW and the conversion from commercial to VAP, this research expects that the concentrated commercial land use area will be located in the inner-city area due to the downtown; and the commercial land use will intense along with the arterial or highway. As well as, the commercial land use location will follow the residential land use. Moreover, the significant impact variables to create more VAP from the commercial land use will be the population, gender, income, employment and automobile from the SES variables; housing unit, vacant duration, housing value, land value, parcel age, and structure count from the BE variables; and the distance from CBD and parcel size from the GEO variables.

6.4.1 Descriptive Spatial Analysis

The commercial parcel is examined in this section. The commercial parcel count per block group was employed, using a quantile classification. From 1990 to 2010, the amount of commercial parcels per block group showed that along Highway 35W and Highway 30, the commercial count ratio increased, especially the eastern edge of the city showed a large amount of commercial land use. Relatively, the number of the commercial parcels indicate a stable number and rate compared to than other land use parcels (see Figure 34).

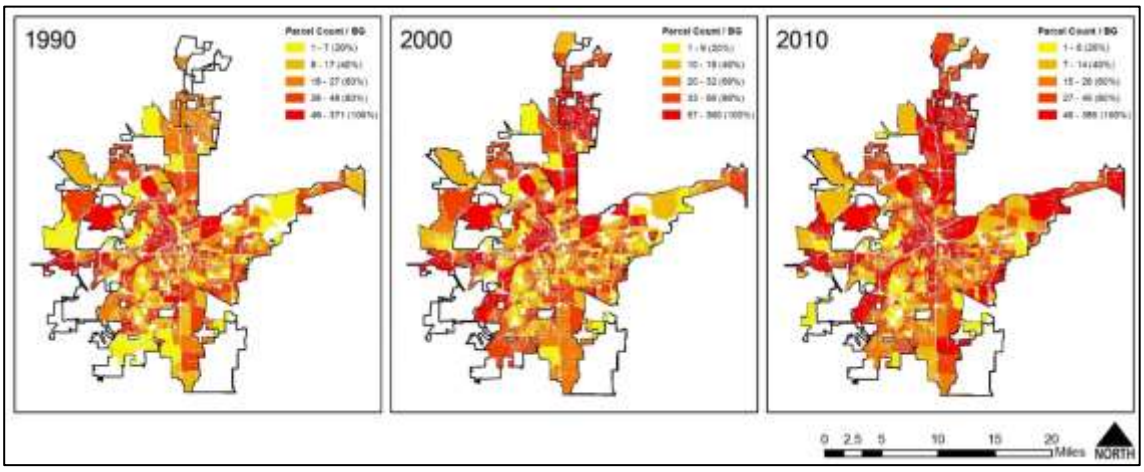


Figure 34 The Number of Commercial Parcels per Block Group by Quantile

In this research, the number of commercial parcels per block group as a convinced category classification shows the pattern of commercial parcel growth more obviously. In the 1990s and 2000s, there were only a few block groups which included more than 200 commercial parcels. The block groups which included more than 200 commercial parcels expanded and are located on the north side and around the center of the city, and along the highways (see Figure 35).

The area ratio of the commercial parcels per block group results displays similar results with the count ratio. The area ratio was analyzed using the convinced category classification. A large portion of the commercial block group was continuously augmented from 1990 to 2010, the blue and dark blue show more in 2010 and they are spread out over all the city (see Figure 36).

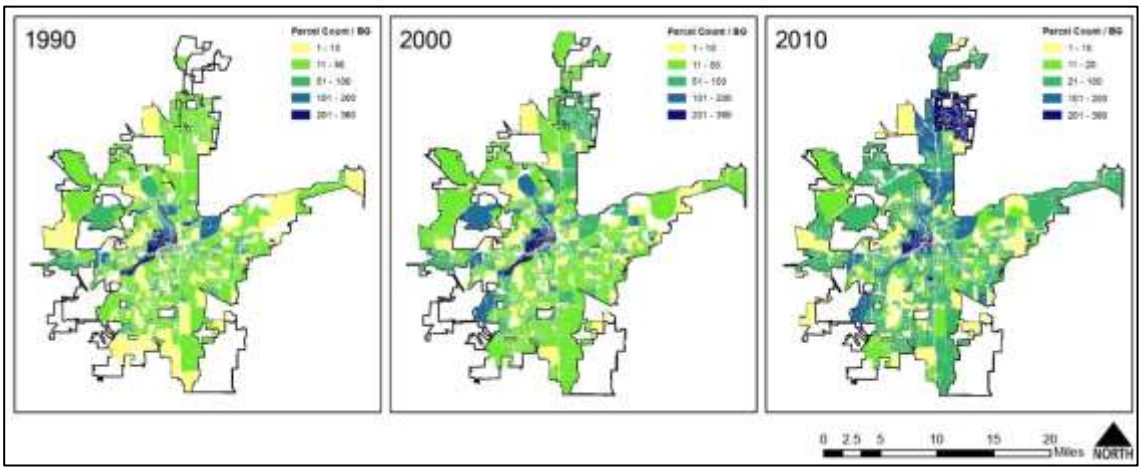


Figure 35 The Count of Commercial Parcels per Block Group

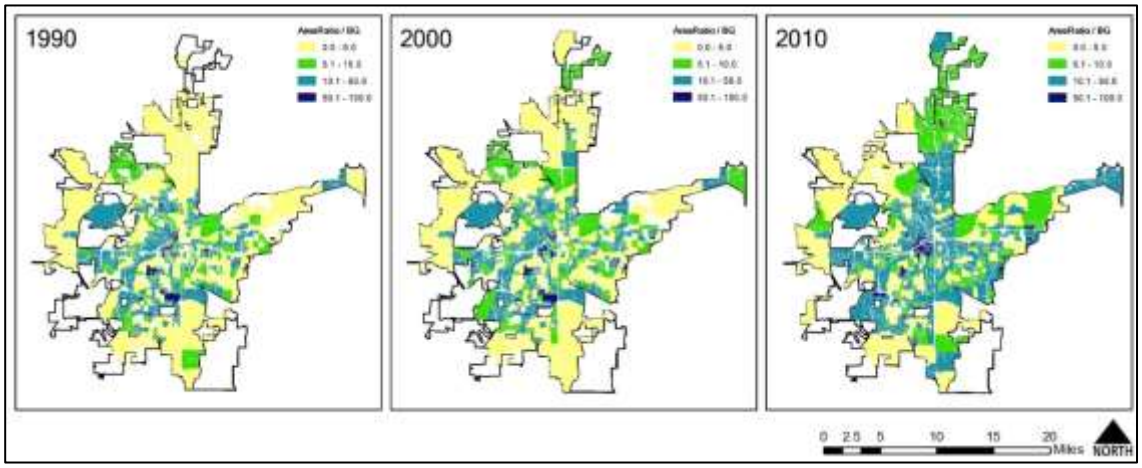


Figure 36 The Area Ratio of Commercial Parcels per Block Group

The results of the mean center analysis of commercial land showed that each year the mean center moved toward the center of the city. Also, the directional distribution analysis of the commercial land showed a relatively stable distribution pattern (see Figure 37). Compared with other land uses, the directional distribution result of commercial land showed the most concentrated results.

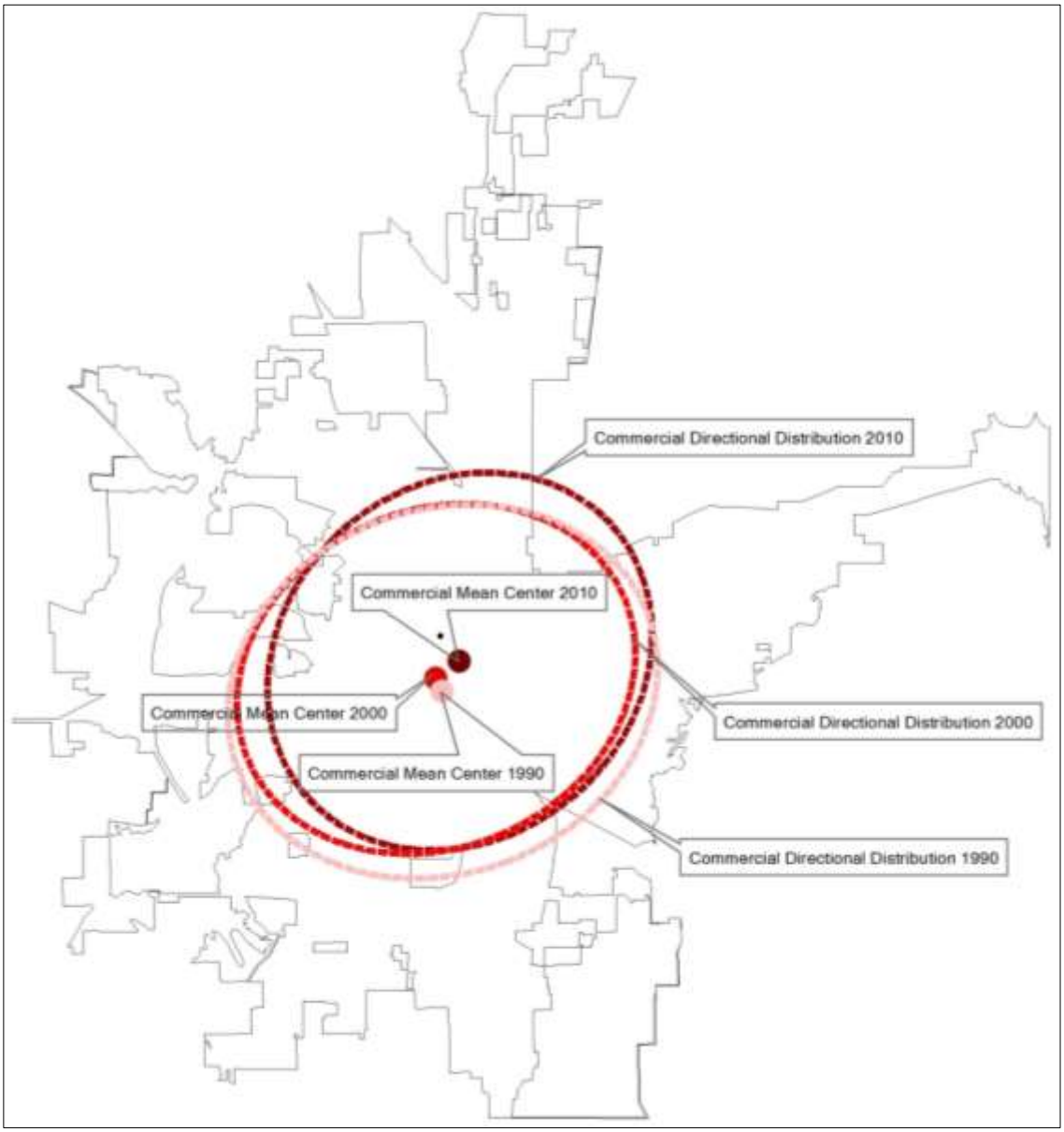


Figure 37 The Mean Center and Directional Distribution of Commercial Parcels

To examine the commercial land use clustering pattern, this research employed a spatial autocorrelation and hotspot analysis for commercial land use, using the parcel area ratio and parcel count ratio. First, this research analyzed the spatial pattern of

commercial parcels to determine if the dispersion was random or clustered, using the Global Moran's I tool. All of the parcel area ratios and parcel count ratios of commercial land indicated clustered patterns. Based on all the given z-scores; there is a less than 1 percent likelihood that this clustered pattern could be the result of random chance, except for the area ratio in 2000. The 2000 year area ratio of commercial parcels is a less than a 10% likelihood that this clustered pattern could be the result of random chance. (See Appendix B).

Based on the commercial land Global Moran's I results, this research discovered how the commercial land parcels clustered, using the Local Moran's I tool. The count ratio of commercial parcels showed very distinctive results. Unlike other land uses, the large number of commercial land parcels was clustered in the center of the city, in the CBD, in 1990. After ten years, a large number of commercial clustering areas moved to the western part of the city, and the clustering of commercial land around the CBD was less strong in 2000. After another ten years, the clustering of a large number of the commercial parcels relocated to northwestern part of the city in 2010 (see Figure 38).

The area ratio of the commercial land also illustrated that a large portion of the commercial block groups were located in the CBD and around the CBD of the city in 1990. Then, a large portion of the commercial block groups scattered in 2000. But, a large portion of the commercial block groups relocated to the CBD in 2010 (see Figure 39).

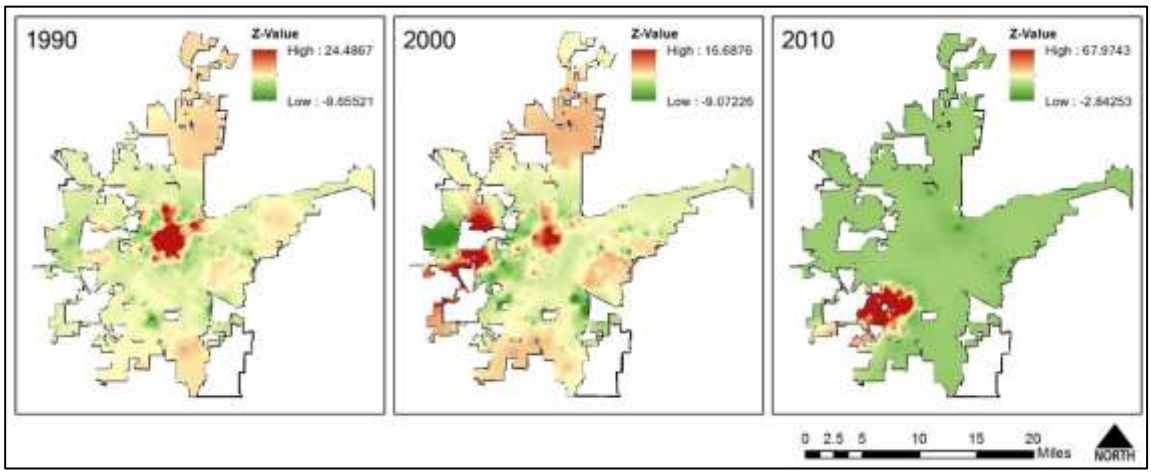


Figure 38 The Local Moran's I Results for the Count of Non-Vacant Parcels

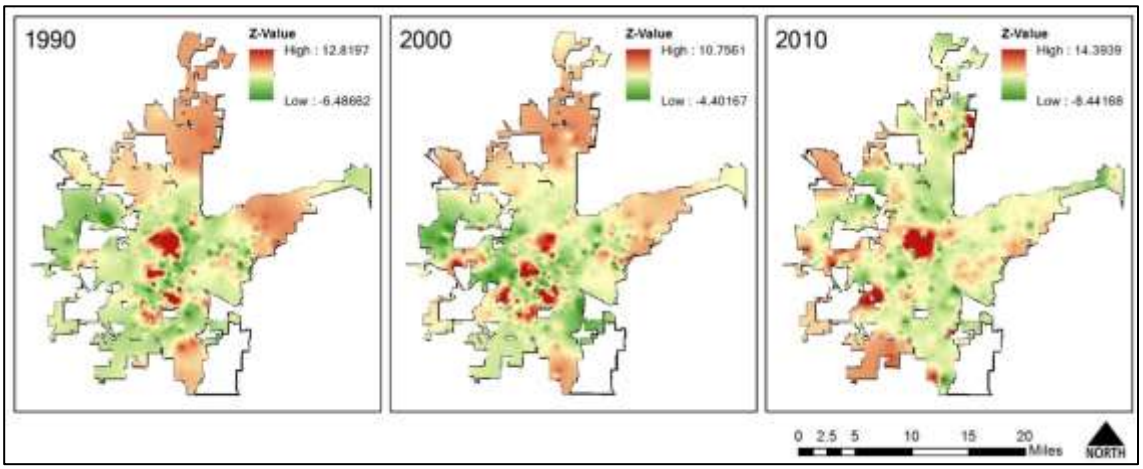


Figure 39 The Local Moran's I Results for the Area of Non-Vacant Parcels

The hotspot analysis of the commercial land parcels explains that the results are equal to the results of the Local Moran's I. In 1990, many of the commercial parcels gathered in the CBD and surrounding area. Then they moved to the west side of the city in 2000, and they were found in the northwestern part of the city in 2010 (see Figure 40).

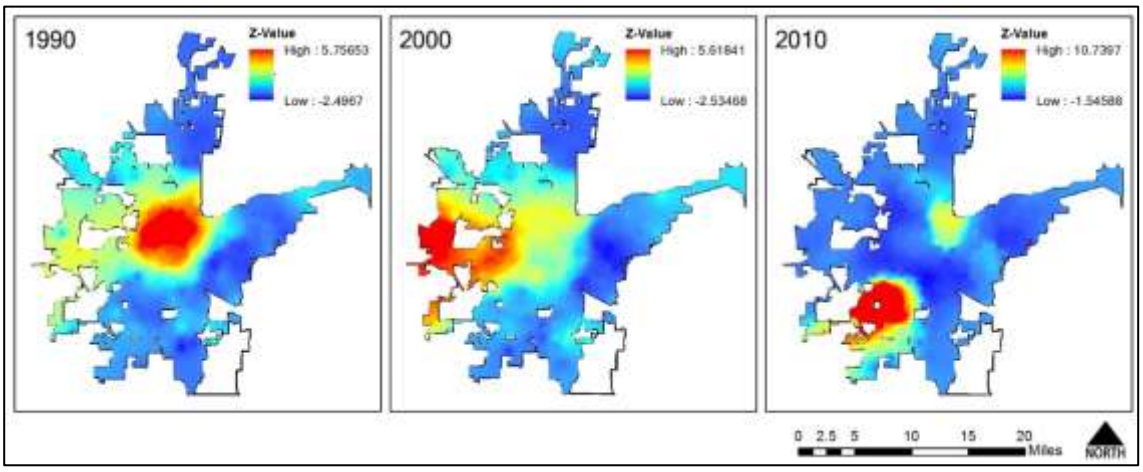


Figure 40 The Hotspot Results of the Count of Non-Vacant Parcels

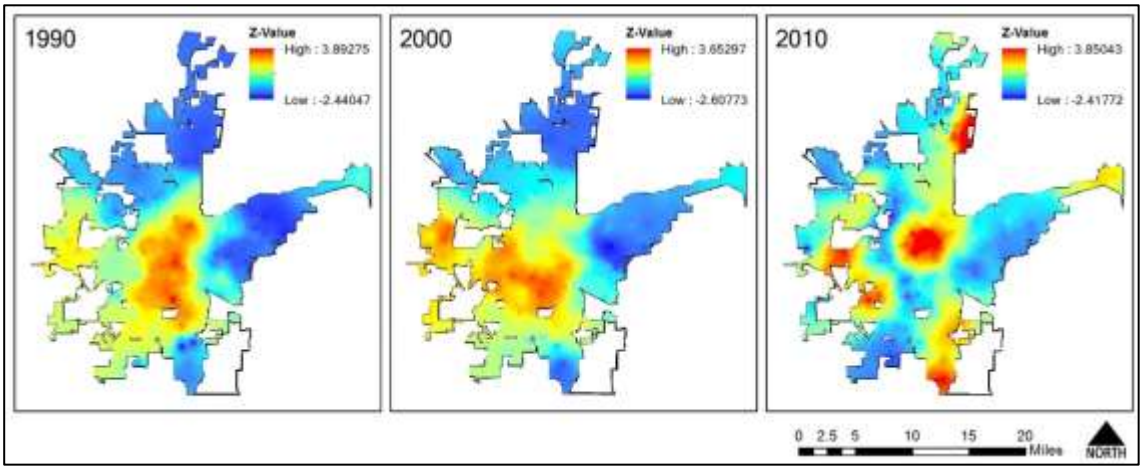


Figure 41 The Hotspot Results of the Area of Non-Vacant Parcels

On the other hand, there is a large amount of commercial land clustered near the center of the city on the north side. Indeed, they moved in a western direction from 1990 to 2000. Nevertheless, they were found in the CBD again in 2010 (see Figure 41).

6.4.2 Findings

Through the spatial analysis of commercial land in the city of the Fort Worth, this research found that the number of commercial parcels was comparatively unchanged from 1990 to 2010. The commercial land parcels were mostly located in the center of the city in the 1990s, but they moved toward the west of the city and concentrated in the northwestern city edge area (see Table 19). Moreover, the commercial land parcels showed a most consistent special distribution direction. A large number of and large sized commercial land parcels were clustered in the center of the city, while a small number of and small sized commercial land parcels were clustered on the edge of the city.

Table 19 Commercial Land Spatial Analysis Findings

- In 1990, almost commercial land use concentrated in the CBD area
- Along with the highway, the commercial land use dispersed toward edge of the city
- Related to the residential land use, the many commercial parcels are located on the edge of the city, suburban area, especially nearby the Benbrook city area
- Commercial land use concentrated in the CBD area continuously until 2010

6.4.3 Discrete-Time Hazard Quantitative Analysis

The occurrence of vacant and abandoned commercial properties over the study period is depicted in Figure 42. The conversion from commercial properties to vacant properties happened along with the major road such as highway and arterial roads. Indeed, they occurred mostly in the inner city area rather than the edge of the city, except on the western edge of the city.

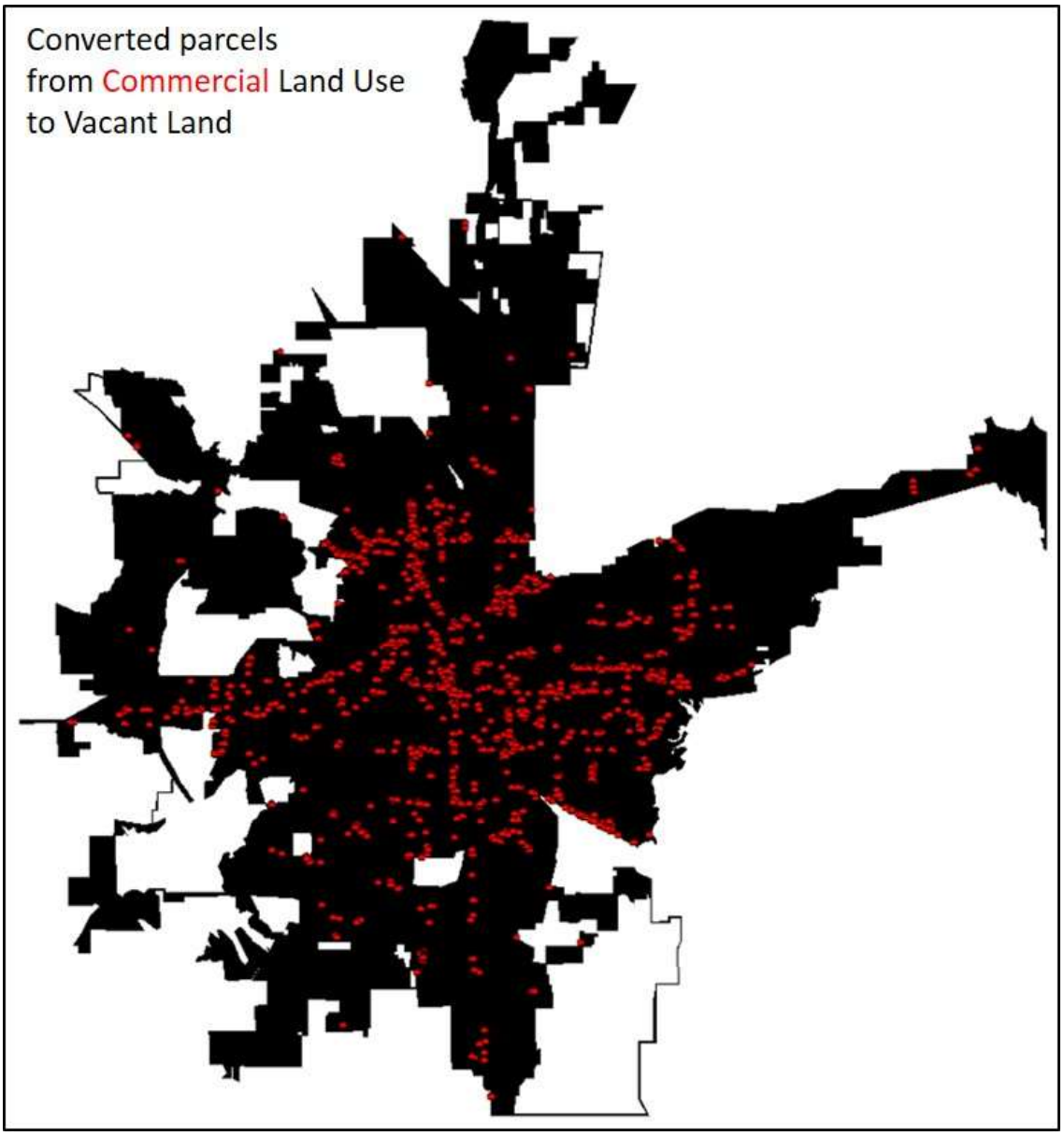


Figure 42 The Occurrence of VL from Commercial Properties from 1990 to 2010

Using a discrete-time hazard analysis, this research discovered which factors have a significant relationship with the conversion from commercial land to vacant. The commercial land observation was 6918, among them, 1,419 (20.5%) converted to vacant

from 1990 to 2010 (see Table 20). The dependent variable is the commercial parcel's usage status. The explanatory variables included those identified by the literature review. The SES characteristics were measured using block group level data from the 1990 census. Specifically, eight variables were selected including population, gender, race, income, automobile, employment, and family type. The BE characteristics were determined using block group level data from the 1990 census, as well. Specifically, thirteen variables were selected including housing unit, ownership, the purpose of vacancy, duration of vacancy, building type and structure, housing value, land value, parcel age, and structure count. The GEO characteristics were generated using the NCTCOG land use data in 1990 at the parcel level. Especially, four variables were selected: hotspot z-score, Local Moran's z-score, distance from the CBD, and the parcel size. The hotspot and Local Moran's I z-scores were generated using the size of the parcel. The distance from the CBD was measured from the CBD to the parcel's centroid point.

Model I includes only the SES variables. The commercial conversion Model I results indicated that male population and vehicle ownership produced fewer vacancies. While total population, non-white population, unemployment, and family with children produced more vacancies. The educational level and median household income had no relationship with the commercial conversion. The estimated odds ratio for a commercial property becoming vacant or abandoned are nearly 30 percent lower when the male population in the city increases by 10 percent. The estimated odds are about 4 percent lower when vehicle ownership in a city increases by 10 percent.

Table 20 The Commercial Data Descriptions

Variable			Commercial (Obs. 6918) Mean	Std. Dev.	Min	Max
SES (8)	Population	Total Population (100Person)	7.93	5.08	0.00	34.98
	Gender	Male Population (%)	50.80	10.56	0.00	100.00
	Race	Non-White (%)	46.87	26.34	0.00	100.00
	Education	Less than 9th Grade (%)	17.52	17.24	0.00	64.56
	Income	Households Median Income ($1000)	39.08	18.20	0.00	92.14
	Automobile	Vehicle (%)	70.33	34.69	0.00	523.60
	Employment	Unemployed (%)	5.20	9.02	0.00	103.33
	Family Type	With Children (%)	18.01	38.45	0.00	352.38
BE (13)	Housing Unit	Total Housing Unit	419.57	206.58	0.00	1488.00
		Occupied Units (%)	82.82	15.24	0.00	100.00
	Ownership	Ownership (%)	36.40	27.69	0.00	100.00
	Vacant Purpose	Vacant Units for sale only (%)	0.52	0.08	0.00	0.67
	Vacant Duration	Less than 2months (%)	8.81	15.62	0.00	88.70
		2 up to 6 months (%)	13.68	19.15	0.00	87.50
		More than 6months (%)	22.66	28.88	0.00	94.44
	Building Type & Structure	Multihousing (%)	0.58	0.37	0.00	1.00
		Mobile Home or trailer (%)	0.05	0.13	0.00	0.75
	Housing Value	Median Housing Value ($1000)	70.81	57.06	0.00	434.60
	Land Value	Land Value($1000)	374.45	1134.32	0.00	33000.00
	Parcel Age	Parcel Age (2015-Parcel year)	30.71	28.29	0.00	122.00
	Structure Count	Structure Count	0.01	0.08	0.00	2.00
GEO (4)	Spatial	Hotspot	-0.76	3.18	-2.73	28.81
		Local MoransI	1.11	24.95	-16.60	982.24
	Distance	Distance from CBD (1000feet)	17.16	13.20	0.26	91.87
	Size	Parcel Size (100sqft)	199.14	703.80	0.00	23000.00

Whereas, the estimated odds ratio for a commercial land changing to VAP is nearly 1.5 percent higher when the total population in the city increases by 100 people. Moreover, the estimated odds are 13 percent higher when the non-white population rate increases by 10 percent. Besides, when the unemployment rate increases by 10 percent, the estimated odds ratio for a commercial land conversion to vacant are 8 percent higher. The estimated odds ratio for conversion from commercial to vacant is 6 percent when the family with children rate increases by 10 percent (see Table 21).

Model II adds the BE characteristics to the model. After adding the BE variables, the estimated odds ratio of the socioeconomic variables shows noticeably different results. The results point out that a large male population, a low educational level, a high vehicle ownership, a high occupied unit rate, multihousing and mobile home or trailer, high land value, and old parcels produced fewer vacancies. While a high non-white population, family with children, purpose of vacancy, units vacant 2 up to 6 months, and many structures produced more vacancies. Compared with Model I, total population (more to no relationship), unemployment (more to no relationship), and a low educational level (no relationship to less) showed an altered relationship with commercial conversion to vacant in Model II; and total population, household median income, unemployment, total housing units, home ownership, units vacant less than 2 months or more than 6 months, and median housing value had no relationship with the commercial conversion to VAP.

The estimated odds ratio for a commercial property becoming vacant or abandoned are nearly 35 percent lower when the male population in the city increases by

10 percent. A low educational level population, vehicle ownership, occupied unit, multihousing, and mobile home or trailer, when each variable increases by 10 percent in a city, the estimated odds ratio for the conversion of land for low educational level population are about 14 percent lower, for vehicle ownership are about 4 percent lower, for occupied units are 8 percent lower, for multihousing are nearly 800 percent lower, and mobile home or trailer are nearly 710 percent lower. Also, when the land value increases by $1000, the estimated odds ratio for a commercial conversion are 0.1 percent lower. Model II also suggested that older properties in the study area were less likely to become vacant. The estimated odds of a commercial parcel becoming vacant are nearly 11 percent lower for each year it ages. From the commercial Model II results, this research found that multihousing and mobile home or trailer had a most significant relationship with commercial land conversion to VAP.

On the other hand, when the non-white population increases by 10 percent, the estimated odds ratio for a commercial conversion to vacant are 16 percent higher. The estimated odds ratio for conversion from commercial to vacant is 3 percent when the family with children increases by 10 percent. Also, if the commercial unit which has been vacant from 2 up to 6 months rate increases by 10 percent, the estimated odds for a commercial conversion to vacant are 6 percent higher. Moreover, if the commercial structures increase by 1 each, the estimated odds of a commercial parcel being changed are 51 times larger than the odds for a commercial parcel not being changed. If the vacant commercial units for sale only increases by 1 percent, the estimated odds of a commercial parcel being changed are 192 times larger than the odds for a commercial

parcel remaining the same (see Table 21). Through the results of commercial Model II, this research proved that commercial land conversion to vacant had a significant relationship with a new commercial structure.

Model III is the full model for commercial land conversion to VAP. It adds the GEO characteristics variables, especially the variables measuring the distance from the CBD and parcel size. The substantive findings on the SES showed very similar results. The critical findings on the BE remained similar. Among the added GEO characteristics, the commercial z-score of the hotspot, Local Moran's I, and the parcel size showed that they had no relationship with the commercial land conversion. However, the estimated odds ratio for a commercial property becoming vacant or abandoned are nearly 0.06 percent higher when the distance from the CBD increases by 1000 feet (see Table 21).

In the Model I, only consider the SES variables, the R-square value is a fairly small (0.0343). It represents that the SES variables have a significant relationship with the conversion from commercial land use to VAP, it is difficult to explain this phenomenon with only SES variables. In the Model II, when the BE variables added, the R-square value is increased as 0.4494. It means the BE variables are clearly the most important influenced factors rather than SES variables.

Table 21 The Commercial Land Conversion Results of the DTHM Analysis

Variable			Model 1 COEF (OR)	Model 2 COEF (OR)	Model 3 COEF (OR)
SES	Population	Total Population (100Person)	0.0143** (1.014)		
	Gender	Male Population (%)	-0.0287*** (0.972)	-0.0353*** (0.9653)	-0.0340*** (0.9665)
	Race	Non-White (%)	0.0128*** (1.013)	0.0162*** (1.0163)	0.0157*** (1.0158)
	Education	Less than 9th Grade (%)		-0.0140*** (0.9861)	-0.0140*** (0.9861)
	Income	Households Median Income ($1000)			
	Automobile	Vehicle (%)	-0.0044*** (0.996)	-0.0036*** (0.9964)	-0.0038*** (0.9962)
	Employment	Unemployed (%)	0.0082** (1.008)		
	Family Type	With Children (%)	0.0062*** (1.006)	0.0033** (1.0033)	0.0032** (1.0032)
BE	Housing Unit	Total Housing Unit			
		Occupied Units (%)		-0.0081* (0.9920)	-0.0086* (0.9915)
	Ownership	Ownership (%)			
	Vacant Purpose	Vacant Units for sale only (%)		5.2591*** (192.3131)	5.6656*** (288.7558)
	Vacant Duration	Less than 2months (%)			
		2 up to 6 months (%)		0.0064** (1.0064)	0.0058** (1.0058)
		More than 6months (%)			
	Building Type & Structure	Multihousing (%)		-1.6004*** (0.2018)	-1.6159*** (0.1987)
		Mobile Home or trailer (%)		-1.2547*** (0.2852)	-1.1634*** (0.3124)
	Housing Value	Median Housing Value ($1000)			
	Land Value	Land Value ($1000)		-0.0009*** (0.9991)	-0.0008*** (0.9992)
	Parcel Age	Parcel Age (2015-Parcel year)		-0.1137*** (0.8925)	-0.1134*** (0.8928)
	Structure Count	Structure Count		3.9317*** (50.9950)	3.8826*** (48.5511)
GEO	Spatial	Hotspot			
		Local MoransI			
	Distance	Distance from CBD (1000feet)			
	Size	Parcel Size (100sqft)			-0.0006*** (0.9994)
		R2	0.0343	0.4494	0.4533

n = 6918, number of events = 1419
*p < 10%, ** p < 5%, *** p < 1%

6.4.4 Findings

From the results of the discrete time hazard quantitative analysis of the commercial land conversion to VAP in the city of the Fort Worth, this research found that only considering the SES, total population had a most significant relationship with the conversion to VAP, while large male population had a most significant relationship with less vacancy creation. Within Model II, the SES and BE variables, multihousing, had a significant relationship with less vacancy creation, while temporary vacant commercial units for sale have a most significant relationship with the conversion to VAP. In the full model, including SES, BE, and GEO characteristics, the results are equal to Model II; many multihousing structures had a significant relationship with the less vacant conversion. On the other hand, the temporary vacant commercial unit for sale had a significant relationship with the conversion to VAP in the full model. As well, vehicle ownership showed less of a relationship in the commercial land conversion to vacant. Besides, the large sized commercial parcels had a significant relationship with producing less VAP (see Table 22).

Table 22 Commercial Land DTHM Analysis Findings (From Commercial to VAP)

	More	Fewer
SES	• Non-white population • The family with children	• Male population • Low educational attainment • Many vehicle owners
BE	• Vacant commercial unit for sale only • 2 up to 6 months vacant duration • Many structure count	• Large occupied units • Multihousing / Mobile home or trailer • High land value • Old parcel age
GEO		• Large size parcel

According to the findings of the results to conversion VAP from commercial land use implicate several important issues. First of all, not like residential land use, the distance from the CBD has no relationship; while the large size commercial parcel creates a fewer VAP. It means that large size vacant parcel in the commercial land use area has a more redevelopment or regeneration opportunities rather than small size parcel. Therefore, rather than new development or new construction, the CFW should consider the reuse strategies throughout improvement of existing or once developed the commercial parcel. Indeed, in the commercial land use conversion, the population has no significant relationship; while the racial segregation and the family with children produced more VAP, same as residential land use. Besides, the vacant parcel or structure in the commercial land use create more vacancy; it improves the Broken Window phenomenon that if a window in a structure is broken and is left unrepaired, all the remaining windows will soon be broken. Also, this finding is consistency the other finding that largely occupied units create fewer VAP. More precisely, this is the commercial land use. Thus, VAP or unoccupied commercial parcel decrease the attraction of visitors. Based on these finding, the government as a state, city, and community /neighborhood level, they should consider the revitalization and regeneration of the commercial area, especially nearby the downtown.

6.5 Industrial Land to Vacant Land

The industrial land use in CFW and the conversion from industrial to VAP, this research expects that the concentrated industrial land use area will be located on the edge

of the city; and the industrial land use in the CFW will be decreased as time goes by. Moreover, the significant impact variables to create more VAP from the industrial l land use will be the population, gender, race, education, income, automobile, and employment from the SES variables; vacant duration, ownership, building type and structure, housing value, land value, parcel age, and structure count from the BE variables; and the distance from CBD and parcel size from the GEO variables.

6.5.1 Descriptive Spatial Analysis

In the case of the industrial land use parcels, the quantile classification results of the number of parcels showed that there is no enormous change or pattern of the industrial land use from the 1990s to 2010 (see Figure 43). To determine more precise industrial land use patterns, this research used a convinced category classification. The dark blue section includes industrial parcels of more than 100 in a block group. From 1990 to 2000, the results showed little change other than that the dark blue section has increased mostly along Highway I-35 and the eastern part of the city. From 2000 to 2010, there is a noticeable difference in that most of the block group which contained more than 100 industrial land parcels has moved. Only some parts of the city show dark blue areas (see Figure 44).

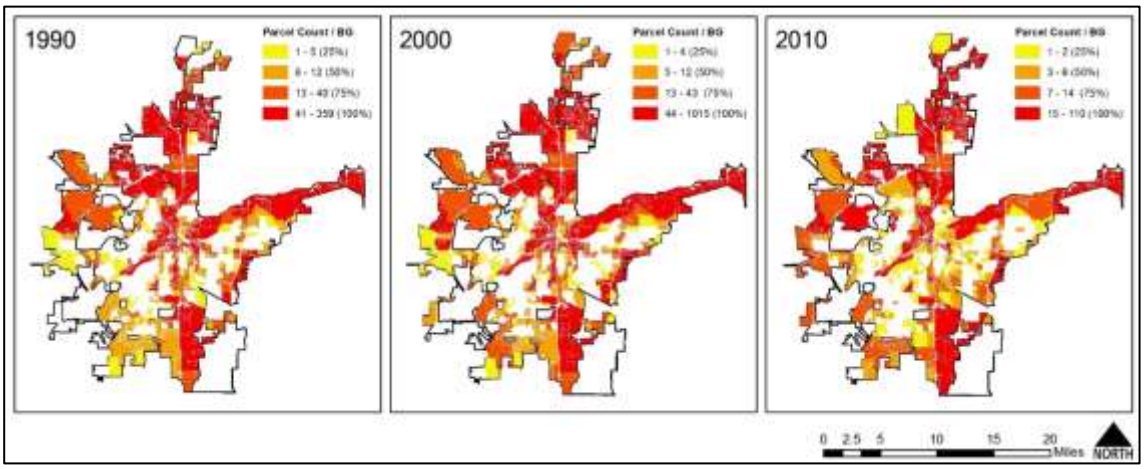


Figure 43 The Number of Industrial Parcels per Block Group by Quantile

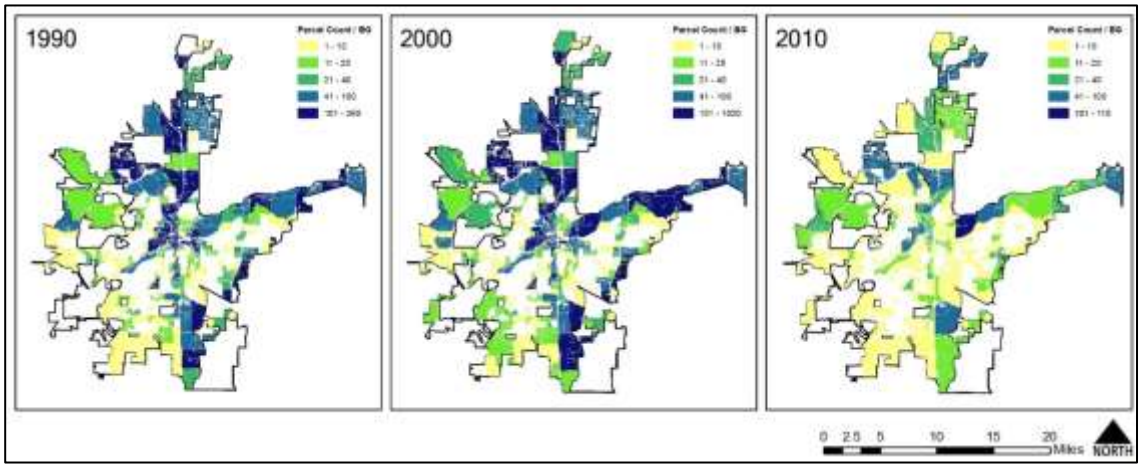


Figure 44 The Count of Industrial Parcels per Block Group

The area ratio of industrial land results showed comparable results, even though this research used a convinced category classification for the detailed analysis. Most of the industrial land which is more than a 10 percent portion in the block group were located along Highway I-35 in 1990 and they had increased conjointly at the boundary of the eastern edge of the city in 2000. They had vanished by 2010 (see Figure 45).

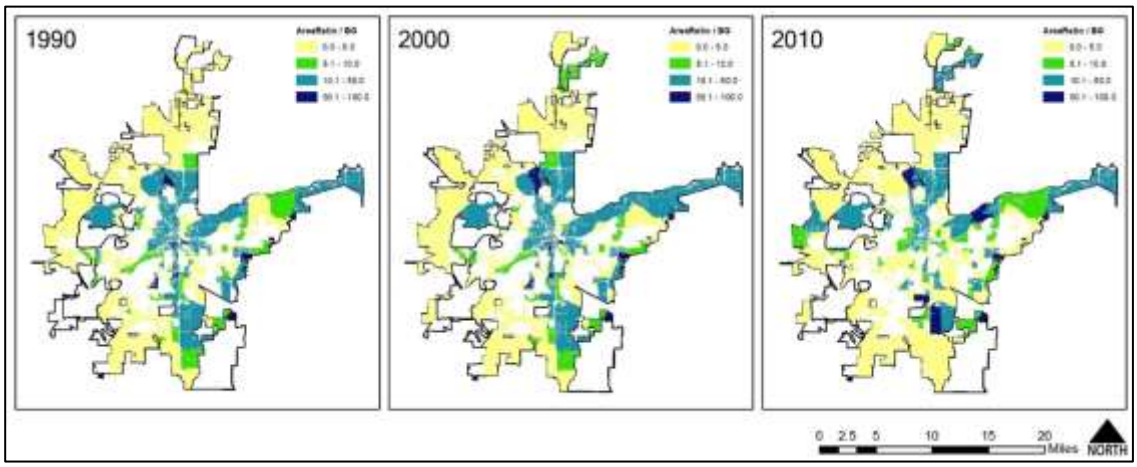


Figure 45 The Area Ratio of Industrial Parcels per Block Group

The results of the mean center and directional distribution analysis of the industrial land parcels showed similar results to the commercial results. All of the mean centers are located on the eastern side of the city, and they have different distances from the CBD. The directional distribution results showed a relatively regular directional distribution (see Figure 46).

To examine the clustering pattern of industrial land use, this research employed a spatial autocorrelation and hotspot analysis in industrial land use, using the parcel area ratio and parcel count ratio. First, this research analyzed the spatial pattern of industrial parcels to determine if the dispersion was random or clustered using the Global Moran's I tool. All of the parcel area ratios of the industrial parcels indicated clustered patterns. However, only the result of the count ratio in 1990 and 2000 indicated clustered patterns.

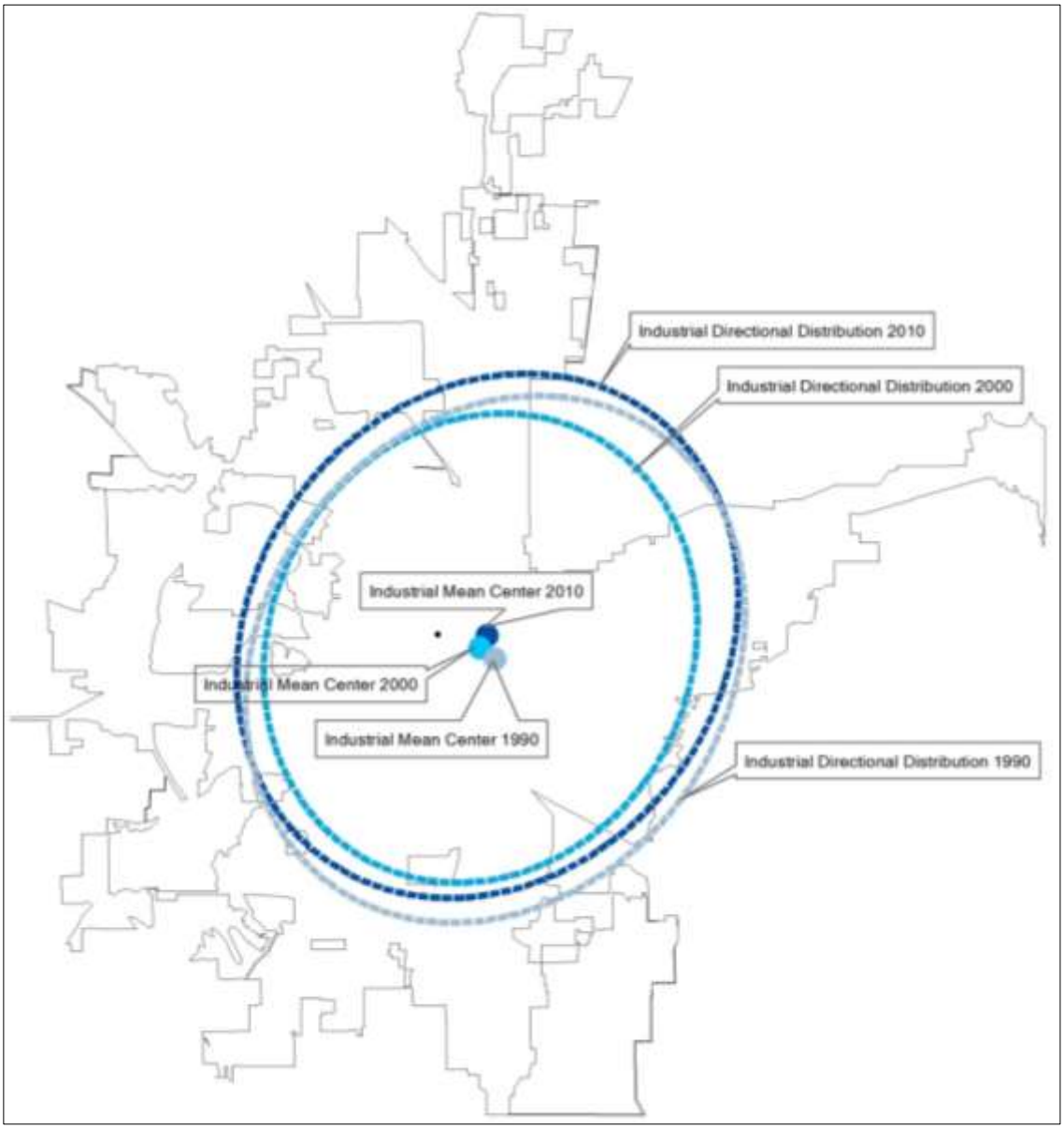


Figure 46 The Mean Center and Directional Distribution of Industrial Parcels

Based on all the given z-scores; there is a less than 1 percent likelihood that this clustered pattern could be the result of random chance, except for the count ratios in 2000 and 2010. For the count ratio of industrial parcels in 2000, there is a less than 5%

likelihood that this clustered pattern could be the result of random chance. Also, for the count ratio of industrial parcels in 2010, the pattern does not appear to be significantly different than random (see Appendix B). Following the results of the Global Moran's I, the count ratio of the industrial parcels in 2010 is not necessary. However, to compare them with other land use types, this research included the 2010 industrial count ratio analysis as well. The results of the Local Moran's I for the count ratio of industrial parcels in the CFW showed that the clustering areas of the industrial parcels were near the CBD and the eastern edge of the city in 1990. In 2000, the industrial clustering area near the CBD was gone; they had moved to the northwestern part of the city (see Figure 47).

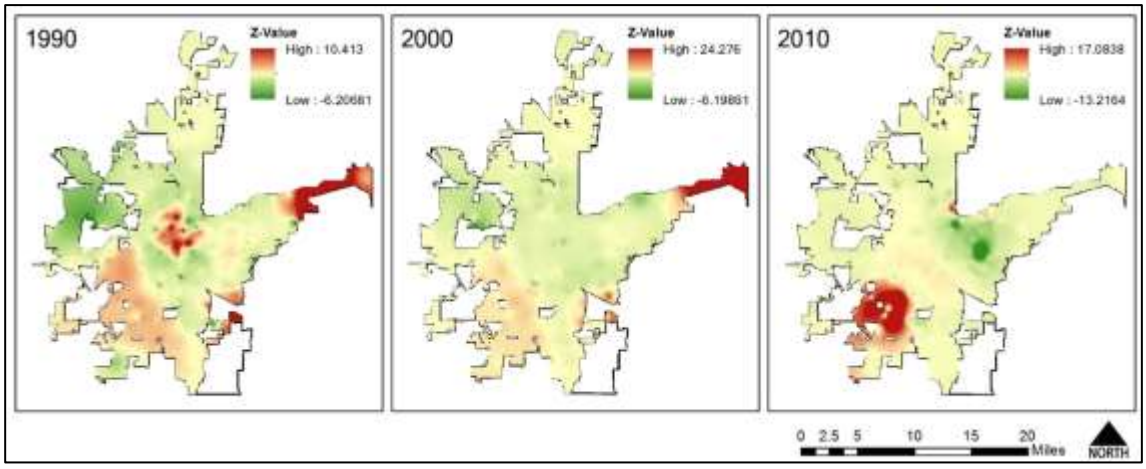


Figure 47 The Local Moran's I Results for the Count of Industrial Parcels

The results of the area ratio of industrial Local Moran's I illustrated that a large portion of the industrial land was in the upside of the CBD and the eastern part of the city, and the northwestern part also showed clusters in 1990. A large portion of the industrial

land in the upside of the CBD was connected in 2000. It moved to the northern side of the city in 2010 (see Figure 48).

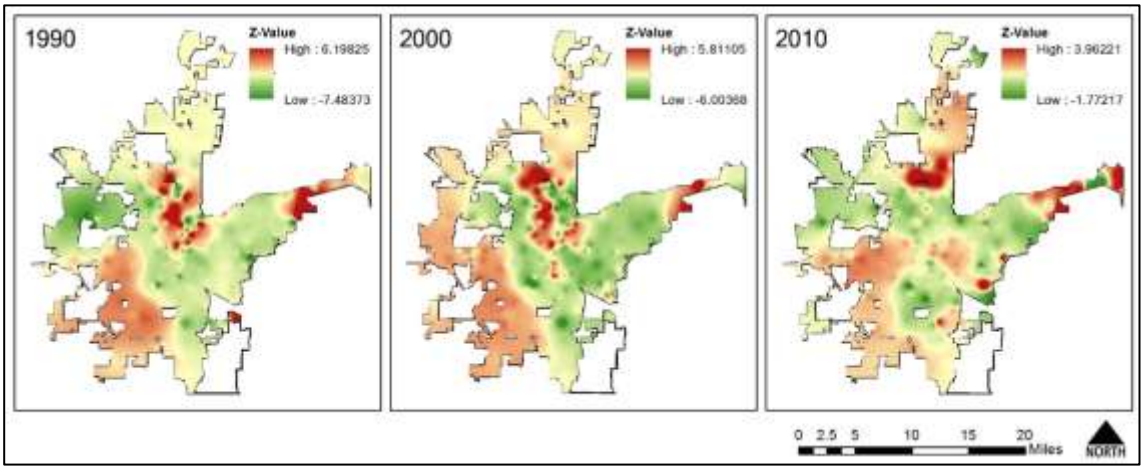


Figure 48 The Local Moran's I Results for the Area of Industrial Parcels

The industrial land hot spot analysis results explained that the nearby CBD industrial clustered area and the eastern edge of the city area included large numbers of industrial parcels. While in the northwestern part a small number of industrial parcels were clustered. The clustered area near the CBD vanished in 2000. Then, a large number of industrial parcels were clustered in the northwestern part and the corner of the east side of the city (see Figure 49). The area ratio of the industrial land hotspot results explained that the upside of the CBD clustering area is generated by a large portion of the industrial land use in 1990 and 2000. While the northwestern industrial clustered area is generated by a small portion of the industrial land use in 1990, 2000, and 2010. The clustered area on the eastern edge of the city includes a large portion of the industrial land use (see Figure 50).

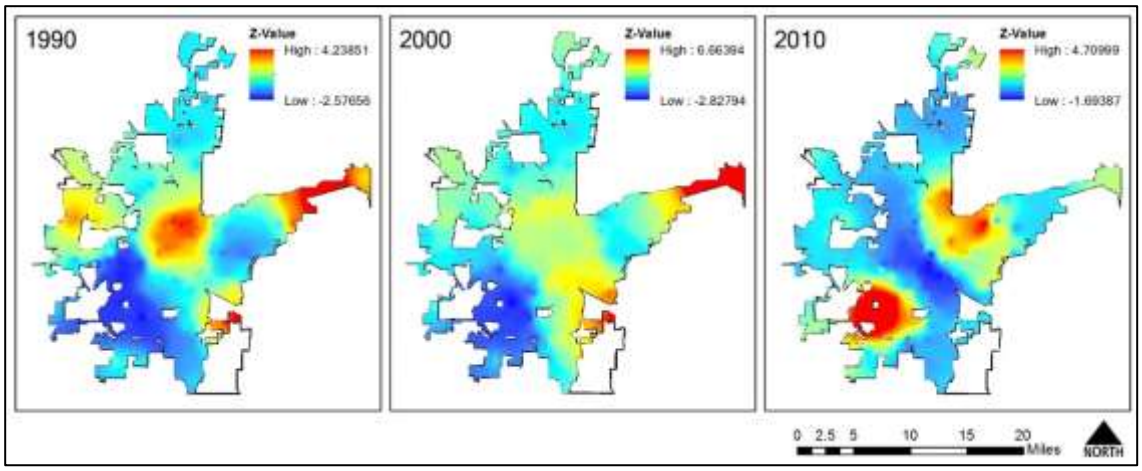


Figure 49 The Hotspot Results for the Count of Industrial Parcels

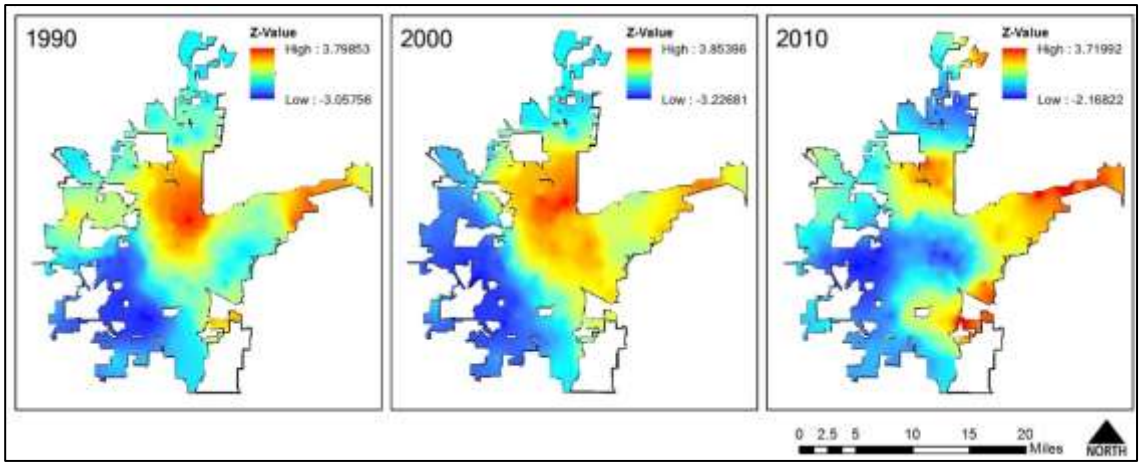


Figure 50 The Hotspot Results for the Area of Industrial Parcels

6.5.2 Findings

Through the descriptive spatial analysis of the industrial land in the CFW, this research found that the number of industrial land parcels fluctuated from 1990 to 2010. Especially, the number of industrial parcels increased enormously in 2000, while after

2000, the number of industrial parcels decreased dramatically. The industrial land parcels were mostly located along the highway during the whole study period, mostly located in the northern and eastern areas of the city. Moreover, the industrial land parcels had a regular distribution pattern. Many of the industrial land parcels were clustered on the eastern edge of the city until 2000, then moved to the northwestern area of the city. Large sized industrial parcels were clustered in the eastern corner of the city until 2000, and moved to the eastern edge of the city in 2010 (see Table 23).

Table 23 Industrial Land Spatial Analysis Findings

- Mostly, industrial land parcels were located along the highway during the whole study period
- Same as residential and commercial land use, most of the industrial land use parcel is located near the Benbrook city – following the residential and commercial land use
- Nevertheless, still large portion of the industrial land use remains near the CBD in CFW; they shift toward the direction of the City of Arlington and Grapevine

6.5.3 Discrete-Time Hazard Quantitative Analysis

The occurrence of vacant and abandoned industrial properties over the study period is depicted in Figure 51. The conversion from industrial properties to vacant properties take place along with the major road such as highway and arterial roads, especially in the inner city area. Indeed, they occurred mostly following the vertical direction (north-south) and the edge of the east and north area.

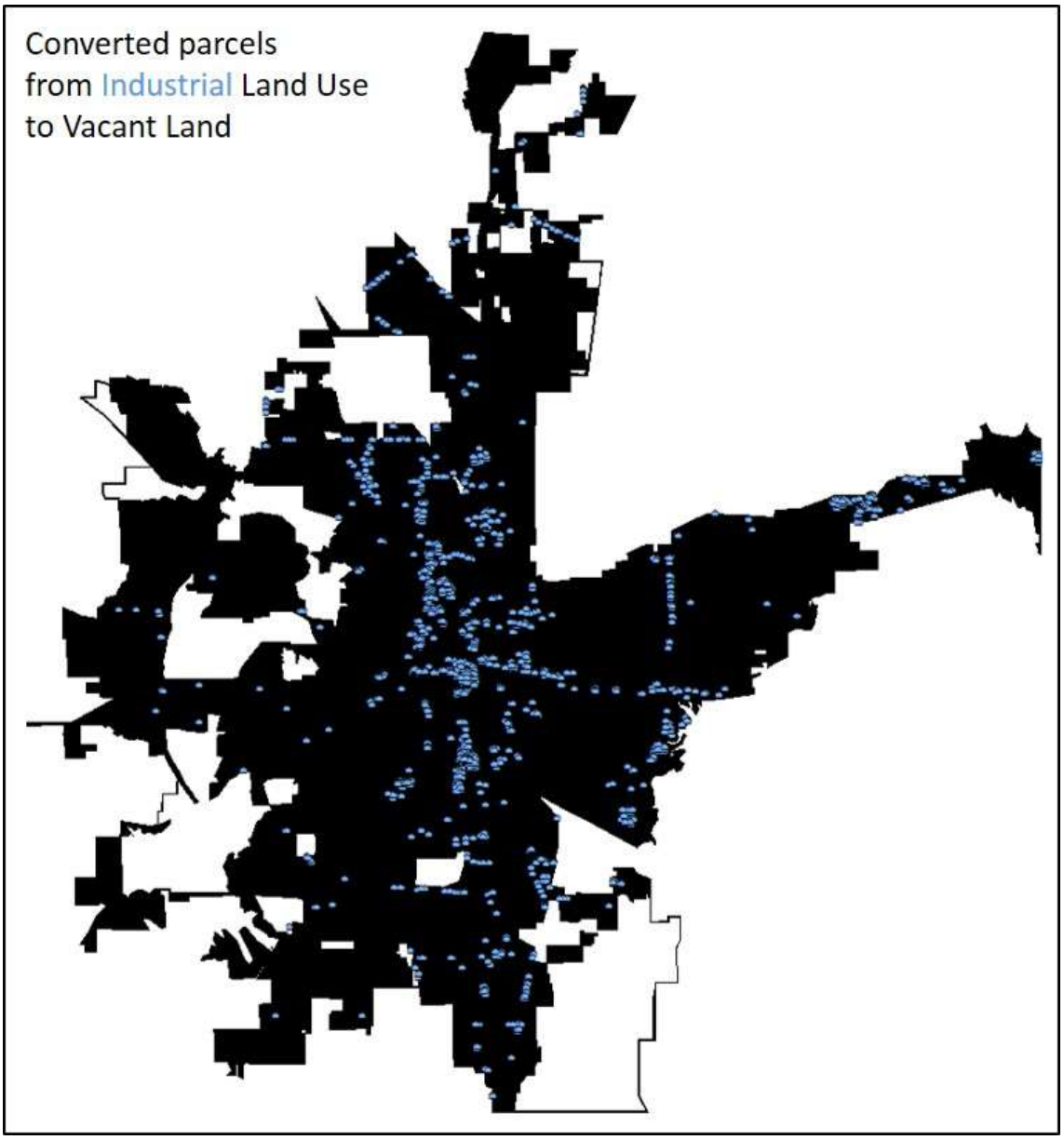


Figure 51 The Occurrence of VL from Industrial Properties from 1990 to 2010

Using the discrete time hazard analysis, it was determined what factors have a significant relationship with the conversion from industrial land to vacant. The industrial observation was 2273, among them, 1,413 (62.2%) converted to vacant from 1990 to

2010 (see Table 24). The dependent variable is the industrial parcel's usage status. The explanatory variables included those identified by the literature review. The SES characteristics were measured using block group level data from the 1990 census. Specifically, eight variables were selected including population, gender, race, income, automobile, employment, and family type.

The BE characteristics were determined using block group level data from the 1990 census, as well. Specifically, thirteen variables were selected including housing unit, ownership, the purpose of vacancy, duration of vacancy, building type and structure, housing value, land value, parcel age, and structure count. The GEO characteristics were generated using the NCTCOG land use data from 1990 at the parcel level. Especially, four variables were selected: hotspot z-score, Local Moran's z-score, distance from the CBD, and the parcel size. The hotspot and Local Moran's I z-scores were generated using the parcel's size. The distance from the CBD was measured from the CBD to the parcel's centroid point.

Model I includes only the SES variables. The industrial conversion Model I results indicate that the lower education level, a high median income, and high vehicle ownership produced fewer vacancies. While only the non-white population produced more vacancies.

The total population, gender, employment, and the family type had no relationship with the industrial conversion. The estimated odds ratio for an industrial property becoming vacant or abandoned are nearly 13 percent lower when the low-level education population rate in the city increases by 10 percent.

Table 24 The Industrial Data Description

Variable			Industrial (Obs. 2273)			
			Mean	Std. Dev.	Min	Max
SES (8)	Population	Total Population (100Person)	9.66	7.93	0.00	34.98
	Gender	Male Population (%)	53.82	14.16	0.00	100.00
	Race	Non-White (%)	49.15	28.86	0.00	100.00
	Education	Less than 9th Grade (%)	14.51	16.69	0.00	64.56
	Income	Households Median Income ($1000)	32.67	17.41	0.00	82.50
	Automobile	Vehicle (%)	87.40	45.12	24.47	480.34
	Employment	Unemployed (%)	7.16	13.64	0.00	103.33
	Family Type	With Children (%)	20.69	36.33	0.00	181.46
BE (13)	Housing Unit	Total Housing Unit	416.13	164.94	6.00	1764.00
		Occupied Units (%)	87.30	7.08	53.19	100.00
	Ownership	Ownership (%)	49.17	28.38	0.00	100.00
	Vacant Purpose	Vacant Units for sale only (%)	0.27	0.32	0.00	1.00
	Vacant Duration	Less than 2months (%)	10.49	17.07	0.00	85.38
		2 up to 6 months (%)	20.09	24.82	0.00	80.00
		More than 6months (%)	21.03	26.41	0.00	89.61
	Building Type & Structure	Multihousing (%)	0.44	0.37	0.00	1.00
		Mobile Home or trailer (%)	0.05	0.12	0.00	0.61
	Housing Value	Median Housing Value ($1000)	78.23	67.77	0.00	500.00
	Land Value	Land Value($1000)	256.35	875.29	0.00	16000.00
	Parcel Age	Parcel Age (2015-Parcel year)	9.82	20.23	0.00	111.00
	Structure Count	Structure Count	0.01	0.12	0.00	2.00
GEO (4)	Spatial	Hotspot	-0.26	2.37	-4.19	15.46
		Local MoransI	0.46	4.29	-7.30	92.97
	Distance	Distance from CBD (1000feet)	26.09	24.13	1.73	97.00
	Size	Parcel Size (100sqft)	698.36	3360.49	0.00	110000.00

The estimated odds are about 11 percent lower when the household median income rate in city increases by 10 percent. Moreover, the estimated odds are 2 percent lower when the vehicle ownership rate increases by 10 percent. The estimated odds ratio for an industrial land changing to VAP is nearly 15 percent higher when the non-white population in the city increases by 10 percent (see Table 25).

Model II adds the BE characteristics to the model. After adding the BE variables, the estimated odds of the socioeconomic variables showed altered results. The results point out that the total population, high household median income, high unemployment, short duration vacancy of an industrial unit, an industrial unit vacant more than 6 months, high land value, and old industrial parcels produced fewer vacancies. While, large male population, largely non-white, lower education level, high vehicle ownership, total housing unit, high occupied units, high ownership, multihousing, mobile home or trailer, and high median housing value produced more vacancies. Compared with Model I, the SES variables show changed results, except non-white, median household income, and family with children. The total population (no relationship to less), male population (no relationship to more), educational level (less to more), the family type (less to more), the vehicle ownership (less to more), and unemployment (not significant to less) show the opposite or changed relationships with a commercial conversion to vacant in Model II; and the industrial vacant unit's purpose and structure count showed no relationship with an industrial conversion to VAP.

The estimated odds ratio for an industrial property becoming vacant or abandoned are nearly 6 percent lower when the population in the city increases by 100

people. When the median household income increases by $1000, the estimated odds are nearly 1 percent lower. For the unemployment rate and the industrial unit vacant less than 2 months or more than 6 months, when each variable increases by 10 percent in a city, the estimated odds of the unemployment rate are about 24 percent lower, the industrial unit vacant less than 2 months are about 0.1 percent lower, and the industrial unit vacant more than 6 months are 14 percent lower. Also, when the land value increases by $1000, the estimated odds ratio for an industrial conversion are 0.1 percent lower. Model II also suggested that older industrial properties in the study area are less likely to become vacant. The estimated odds of an industrial parcel becoming vacant are nearly 6 percent lower for each year it ages.

On the other hand, when the male population increases by 10 percent, the estimated odds ratio for an industrial land conversion to vacant are 20 percent higher. The estimated odds ratio for conversion from industrial to vacant is 12 percent when the non-white population rate increases by 10 percent. Also, when the low education level population increases by 10 percent, the estimated odds for an industrial conversion to vacant are 17 percent higher. High vehicle ownership in the study area is more likely to become vacant. The estimated odds of an industrial parcel becoming vacant are nearly 30 percent higher for every 10 percent it increases. Also, when the median housing value increases by $1000, the estimated odds are 2 percent higher.

Table 25 The Industrial Land Use Conversion Results of the DTHM Analysis

Variable			Model 1 COEF (OR)	Model 2 COEF (OR)	Model 3 COEF (OR)
SES	Population	Total Population (100Person)		-0.0598*** (0.9419)	-0.0714*** (0.9311)
	Gender	Male Population (%)		0.0209*** (1.0212)	0.0252*** (1.0255)
	Race	Non-White (%)	0.0142*** (1.014)	0.0122*** (1.0123)	0.0146*** (1.0147)
	Education	Less than 9th Grade (%)	-0.0130*** (0.987)	0.0169*** (1.0170)	0.0199*** (1.0201)
	Income	Households Median Income ($1000)	-0.0111*** (0.989)	-0.0099** (0.9901)	-0.0112*** (0.9888)
	Automobile	Vehicle (%)	-0.0021* (0.998)	0.0029* (1.0029)	0.0032* (1.0032)
	Employment	Unemployed (%)		-0.0241*** (0.9761)	-0.0299*** (0.9705)
	Family Type	With Children (%)			
BE	Housing Unit	Total Housing Unit		0.0017*** (1.0017)	0.0022*** (1.0022)
		Occupied Units (%)		0.0332*** (1.0338)	0.0332*** (1.0337)
	Ownership	Ownership (%)		0.0274*** (1.0277)	0.0295*** (1.0300)
	Vacant Purpose	Vacant Units for sale only (%)			
	Vacant Duration	Less than 2months (%)		-0.0100** (0.9901)	-0.0178*** (0.9824)
		2 up to 6 months (%)			
		More than 6months (%)		-0.0137*** (0.9864)	-0.0127*** (0.9874)
	Building Type & Structure	Multihousing (%)		2.5048*** (12.2407)	2.7359*** (15.4235)
		Mobile Home or trailer (%)		2.1025*** (8.1864)	2.0246*** (7.5732)
	Housing Value	Median Housing Value ($1000)		0.0022** (1.0022)	
	Land Value	Land Value ($1000)		-0.0009*** (0.9991)	-0.0007*** (0.9993)
	Parcel Age	Parcel Age (2015-Parcel year)		-0.0667*** (0.9355)	-0.0648*** (0.9373)
	Structure Count	Structure Count			
GEO	Spatial	Hotspot			
		Local MoransI			
	Distance	Distance from CBD (1000feet)			0.0110** (1.0111)
	Size	Parcel Size (100sqft)			-0.0003*** (0.9997)
		R2	0.0375	0.2899	0.3046

n = 2273, number of events = 1413
*p < 10%, ** p < 5%, *** p < 1%

Moreover, when mobile home or trailer increases 10 percent, the estimated odds of an industrial parcel being changed are 8 times larger than the odds for an industrial parcel remaining the same. When multihousing increases 1 percent, the estimated odds of an industrial parcel being changed are 12 times larger than the odds for an industrial parcel remaining the same (see Table 25).

Model III is the full model. It adds the GEO characteristics variables, especially the variables measuring the distance from the CBD and parcel size. The substantive findings on the SES remain similar. The important findings on the BE showed parallel results, except for the median housing value. The median housing value result changed from more vacancy to no relationship. Among the added GEO characteristics, the industrial z-score of the hotspot and Local Moran's I showed that they had no relationship with the industrial land conversion. Nevertheless, the estimated odds ratio for an overall non-vacant property becoming vacant or abandoned are nearly 0.03 percent lower when the industrial parcel size increases by100 square feet. Moreover, when the distance from the CBD increases by 1000 feet, the estimated odds are 1 percent higher (see Table 25).

In the Model I, only consider the SES variables, the R-square value is a fairly small (0.0375). It represents that the SES variables have a significant relationship with the conversion NVL from VAP, it is difficult to explain this phenomenon with only SES variables. In the Model II, when the BE variables added, the R-square value is increased as 0.2899. Even though the increased value is not enormous like as residential or commercial land use. This research takes on that due to the sample size; the industrial

sample size is quite smaller than residential or commercial land use. It means the BE variables are clearly the most important influenced factors rather than SES variables.

6.5.4 Findings

From the results of the discrete time hazard quantitative analysis of the industrial land conversion to VAP in the city of Fort Worth, this research found that household median income had a significant relationship with fewer vacancy conversions in the industrial land. Only considering the SES, only the non-white variable had a significant relationship with industrial land conversion to VAP, while low educational level had a most significant relationship with the creation of fewer vacancies. Within Model II, for SES and BE variables, the old industrial parcels had a most significant relationship with the creation of fewer vacancies, while multihousing had a most significant relationship with industrial land conversion to VAP. In the full model, including SES, BE, and GEO characteristics, many multihousing structures had a most significant relationship with the conversion to more VAP. On the other hand, the total population had a most significant relationship with the conversion of industrial land to VAP in the full model. Besides, the further the distance from the CBD a parcel was had a significant relationship with producing more VAP. Conversely, the large sized parcels had a significant relationship with producing less VAP.

Table 26 Industrial Land DTHM Findings (From Industrial to VAP)

	More	Fewer
SES	• Male population • Non-white population • Low educational attainment • More vehicle owner	• Large population • High median income • High unemployment
BE	• Large housing unit • Large occupied unit • High ownership • Multihousing • Mobile home or trailer	• Less than 2 months or more than 6 months vacant duration • High land value • Old parcel age
GEO	• Further distance from CBD	• Large size parcel

According to the findings of the results to conversion VAP from industrial land use implicate several important points. First of all, in the industrial land use, same as residential and commercial land use, the further distance from CBD and small size parcel create a more VAP. It represented that large size and located nearby CBD vacant parcel in the industrial land use have a high potential for redevelopment and reuse. Moreover, same as the residential results, racial segregation, and low educational, male population create a more VAP. The interesting finding from industrial land use conversion is high median income create a fewer VAP. It implies that high median income population usually lives in the well-maintained neighborhood/community. This finding corresponds with the other finding that high land value. The well-maintained and protected parcels are usually located in the high-income neighborhood (see Table 26).

6.7 Comparison of All Land Use Type

6.7.1 Inner City vs. Suburban

The CFW is one of the fast growing and expanding cities in the United States. Due to this population and economic growth and physical annexation, many parcels' land use has changed. Compares the land use location during the entire study time period, especially the core urban area and the area outside of the urban core. Using GIS, buffering was generated at 1 mile, 2 miles, and 5 miles. To identify the buffer zone, this research considered the projected economic and demographic growth, existing transportation, infrastructure, commercial nodes, housing, and job concentrations, based on the Tachieva's transect zone (Tachieva, 2010). There is a CBD area which is around the 1 mile buffer within the CBD. To determine the pattern of land use location movement, this study assumed that the urban core is within 2 miles from the CBD, and the urban area is within 5 miles from the CBD. The area outside of 5 miles from the CBD was defined as outside of the urban area. Moreover, the CBD in CFW has about an one-mile diameter, the highway 820 located as a loop around 5-mile diameter from the CBD.

In 1990, within the 1 mile buffer from the CBD, the major land use was commercial. Within the 2 mile buffer from the CBD, the land use was a combination of commercial, industrial, residential, and vacant (see Appendix D). In 2000, there was not much change from 1990 within the 1 mile and 2 mile buffer zones (see Appendix D). In 2010, within a 1 mile buffer from the CBD, the commercial land use increased and this land was mostly converted from 1990's industrial land use. The parcels that were vacant

in 1990 changed to other land uses in 2010 as well. In 2010, the 2 mile buffer from the CBD showed a similar pattern with the 1 mile buffer zone (see Appendix D).

To determine a more exact land use change pattern, the total size of the parcel in square miles and the total number of parcels within the buffer zones was calculated. Within the 1 mile buffer zone, the total vacant parcel size decreased over time. However, the total commercial and industrial parcel sizes were extremely large within 1 mile buffer zone and the total commercial parcel size increased as time went by within this zone (see Table 27 and see Figure 52).

Table 27 The Total Size of the Parcels in the Buffer Zones (in Square Miles)

	1990		2000		2010	
1 Mile	1 Mile	Outside 1 Mile	1 Mile	Outside 1 Mile	1 Mile	Outside 1 Mile
Residential	0.1	55.6	0.1	56.8	0.1	68.9
Commercial	0.7	15.8	0.6	17.9	0.9	25.5
Industrial	0.8	15.7	0.7	17.5	0.3	17.3
Vacant	0.1	109.5	0.2	98.7	0.2	41.7

2 Mile	2 Mile	Outside 2 Mile	2 Mile	Outside 2 Mile	2 Mile	Outside 2 Mile
Residential	1.9	53.8	1.8	55.2	1.4	67.6
Commercial	2.0	14.5	1.9	16.7	3.0	23.4
Industrial	2.0	14.5	1.9	16.4	0.8	16.9
Vacant	0.8	108.8	0.9	98.0	1.0	40.8

5 Mile	5 Mile	Outside 5 Mile	5 Mile	Outside 5 Mile	5 Mile	Outside 5 Mile
Residential	23.6	32.2	22.3	34.6	20.6	48.4
Commercial	6.5	10.0	6.4	12.2	9.5	16.8
Industrial	6.6	9.9	6.3	12.0	4.0	13.6
Vacant	8.4	101.1	8.0	90.9	6.2	35.6

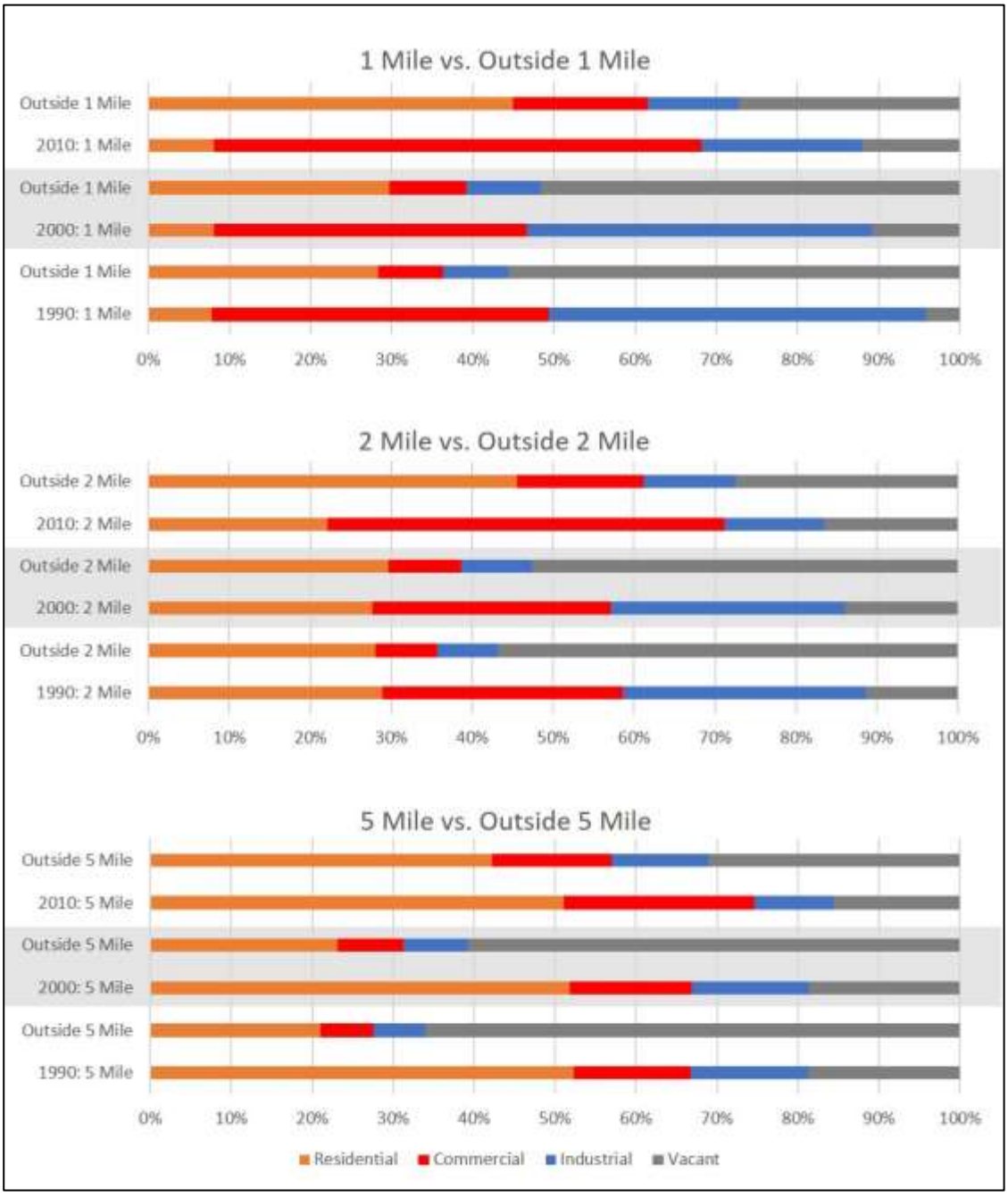


Figure 52 The Total Size of the Parcels in the Buffer Zones (100% Stacked Bar)

Within the 2 mile buffer zone, the results showed a similar pattern to the results within the 1 mile zone. On the other hand, within the 5 mile buffer zone, in 1990 and

2000, the total vacant parcel size was considerably larger than the other total land use parcel sizes, while in 2010, within and outside the 5 mile buffer zone, the gap between the total vacant parcel sizes is not so large. Considering the size of the whole CFW, the 5 mile buffer zone is still almost in an urban area. Thus, this research found that a large amount of VAP in the urban area is larger than in the suburban areas.

Regarding the total number of land use parcels within the buffer zones, the following results were discovered. Within the 1 mile buffer zone in 1990, the number of vacant parcels showed that the total number of vacant parcels outside of the 1 mile buffer zone was much larger than the total number of vacant parcels within 1 mile buffer zone. But, in 2010, the total number of vacant parcels within the 1 mile buffer zone was much larger than the total number of vacant parcels outside of the 1 mile buffer zone (see Table 28 and Figure 53). This buffer zone is the smallest buffer zone in the real CBD area in Fort Worth.

From this outcome, this research confirmed that the core urban area has a larger number of VAP parcels compared to outside the urban core area. The results of the number of VAP parcels within the 2 mile buffer zone were similar to the results found within the 1 mile buffer zone. Within the 5 mile buffer zone, the number of vacant parcels are little higher than the number outside of the 5 mile buffer zone. From this study if was found that the core urban area had a large number of vacant parcels, but their size was smaller than those outside of the urban area.

Table 28 The Total Number of Parcels in the Buffer Zone

	1990		2000		2010	
1 Mile	1 Mile	Outside 1 Mile	1 Mile	Outside 1 Mile	1 Mile	Outside 1 Mile
Residential	373	161617	304	172022	309	192607
Commercial	1262	15164	1133	14393	1120	13929
Industrial	762	8147	691	9349	161	2356
Vacant	98	76758	289	63249	507	34335

2 Mile	2 Mile	Outside 2 Mile	2 Mile	Outside 2 Mile	2 Mile	Outside 2 Mile
Residential	7723	154267	7363	164963	5023	187893
Commercial	3300	13126	2976	12550	3359	11690
Industrial	2152	6757	2161	7879	355	2162
Vacant	649	76207	825	62713	3183	31659

5 Mile	5 Mile	Outside 5 Mile	5 Mile	Outside 5 Mile	5 Mile	Outside 5 Mile
Residential	80687	81303	78043	94283	63068	129848
Commercial	10579	5847	9221	6305	9178	5871
Industrial	5050	3859	4850	5190	1038	1479
Vacant	4701	72155	4235	59303	13431	21411

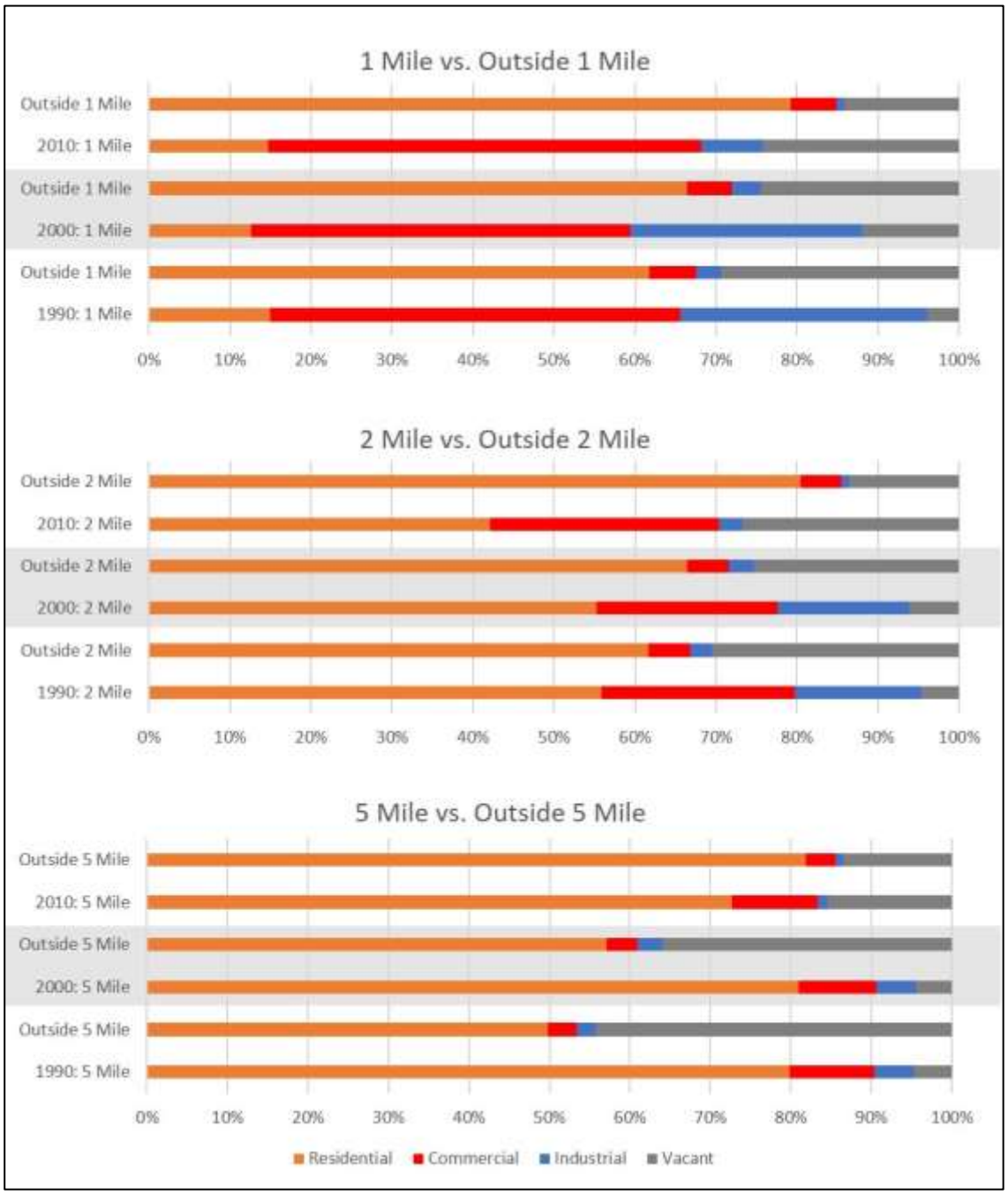


Figure 53 The Total Number of Parcel in the Buffer Zones (100% Stacked Bar)

6.7.2 Descriptive Spatial Analysis

This research examined each land use type in each study year in the CFW, using various tools for the purpose. A comprehensive comparison of each land use type, residential, commercial, industrial, and vacant are compared in this section using the results from the previous section.

First, the mean center and the directional distribution of each land use type in the CFW showed that each land use parcel was moving toward the CBD from 1990 to 2010, except the industrial land use. Moreover, the residential and vacant parcel patterns had an irregular variation across the study years. The directional distribution of commercial and industrial parcels had the most consistent pattern. The commercial parcels are narrower for all the years, which means that the commercial land was concentrated in the core urban area rather than other land use types (see Figure 54).

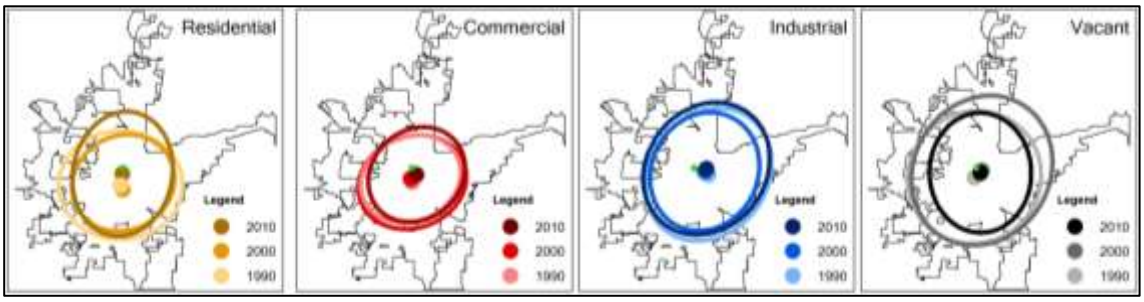


Figure 54 All Land Use Mean Centers and Directional Distribution Results

Each land use type in each year in the CFW had a clustered land use pattern, except industrial land in the year 2010. Excluding the 2010 industrial land use, based on all the given z-scores, for all of the land use in each year there is a less than 10 percent

likelihood that the clustered pattern could be the result of random change; for most of the patterns, there is a less than 1 percent likelihood (see Appendix B).

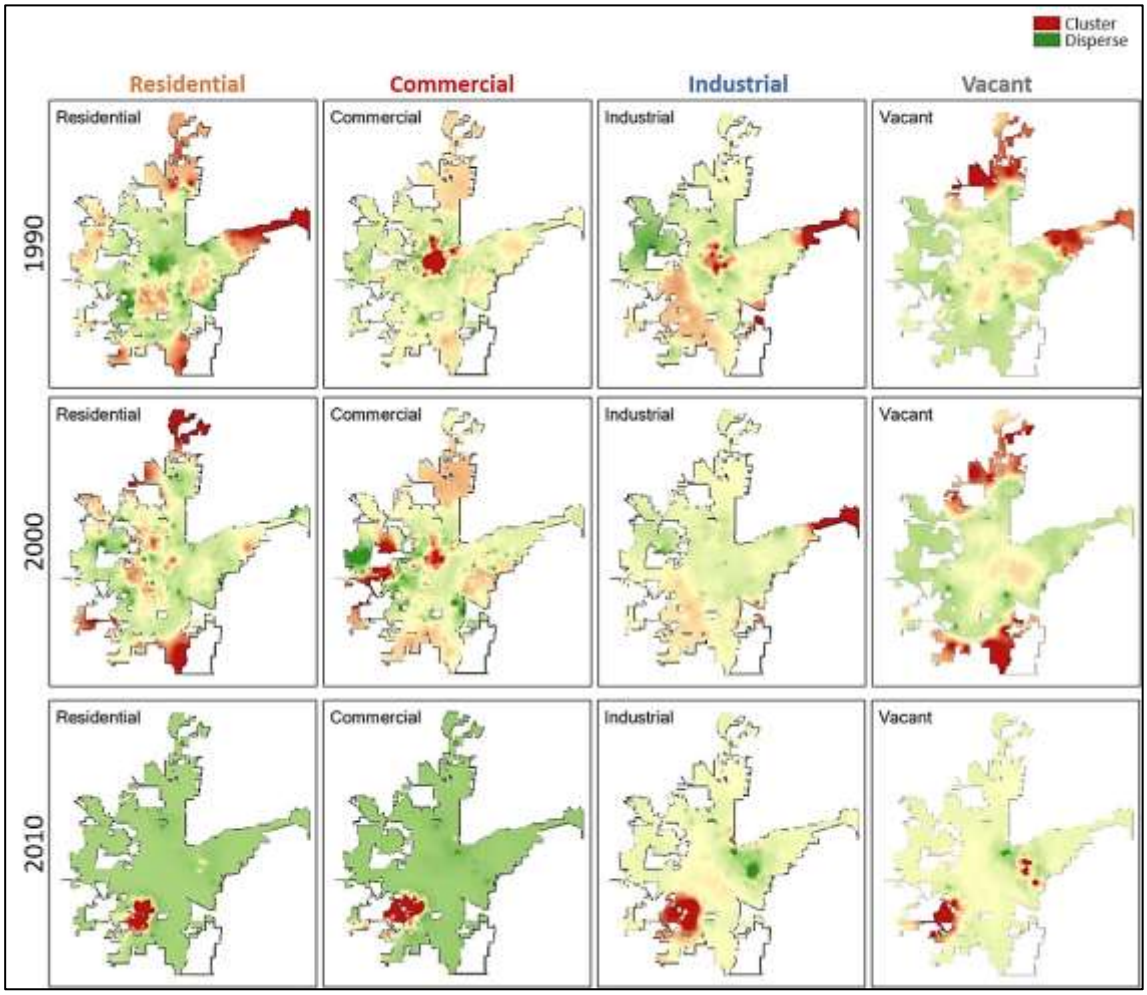


Figure 55 The Local Moran's I Results of All Land Use Count Ratio

Accompanying these results, the Local Moran's I based on the count ratio, and the parcel number ratio was employed. The results of the count ratio indicated that the southwestern area was the most clustered in 2010 in all different land use types.

Residential results showed clustering in the southern area of the urban core and the edge of the city in 1990 and 2000. In 2010, residential land use was overly dispersed, except a small part in the southwestern area. The commercial land was only clustered in the urban area in 1990, and the clustered area moved toward the western side, became overly distributed, and dispersed. Industrial land revealed clustering in the urban core and far eastern side of the city in 1990, then the clustering in the core urban area dispersed in 2000. VAP clustered on the edges of the northern and eastern sides in 1990. Then, in 2000, the eastern clustered area moved to the south and the northern area remained. In 2010, the VAP was overly dispersed (see Figure 55).

The results of the Local Moran's I for the all land use area ratio discovered the following. Residential land was clustered in the southern part of the core urban area and the edge of the city during the whole study time period. In addition, the clustered area moved more toward the urban core in 2010. The commercial land was continuously clustered in the urban core from 1990 to 2010, even though it was also continuously distributed and dispersed. The most clustered industrial land was around the northern part of the urban core and the southeastern side, then it was dispersed from the urban core. In the 1990s, VAP clustered mostly in the far eastern edge of the city, then moved toward the southern edge of the city in 2000. In the end, VAP showed no strong clustering in the urban core in 2010 (see Figure 56).

In sum, throughout the descriptive spatial clustering analysis comparisons (Figure 55 and 56), this study find out the spatial land use pattern, during the study period from 1990 to 2010, in CFW.

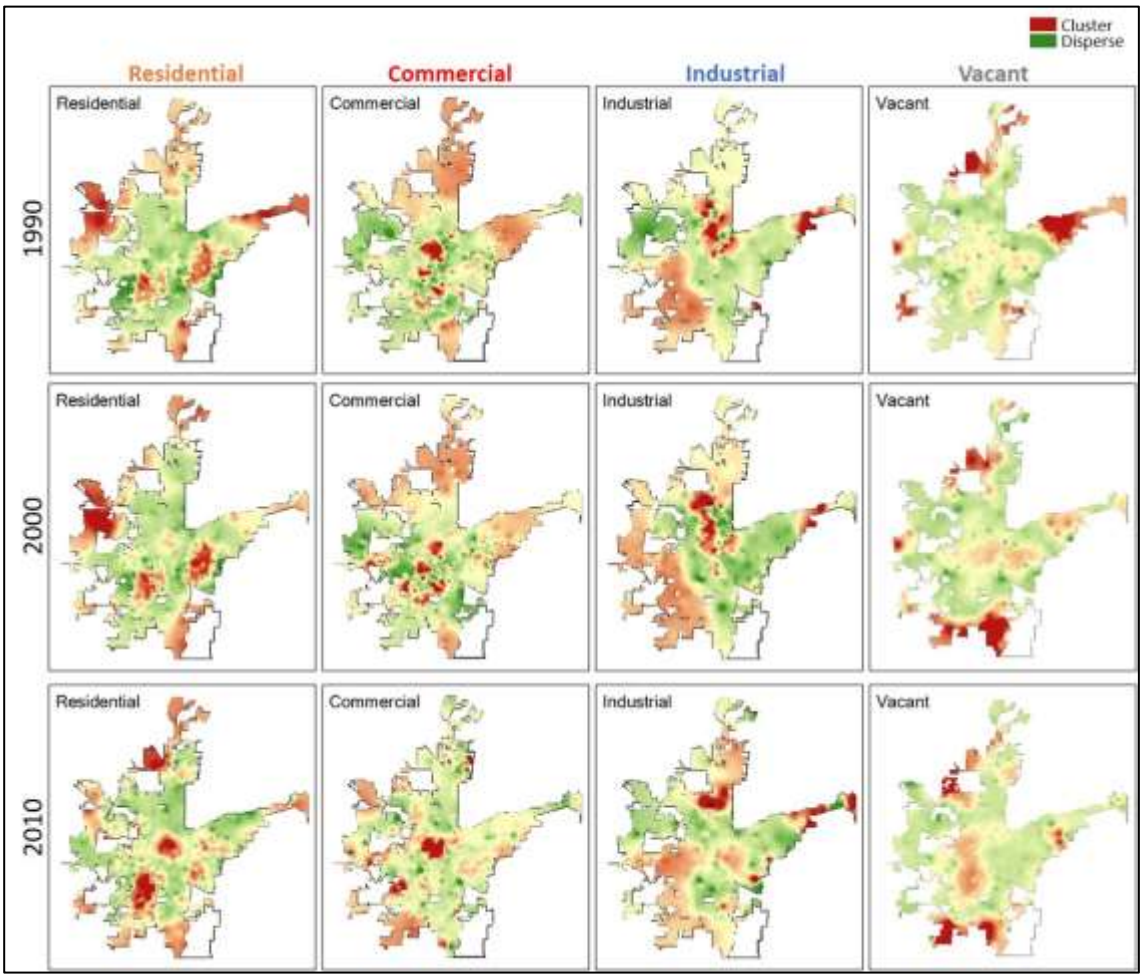


Figure 56 The All Land Use Area Ratio Local Moran'sI Results

The outcomes reveal that residential and vacant land use show a similar pattern that many residential and vacant land use parcels concentrated at the edge of the CFW, especially near the Arlington in the 1990 and 2000; near the Benbrook in 2010. It takes to mean that among different land use type, residential and vacant land are existent at the same time and the same area. According to this finding, this research states that due to the annexation, the CFW had a large amount of the vacant land at the edge of the city, it brings many residential land use development at the same area in 1990 and 2000. On the

other hands, the commercial land use stays continuously near the CBD in 1990 and 2000; they followed the new residential concentrated area where nearby the Benbrook also. The industrial land use shows the same pattern as well.

Using the Local Moran's I, this research determined the locations of clustered areas and dispersed areas for each land use type. In conjunction with these results, this research discovered the characteristics of the clustering areas using the hotspot analysis. First, the results of the count ratio hotspot analysis indicated that the southwestern part of the city showed a large number of parcels clustered in all different land uses in 2010. Specifically, there were many residential parcels clustered in the southern part of the core urban area in 1990, and they moved toward the northwestern part in 2000. The main commercial clustering area was in the core urban area in 1990 but moved toward the edge of the western part of the city in 2000. There was a large number of industrial land parcels clustered in the core urban area in 1990; they disappeared in 2000. The VAP parcels were mainly clustered in the northern and the eastern edges of the city in 1990. They moved to the southern edge of the city in 2000, and they clustered in the eastern corner of the city near the industrial clustering area in 2010 (see Figure 57).

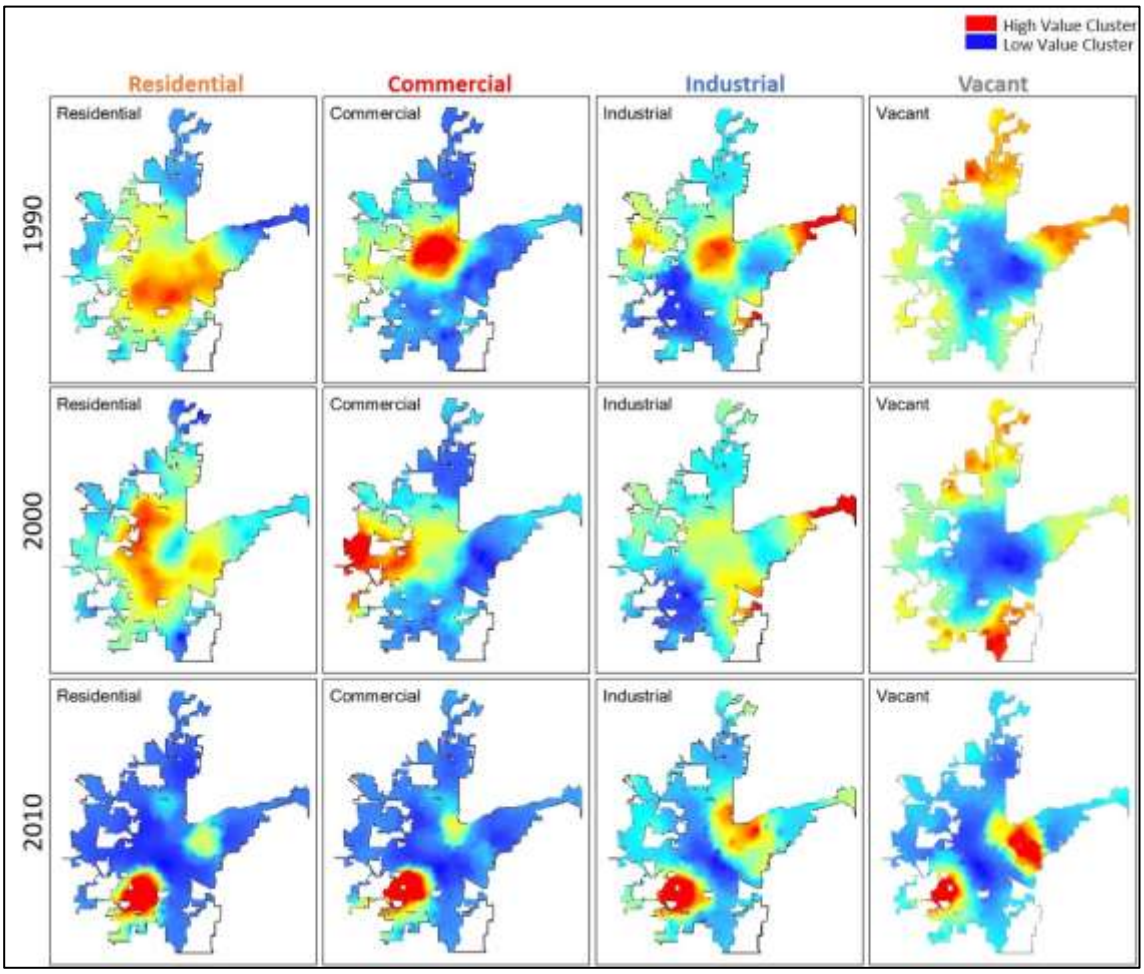


Figure 57 The Hotspot Results for All Land Use Count Ratios

The area ratio hotspot results showed that the large sized residential parcels and the small sized vacant parcels clustered in the southwestern area of the city. The clustering areas for these two land uses did not exactly overlap, but some parts of these clustering areas were connected.

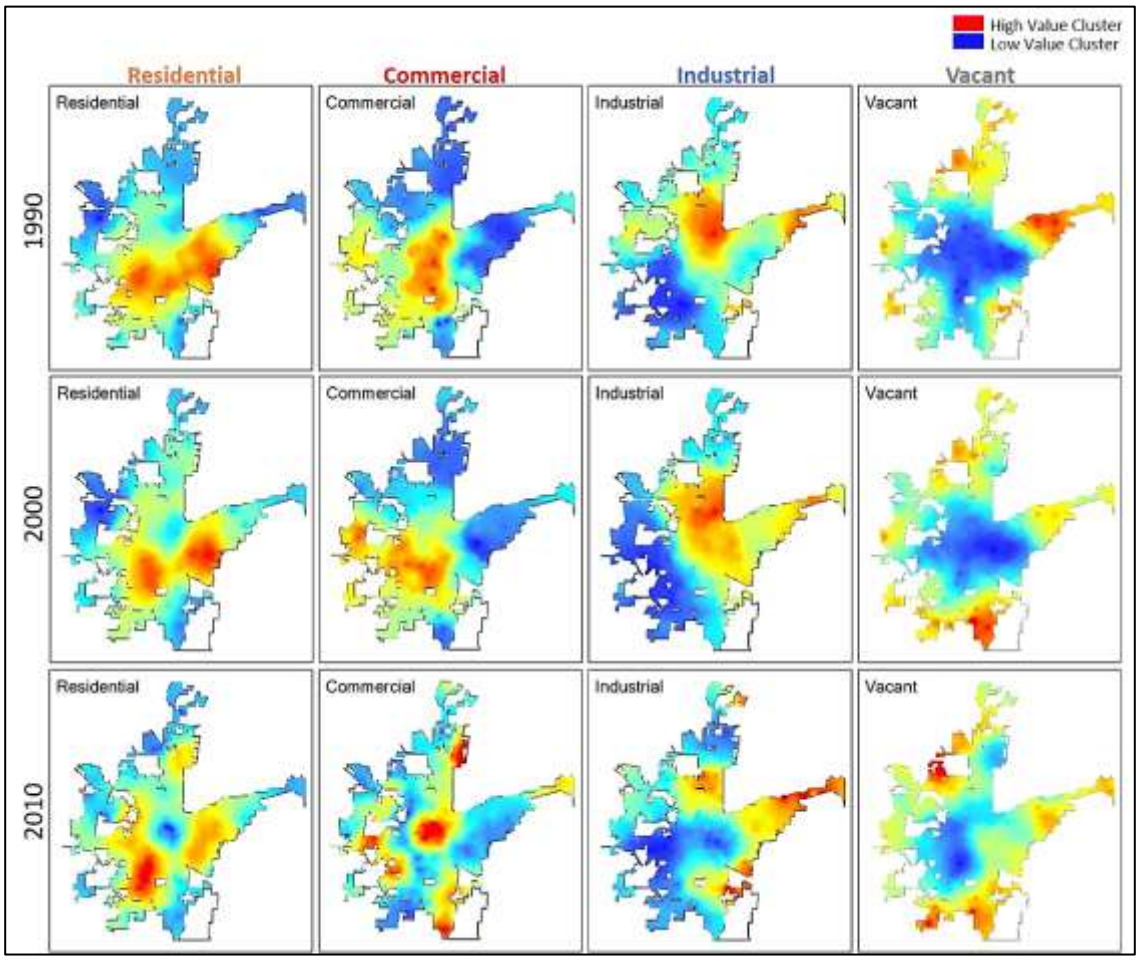


Figure 58 The Hotspot Result for All Land Use Area Ratios

The residential parcels clustered the southern part of the core urban area had an east-west direction in 1990. Then, they disappeared and were distributed toward the northwestern part of the city in 2000 and 2010. The commercial parcels were clustered in the core urban area as well, but in a north-south direction in 1990. Then, they disappeared and were distributed toward the eastern corner area of the city in 2010. The industrial parcels clustered in the eastern corner area of the city in 1990. They were dispersed in 2000 and moved toward the eastern edge of the city. The commercial

clustering area in 2010 followed the industrial clustering area in 2000. The small sized vacant parcels largely clustered in the core urban area in 1990, and the dispersion area was shrinking in 2000 and 2010. Regardless of the parcel size, the vacant parcel clustering areas were dispersed (see Figure 58).

6.7.3 Discrete-Time Hazard Quantitative Analysis

For comprehensive and longitudinal analyses of the conversion of VAP in the CFW, this research compared the discrete time hazard quantitative analysis results gradually by each land use as a model I, model II, and model III. The total overall non-vacant parcel number was 116994, and the conversion parcel number was 16069. The total residential parcel number was 107803, and the event parcel number was 13237. The total commercial parcel observation number was 6918, and the conversion parcel number was 1419. The total industrial parcel number was 2273, and the event parcel number was 1413. Among each land use type, the industrial conversion to VAP percentage is the highest. The conversion of VAP in the overall NVL is 13.7 percent. The residential conversion to VAP is 12.3 percent. The commercial and industrial conversion to VAP is 20.5 percent and 62.2 percent, respectively.

In Model I, only consider the SES variables, the R-square value of the all of land use is a fairly small (overall = 0.0873, residential = 0.107, commercial = 0.0343, industrial = 0.0375). It represents that the SES variables have a significant relationship with the conversion from of each land use to VAP, it is difficult to explain this phenomenon with only SES variables.

Table 29 All Land Use Model I Results

Variable			Overall COEF (OR)	Residential COEF (OR)	Commercial COEF (OR)	Industrial COEF (OR)
SES	Population	Total Population (100Person)	-0.0553*** (0.946)	-0.0802*** (0.923)	0.0143** (1.014)	
	Gender	Male Population (%)	0.0102*** (1.010)	0.0133*** (1.013)	-0.0287*** (0.972)	
	Race	Non-White (%)	0.0181*** (1.018)	0.0207*** (1.021)	0.0128*** (1.013)	0.0142*** (1.014)
	Education	Less than 9th Grade (%)	-0.0019*** (0.998)	-0.0014* (0.999)		-0.0130*** (0.987)
	Income	Households Median Income ($1000)	-0.0088*** (0.991)	-0.0065*** (0.994)		-0.0111*** (0.989)
	Automobile	Vehicle (%)			-0.0044*** (0.996)	-0.0021* (0.998)
	Employment	Unemployed (%)	0.0086*** (1.009)	0.0042** (1.004)	0.0082** (1.008)	
	Family Type	With Children (%)	-0.0034*** (0.997)	-0.0031*** (0.997)	0.0062*** (1.006)	
		R2	0.0873	0.107	0.0343	0.0375

*p < 10%, ** p < 5%, *** p < 1%

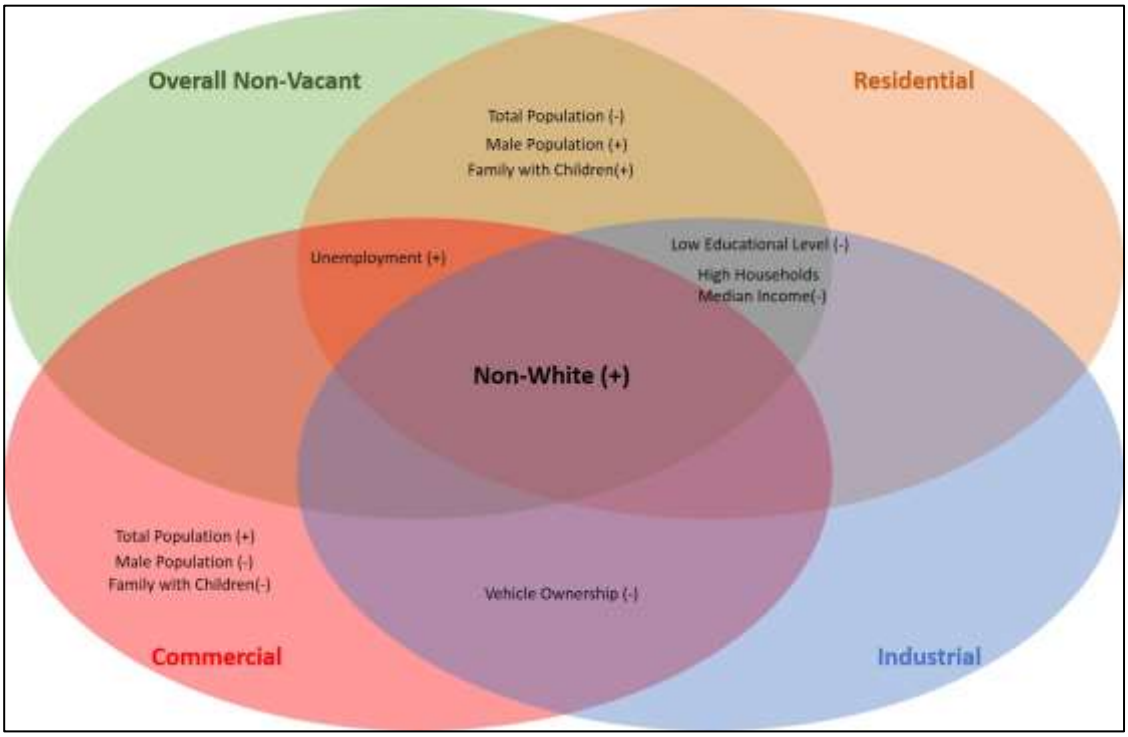


Figure 59 All Land Use Model I Results

In Model I, a large non-white population showed a significant relationship with creating more VAP. Among each land use, the impact of the non-white population on residential land use was stronger than in any other land use. The results of the overall non-vacant and residential are almost similar. Only the conversion from industrial to VAP had no relationship with the total population, male population, unemployment, and the family with children. The conversion from commercial to VAP had no relationship with a low educational level or household median income (see Table 29 and Figure 59).

In model II, a large non-white population had a significant relationship with producing more VAP in all the different land uses, similar to Model I's result. Moreover, high land value and old parcels have a significant relationship with producing less VAP in all land uses. The total population and median household income had no relationship with the conversion of VAP in commercial land use only; while the total population and household median income had a significant relationship with creating less VAP in other land uses. Also, a low educational level population had a significant relationship with creating more VAP in overall non-vacant, residential, and industrial land uses, while only commercial land showed an opposite result of a less likelihood of being vacant. The family with children had a significant relationship with producing more VAP in the all land use types except industrial land use. On the other hand, the total housing unit showed a significant relationship with more vacancies in industrial land use only. The temporarily vacant unit for sale had a significant relationship with more vacancies only in commercial land use. The unit vacant more than 6 months in the overall non-vacant, residential, and industrial land uses had a significant relationship with fewer vacancies.

Table 30 All Land Use Model II Results

Variable			Overall COEF (OR)	Residential COEF (OR)	Commercial COEF (OR)	Industrial COEF (OR)
SES	Population	Total Population (100Person)	-0.0230*** (0.9773)	-0.0458*** (0.9553)		-0.0598*** (0.9419)
	Gender	Male Population (%)	-0.0143*** (0.9858)		-0.0353*** (0.9653)	0.0209*** (1.0212)
	Race	Non-White (%)	0.0128*** (1.0129)	0.0139*** (1.0140)	0.0162*** (1.0163)	0.0122*** (1.0123)
	Education	Less than 9th Grade (%)	0.0076*** (1.0076)	0.0130*** (1.0131)	-0.0140*** (0.9861)	0.0169*** (1.0170)
	Income	Households Median Income ($1000)	-0.0049*** (0.9951)	-0.0033** (0.9968)		-0.0099** (0.9901)
	Automobile	Vehicle (%)	-0.0008** (0.9992)		-0.0036*** (0.9964)	0.0029* (1.0029)
	Employment	Unemployed (%)	0.0077*** (1.0077)			-0.0241*** (0.9761)
	Family Type	With Children (%)	0.0015*** (1.0015)	0.0019** (1.0019)	0.0033** (1.0033)	
BE	Housing Unit	Total Housing Unit				0.0017*** (1.0017)
		Occupied Units (%)	-0.0060*** (0.9940)		-0.0081* (0.9920)	0.0332*** (1.0338)
	Ownership	Ownership (%)	0.0086*** (1.0086)			0.0274*** (1.0277)
	Vacant Purpose	Vacant Units for sale only (%)			5.2591*** (192.3131)	
	Vacant Duration	Less than 2months (%)	0.0029*** (1.0029)	-0.0049*** (0.9951)		-0.0100** (0.9901)
		2 up to 6 months (%)	-0.0023*** (0.9977)		0.0064** (1.0064)	
		More than 6months (%)	-0.0028*** (0.9972)	-0.0054*** (0.9947)		-0.0137*** (0.9864)
	Building Type & Structure	Multihousing (%)			-1.6004*** (0.2018)	2.5048*** (12.2407)
		Mobile Home or trailer (%)		-0.5632*** (0.5694)	-1.2547*** (0.2852)	2.1025*** (8.1864)
	Housing Value	Median Housing Value ($1000)	0.0027*** (1.0027)	-0.0024*** (0.9976)		0.0022** (1.0022)
	Land Value	Land Value ($1000)	-0.0014*** (0.9986)	-0.0015*** (0.9985)	-0.0009*** (0.9991)	-0.0009*** (0.9991)
	Parcel Age	Parcel Age (2015-Parcelyear)	-0.0776*** (0.9253)	-0.0631*** (0.9389)	-0.1137*** (0.8925)	-0.0667*** (0.9355)
	Structure Count	Structure Count	-4.1841*** (0.0152)	-4.7578*** (0.0086)	3.9317*** (50.9950)	
		R2	0.7502	0.8091	0.4494	0.2899

*p < 10%, ** p < 5%, *** p < 1%

The structure count also had a significant relationship with the conversion of VAP in the overall non-vacant, residential, and commercial land uses. In the overall non-vacant and residential land uses, a large number of structures produced fewer vacancies, while many industrial structures produced more vacancies (see Table 30 and Figure 60).

In Model II, when the BE variables added, the R-square value of each land use is increased (overall = 0.7502, residential = 0.8091, commercial = 0.4494, industrial = 0.2899). It means the BE variables are clearly the most important influenced factors rather than SES.

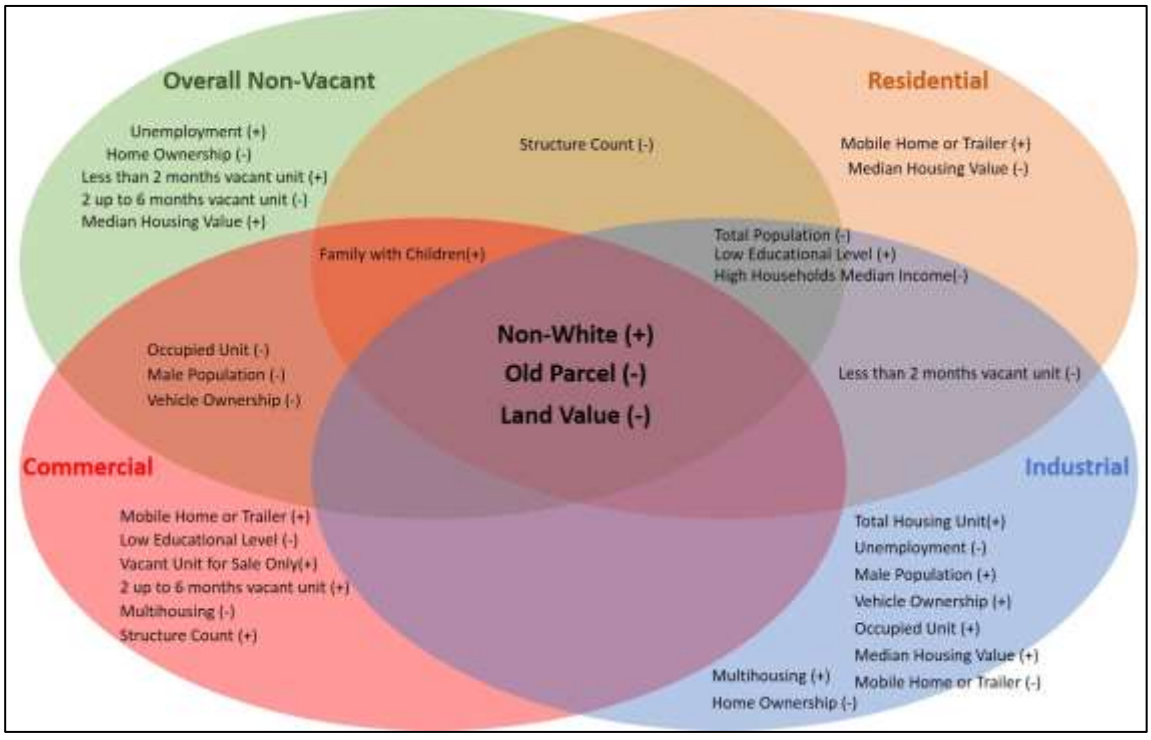


Figure 60 All Land Use Model II Results

Model III is the full model in this research. According to the results, this research found that a large non-white population had a significant relationship with more vacancies in the all the land uses, similar to the results of the model I and model II. Furthermore, high land value and old parcels had a significant relationship with fewer vacancies in all land uses, typically. The GEO variables, the hotspot, and Local Moran's I z-scores, had no relationship with the conversion of VAP in the all land use types.

The results of total population, gender, race, education, income, family type, occupied units, home ownership, the purpose of the vacancy, the duration of the vacancy, mobile home or trailer, land value, parcel age, and structure count in each land use had continuously similar outcomes to the results of model II. Vehicle ownership in overall non-vacant, commercial, and industrial land showed similar results to model II.

Only in the residential land use model III, vehicle ownership variable changed from model II. It does not have a relationship in model II while it had a significant relationship with fewer vacancies in model III. The unemployment results in Model III had changed in all land use types except industrial land use. Unemployment had no relationship with the overall non-vacant and commercial land use. It did have a significant relationship with fewer vacancies in residential land use. The total housing unit also showed different results from model II in the overall non-vacant and residential land uses in model III. The housing unit had a significant relationship with more vacancies in the overall non-vacant and residential land uses.

Table 31 All Land Use Model III Results

Variable			Overall COEF (OR)	Residential COEF (OR)	Commercial COEF (OR)	Industrial COEF (OR)
S E S	Population	Total Population (100Person)	-0.0288*** (0.9716)	-0.0620*** (0.9399)		-0.0714*** (0.9311)
	Gender	Male Population (%)	-0.0137*** (0.9864)		-0.0340*** (0.9665)	0.0252*** (1.0255)
	Race	Non-White (%)	0.0144*** (1.0145)	0.0161*** (1.0163)	0.0157*** (1.0158)	0.0146*** (1.0147)
	Education	Less than 9th Grade (%)	0.0081*** (1.0081)	0.0158*** (1.0160)	-0.0140*** (0.9861)	0.0199*** (1.0201)
	Income	Households Median Income ($1000)	-0.0057*** (0.9943)	-0.0042*** (0.9958)		-0.0112*** (0.9888)
	Automobile	Vehicle (%)	-0.0008** (0.9992)	-0.0007* (0.9993)	-0.0038*** (0.9962)	0.0032* (1.0032)
	Employment	Unemployed (%)		-0.0116*** (0.9885)		-0.0299*** (0.9705)
	Family Type	With Children (%)	0.0010** (1.0010)	0.0026*** (1.0026)	0.0032** (1.0032)	
B E	Housing Unit	Total Housing Unit	0.0003** (1.0003)	0.0002* (1.0002)		0.0022*** (1.0022)
		Occupied Units (%)	-0.0063*** (0.9937)		-0.0086* (0.9915)	0.0332*** (1.0337)
	Ownership	Ownership (%)	0.0084*** (1.0084)			0.0295*** (1.0300)
	Vacant Purpose	Vacant Units for sale only (%)			5.6656*** (288.7558)	
	Vacant Duration	Less than 2months (%)	0.0021*** (1.0021)	-0.0085*** (0.9916)		-0.0178*** (0.9824)
		2 up to 6 months (%)	-0.0027*** (0.9973)		0.0058** (1.0058)	
		More than 6months (%)	-0.0029*** (0.9971)	-0.0074*** (0.9927)		-0.0127*** (0.9874)
	Building Type & Structure	Multihousing (%)	0.2085** (1.2319)		-1.6159*** (0.1987)	2.7359*** (15.4235)
		Mobile Home or trailer (%)		-0.6509*** (0.5216)	-1.1634*** (0.3124)	2.0246*** (7.5732)
	Housing Value	Median Housing Value ($1000)	0.0024*** (1.0024)	-0.0027*** (0.9973)		
	Land Value	Land Value ($1000)	-0.0014*** (0.9986)	-0.0014*** (0.9986)	-0.0008*** (0.9992)	-0.0007*** (0.9993)
	Parcel Age	Parcel Age (2015-Parcelyear)	-0.0772*** (0.9257)	-0.0618*** (0.9400)	-0.1134*** (0.8928)	-0.0648*** (0.9373)
	Structure Count	Structure Count	-4.2339*** (0.0145)	-4.8501*** (0.0078)	3.8826*** (48.5511)	
G E O	Spatial	Hotspot				
		Local MoransI				
	Distance	Distance from CBD (1000feet)	0.0119*** (1.0120)	0.0234*** (1.0237)		0.0110** (1.0111)
	Size	Parcel Size (100sqft)		-0.0007*** (0.9993)	-0.0006*** (0.9994)	-0.0003*** (0.9997)
		R2	0.7508	0.8105	0.4533	0.3046

*p < 10%, ** p < 5%, *** p < 1%

Multihousing had a significant relationship with creating more VAP in overall NVL use in model III. The median housing value in industrial land use represented a changed result that had no significant relationship with conversion land use (see Table 31). The further the distance from the CBD of overall non-vacant, residential, and industrial land had a significant relationship with more vacancies; while it had no significant relationship with the conversion of VAP in commercial land use. The large size residential, commercial, and industrial parcels had a significant relationship with fewer vacancies, while it had no significant relationship with the conversion of VAP in the overall NVL. This research determined that the parcels which were a further distance from the CBD and were small sized created more VAP conversion (see Figure 61).

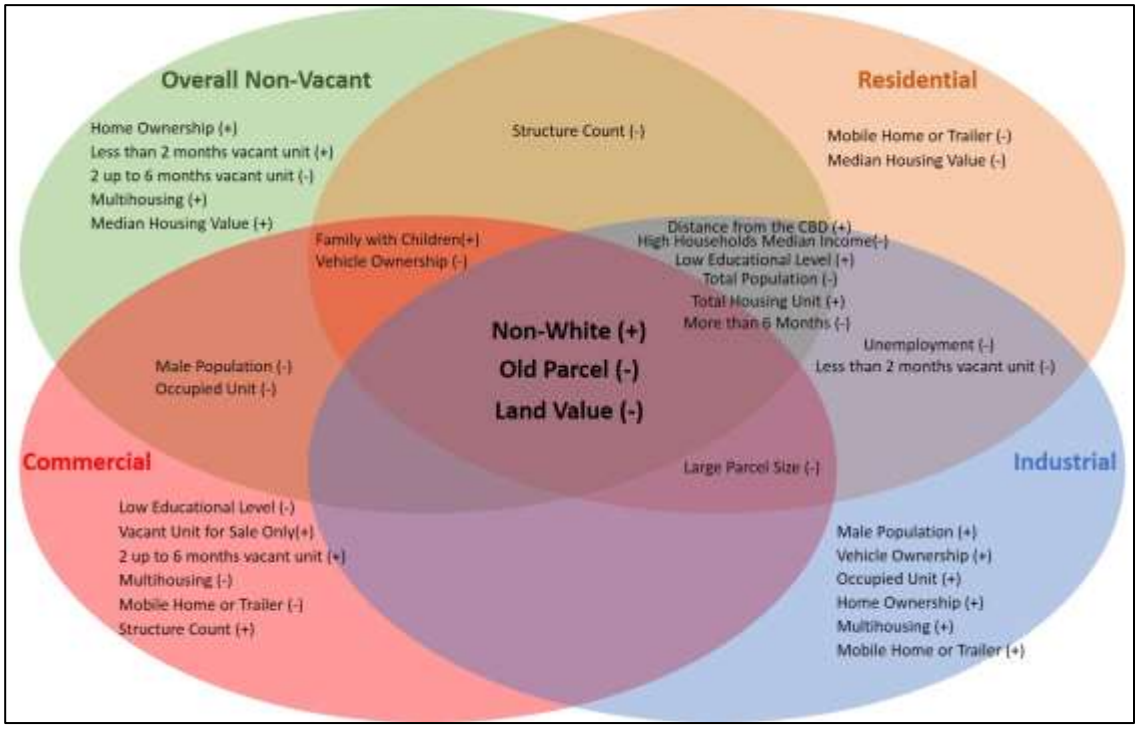


Figure 61 All Land Use Model III Results

6.7.4 Findings

6.7.4.1 Inner City vs. Outside of Urban Core Area

Following the results of the each land use type comparison between the inner-city and suburban areas, this research confirmed that within the 1 and 2 mile buffer zone, regardless of the specific study year, the total amount (parcel size) of the commercial and industrial land use types prevailed, when compared with the parcel sizes outside of the buffer zone. Otherwise, the total number of land use parcels for the VAP in 2010 within the 1, 2, and 5 mile zones is larger than the land use parcels outside of each buffer zone. This means that the inner urban area contains a large amount of small VAP.

6.7.4.2 Descriptive Spatial Analysis

The mean center identifies the geographical center of each land use and the tendency, measured every ten years, of residential, commercial, and VAP to move toward the city center. The geographical distribution of each land use indicated that residential and vacant had no regular pattern, while commercial and industrial land use had consistent patterns during the study period. Only the VAP illustrated a concentrated distribution pattern in 2010 rather than over the whole study period.

Through the Global Moran's I, this research confirmed that each year of the study and each different land use had a statistically significant spatial clustering pattern, except the industrial land use in 2010. From these results, this research identified where spatial clustering occurred, and where spatial outliers were located, using Local Moran's I and Hotspot. Related with the number of the land use parcels, regardless the land use

type, a large number of all land use parcels clustered in the southwestern area of the city in 2010. Relatively, a large number of residential, commercial, and industrial parcels clustered in an inner urban area in 1990 and 2000, while a large amount of VAP clustered in a peripheral area in 1990 and 2000. Along with each land use parcel size, relatively large residential and commercial parcels were clustered in an inner urban area during the whole study period. Otherwise, the large sized industrial and vacant parcels were clustered in a boundary of the city, especially in the northeastern area in 1990 and 2000. The large sized industrial parcel clustering moved toward the far eastern edge of the city in 2010, and the large sized vacant clustering was still at the edge of the city in 2010.

6.7.4.3 Discrete-Time Hazard Quantitative Analysis

To determine the impact factors from the conversion of NVL to vacant, this research conducted a discrete time hazard analysis. Only considering the socioeconomic factors for the model I, a large non-white population created more vacant conversion in all the NVAP use. A small total population, large male population, and the many families with children created more vacant conversion from residential land use. Whereas there were totally opposite results for commercial land in that large total population, small male population, a small number of family with children created more vacancy conversions, as did high unemployment rate. Considering in line with the literature that losing a job is linked with the VAP issue, the unemployment rate in the commercial land use result cannot support the literature. The low educational level and

high household median income created less VAP conversion in residential and industrial land use. A large number of vehicle ownership created less VAP conversion in commercial and industrial land use. This can mean that accessibility by using a car is important in the growing and expanding cities.

In model II, the socioeconomic and BE factors considered together, a large non-white population, younger parcels, and low land value had a large probability of becoming converted to VAP in all of the land uses. In residential land use, small number of structures, large mobile home or trailer, and low median housing values had a high probability for being converted to VAP, while these two variables showed totally opposite results in industrial land use in that a small number of mobile homes or trailers and high median housing values had a high probability of conversion to VAP. Moreover, large male population, high vehicle ownership, many occupied units, a large amount of multihousing, low unemployment, a small number of mobile homes or trailers, and low home ownership had a more likelihood to be converted to vacant from industrial land use. In both land uses, – residential and industrial, a unit temporarily vacant less than 2 months, high household median income, high educational level, and the large population was less likely to become a vacant parcel. In commercial land use, many mobile homes or trailers, high educational level, many temporarily vacant units for sale, a large number of structures, fewer occupied units, less male population, and low vehicle ownership were more likely to become a vacant parcel. The more family with children in residential and commercial both was more likely to become a vacant parcel.

In model III, as a full model in this research, a small non-white population, old parcel, and high land values had a less likelihood to be converted to VAP in all the land use types. The results of model III is almost similar to the results of model II. The conspicuous finding from model III is that the mobile home or trailer had less of a likelihood to be converted to vacant the residential land use, while it had more of a likelihood to be converted to vacant the commercial land use. Otherwise, high unemployment, a small number of units temporarily vacant for more than 6 months, fewer housing units, and the closer the distance to the CBD were likely to become VAP from residential and industrial land use. On the other hand, high vehicle ownership was less likely to be converted to vacant residential and commercial land use. This means that accessibility to the residential and commercial via vehicle and high personal car ownership is an important factor in the growing city. Moreover, the large sized parcels had less likelihood of being converted to VAP in the residential, commercial, and industrial areas. Thus, this research proved that the parcel size is a vital factor in creating more VAP, especially the small sized parcels.

7. CONCLUSIONS

This research applied an advanced methodology using critical variables that are significantly related to the conversion of VAP and suggests a direction for questions about the relationships between VAP and conversion-influencing elements, especially in the growing and Sunbelt cities. Therefore, the findings yield a number of important broad implications for academic and professional researchers as well as policymakers.

7.1 Conversion of VAP in the City of Fort Worth

To answer the research question that 1) How have vacant and abandoned properties and non-vacant land patterns been distributed through time? and 2) What factors affect the conversion of non-vacant land to overall vacant and the different land use types – residential, commercial, and industrial? Land use transition was examined spatially through the lens of non-vacant property conversion to vacant and abandoned in the CFW following the descriptive and statistical characteristics of SES, BE, and GEO. The effects of variables used for urban abandonment and land use conversion to vacant property were found to be pronounced and long lasting. Based on the results of the seven research hypotheses, this study will answer the research questions in this section.

In response to the first hypothesis that the urban core will have more vacant or abandoned properties compared to peripheral areas of the city in the year 2010 is larger than in the year 1990 and 2000 because of annexation; this research confirmed that urban core will have more vacant or abandoned properties compared to peripheral areas of the

city; this research found that the VAP in the core urban area was greater than in the peripheral area of the city, regardless of the buffer zone. However, the vacant or abandoned property sizes are small. Thus, the total amount of vacant or abandoned properties in the core urban area is not enormous compared to the peripheral areas of the city. The CFW has numerous small sized vacant properties in the core urban area. As well, the land use distribution pattern of a parcel is diverse. The residential and industrial land use distributions in 2010 showed larger distributions than in 1990. Otherwise, the VAP distribution in 2010 showed a more concentrated pattern than in 1990. The commercial land use distribution in each study period showed a constant pattern and size. Thus, this research confirmed that because of annexation, residential and industrial land use distributions are larger than they were previously, and even though the CFW has experienced a huge annexation, the distribution VAP is concentrated in the inner city.

About the second hypotheses that significant clustering of vacant or abandoned properties will result in increased vacancies or abandonment of adjacent or nearby parcel; this research conducted the spatial analyses. Based on the results from the Global Moran's I, Local Moran's I, and Hotspot analysis of the number of vacant parcels, this research confirmed that the significant clustering of vacant or abandoned properties increased vacancies or the abandonment of adjacent or nearby parcels. Moreover, the large sized vacant properties increased vacancies or abandonment of adjacent or nearby parcels at the margin of the city.

Concerning the third hypothesis that variables influencing conversion of VAP will vary by land use type; following the results of the discrete time hazard model

analysis, there were several common influencing conversions of VAP, but most of the influencing conversions of VAP factors showed a discrepancy by land use type. The residential land use conversion to VAP had a statistically significant relationship with the number of structures, mobile home or trailer, and median housing value. The commercial land use conversion to VAP had a statistically significant relationship with educational level, duration and purpose of a temporarily vacant unit, and multi-housing. The industrial land use conversion to VAP had a statistically significant relationship with gender, vehicle ownership, occupied unit, and home ownership.

Looking at the fourth hypothesis that SES variables will have a stronger influence on residential vacancies while BE variables will have a stronger influence on commercial and industrial vacancies; this research observed that each land use type – residential, commercial, and industrial – showed an almost similar degree of influence on the conversion of VAP. Nevertheless, the noticeable finding of this research was that, among the influencing BE variables for conversion of VAP in residential land use, all of the influencing variables were less likely to become a vacant property, except one variable: total population. For the socioeconomic variables, the non-white population had a significant relationship with all three different land use vacancies. With the BE variables, land value and parcel age had a significant relationship with all three different land use vacancies. Thus, this research confirmed that the SES variable had a stronger influence on residential vacancies while the BE variable had a stronger influence on commercial and industrial vacancies.

Regarding the fifth hypothesis that a further distance from the CBD will increase the chance that property becomes vacant or abandoned; this research proved that the further the distance from the CBD increased the chance that property would become vacant or abandoned in residential and industrial land use. In the results of the overall NVL use, the further the distance from the CBD was more likely to cause a conversion to VAP as well.

In answer to the last hypothesis that small size parcels will increase the chance that property becomes vacant or abandoned; this research identified that small sized parcels increased the chance that property would become vacant or abandoned in all three land uses, residential, commercial, and industrial. From these results, this research confirmed that the further the distance from the CBD and small sized parcels increased the chance of the conversion from NVL use to vacant property.

Along with these hypotheses and confirmations, this research finds the answers to the research questions. For the first research question that how have the patterns of non-vacant and VAP changed through time?, the answer from this research is that 1) the urban core area has a larger number of VAP parcels compared to outside the urban area; 2) VAP is concentrated in the inner city area in CFW; 3) residential and vacant land use show a similar pattern that many residential and vacant land use parcels concentrated at the edge of the CFW, due to the annexation, the CFW had a large amount of the vacant land at the edge of the city, it brings many residential land use development in the same area; and 4) the clustered VAP creates more VAP.

For the second research question that what factors affect the conversion of NVL to vacant overall and for different land use types – residential, commercial, and industrial?, the answer from this research is that 1) the EB variables have stronger relationship with the conversion of vacant land from NVL, rather than SES or GEO variables; 2) each land use reveals that various factors influenced the conversion VAP from NVL; 3) only consider the SES variables, universally the Non-white population creates more vacancy, it means that non-white such as African American, Asian or other minority living area has a more vacant land and conversion of VAP from NVL than White population; 4) when consider the SES and BE variables together, commonly the Non-white population generate more vacancy while the old parcel and high land value generate fewer conversion to VAP, it means that continuously white population living area has a fewer VAP and conversion to VAP possibility and usually the white population living area's land value is expensive than minority living area; 5) when consider the SES, BE, and Geo variables together, the universal variables are same as the Model II results; however, the small size parcel in residential, commercial, and industrial produced more vacancy and the further distance from CBD parcel in residential and industrial land use produced more vacancy rather than large size parcel and closer distance from the CBD parcels.

This study demonstrated empirically the succession of vacant or abandoned property conversions by showing that VAP were concentrated in the core city area over time in the study area. The findings of this research are consistent with the literature that suggests the conversion of VAP caused by a major non-white population, high land

value, the further the distance from the CBD, and small parcel size can be found especially in the inner city area of a growing city this study demonstrated empirically the succession of vacant or abandoned property conversions by showing that VAP were concentrated in the city core area over time in the study area.

7.2 Study Limitations

This research contains several limitations that should be considered when appraising its findings and for future studies. First, this research is focused on the VAP in growing cities; nevertheless, the results of this research are not applicable to all expanding cities. Whether a shrinking city or a growing city, each city has its unique environments. Thus, the results of a single case study cannot be generalizable to vacancy issues of all cities. Second, even though the CFW, Texas, has a definition of VAP, the definition is not clearly characterized. The definition of VAP in the CFW can be applied to multiple aspects – brownfields, vacant housing units, and vacant and agricultural. Third, this research used three different time periods – 1990, 2000, and 2010, and there is not sufficient GIS and SES and BE data for a parcel level study. As a result, it is possible that another land conversion could have happened during the period 1990 to 2000 or 2000 to 2010. Fourth, the residential sample size is tremendously large compared to the commercial and industrial sample sizes. Fifth, VAP parcels are the focus of this research and as such, the contribution of redevelopment and revitalization projects, particularly in and around the CFW, are not captured, even though this research summarized them but did not apply a spatial analysis. Further, the study is limited only

to the CFW and does not include many small nearby cities such as Benbrook, although the effects of rapid growth are manifest across a wider area.

7.3 Implications and Future Research

The implication of this research is to enhancing academic and professional understanding. The proposed research suggests an advanced methodology and multi-dimensional variables such as the descriptive spatial pattern, the relationship between the characteristics of surrounding VAP and SES, BE, and GEO characteristics of VAP, compared to the analytical method of previous studies. The results from two different analysis stages and findings from the proposed research contribute to a comprehensive and profound understanding of important elements for the conversion of VAP that previous studies have not exploited. In addition, this proposed study provides significant insight into academic and professional research by analyzing the expanding and growing cities in the U.S and the world that have been disregarded in previous studies. Notwithstanding the limitations and previous studies, this study has an academic contribution to VAP literature. The most widely accepted variables include population, race, and income related with VAP. However, there has been little research attempting to measure how the SES, BE, and GEO (the nature cause of creating a VAP) variables realize itself in the VAP conversion process from NVL. This research addresses this critical gap by revealing the significant variations of VAP conversion in one of the growing city. As well as, this study improves the current state of knowledge about the VAP conversion and annexation creating a VAP relationship. Although the previous

research focused on the mostly old industrial cities only-shrinking city, it did not attempt to document at which point the annexation in the Sunbelt city or growing city. The annexation process varied considerably with some leading the way of the creating and conversation of VAP.

This research has important practical implications. The findings of this study suggest how determining the factors contributing to vacancy would help cities, especially the vacancies and inner urban area vacancies of growing cities. From a practical perspective, cities have several potential strategies for influencing VAP conversions, such as tax incentive, infill development, adaptive reuse and land acquisition through tax foreclosures and delinquent. It is necessary that cities when adopting growth management plans understand how these approaches are related to target policy areas to determine which combination of policies, strategies, and target areas are most likely to result in preventing future vacancies and promoting regeneration of VAP. Governments and policymakers need to improve their understanding of the condition of VAP and influential elements for regenerating VAP for a better quality of city life, increased tax revenue, and reduction of low-income and segregated areas. In addition, they need to collect and organize the VAP data as a document and to include it in Geographic Information Systems. Governments and cities need to define the concept of VAP precisely and consistently with other cities. Findings from the research suggest directions for strategies to deal with VAP for reuse and how VAP should be maintained and protected. The results of this research make sense at the city level (City of Fort Worth), given that larger parcels are typically capable of supporting the high potential

for reuse from VAP. It suggests an endogenous relationship between comprehensive land use plan (zoning) and reuse (regeneration) of VAP. The Effective land use controls as tools for influencing the location and sustainable development is an argument for more integrated approaches to VAP management. Consequently, the research encourages policies and strategies that aim to achieve better outcomes throughout the conversion of VAP. Moreover, understanding the linkages between land use patterns, distance from CBD and BE variables is an example of how planning practice and research can better respond to the challenges in the growing cities with VAP, the biggest threat to suburbanization and annexation, which is attributable to creating VAP from NVL.

The last implication of this research is to integrate urban revitalization, sustainable communities, and neighborhood development; this research proposes a nationally recognized VAP management tool for a suite of prediction, analysis, and visualization tools for prevent future vacant land creation. Applying this research's methodology, future researchers and practitioners can gauge threats for the past, present, and future vacancies in every VAP city patterns, especially, the patterns of growing cities where is growing concern about the VAP. Through the reliable assessments of environmental, social, and economic impacts and policies caused by notable events such as climate change, historic preservation, and smart growth or smart decline, the academic and professional researchers, as well as policymakers, can predict VAP more accurately. The new methodology can help develop more truthful VAP revitalization strategies, which can translate to better use of public funds.

Future work should use appropriate methodologies, such as multinomial, to capture differentiations among the different land use conversion comparisons. To the extent possible, add a data set to estimate the specific period of time for a consistent set of geographic area, as every 5 year time period from 1990 to 2015. Moreover, the clear typology of VAP is defined. As well, the indicators of the conversion from NVL to VAP clearly needs to emphasized and considered throughout the strategies, design, and policies.

REFERENCES

Accordino, J., & Johnson, G. T. (2000). Addressing the vacant and abandoned property problem. *Journal of Urban Affairs, 22*(3), 301-315.

American Assembly. (2013). *Revitalizing the legacy cities of upstate New York.* Syracuse, New York: American Assembly.

Anselin, L. (1992). *Spatial data analysis with GIS: An introduction to application in the social sciences.* National Center for Geographic Information and Analysis. Santa Barbara, CA: University of California.

Aruninta, A. (2009). WIMBY: A comparative interests analysis of the heterogeneity of redevelopment of publicly owned vacant land. *Landscape and Urban Planning, 93*, 38–45.

Audirac, I. (2007). Urban shrinkage amid fast metropolitan growth (two faces of contemporary urbanism). Retrieved from http://www. coss. fsu. edu/durp/sites/coss. fsu. edu. durp/files/Audirac2009. pdf

Baudry, J. (1991). Ecological consequences of grazing extensification and land abandonment: role of interactions between environment, society, and techniques. *Série A, Séminaires Méditerranéens, 15*, 13-19.

BBC. (2014). *Bitesize.* Retrieved from Geography: http://www.bbc.co.uk/bitesize/standard/geography/settlement/urban_renewal/revision/2/

Beauregard, R. A. (2009). Urban population loss in historical perspective: United States, 1820-2000. *Environment and Planning A, 451*, 514-528.

Berger, A. (2006). Urban land is a natural thing to waste. *Harvard Design Magazine, Fall 2005 / Winter 2006*(23), 48-56.

Bielsa, I., Pons, X., & Bunce, B. (2005). Agricultural abandonment in the North Eastern Iberian Peninsula: The use of basic landscape metrics to support planning. *Journal of Environmental Planning and Management, 48*(1), 85-102.

Blanco, H., Alberti, M., Olshansky, R., Chang, S., Wheeler, S. M., Randolph, J., . Watson, V. (2009). Shaken, shrinking, hot, impoverished and informal: Emerging research agendas in planning. *Progress in Planning, 72*, 195–250.

Bontje, M. (2001). Facing the challenge of shrinking cities in East Germany: The case of Leipzig. *GeoJournal, 61*, 13–21.

Bowman, A. O., & Pagano, M. A. (2000). Transforming America's cities: Policies and conditions of vacant land. *Urban Affairs Review, 35*(4), 559-581.

Bowman, A. O., & Pagano, M. A. (2004). *Terra incognita: Vacant land and urban strategies.* Washington, D.C.: Georgetown University Press.

Brody, S. D. (2008). *Ecosystem planning in Florida.* Burlington, VT: Ashgate.

Bronin, S. C. (2006). Rehabilitating rehab through state building codes. *Yale Law Journal, 115*, 1744-1781.

Carr, J. H. (1999). *Housing policy debate.* Washington, D.C.: Fannie Mae Foundation.

Carter, T., & Polevychok, C. (2003). *Comprehensive neighbourhood studies: Characterizing decline.* Canada Research Chair in Urban Change and Adaptation. University of Winnipeg.

City of Fort Worth. (2015). *2015 Comprehensive plan.* Retrieved from Fort Worth: http://fortworthtexas.gov/uploadedFiles/Planning_and_Development/Planning_and_Design/Comprehensive_Plan/Glossary.pdf

City of Youngstown. (2005). *Youngstown 2010 citywide plan.* Youngstown, OH: City of Youngstown.

Colantonio, A., & Dixon, T. (2009). *Measuring socially sustainable urban regeneration in Europe.* Oxford Brookes University: Oxford Institute for Sustainable Development (OISD).

Coleman, A. (1982). Dead space in the dying inner city. *International Journal of Environmental Studies, 19*(2), 103-107.

Cox, D. (1972). Regression models and life-tables. *Journal of the Royal Statistical Society, 34*, 187-220.

Crager, E. (2012). *A comparison study of urban redevelopment strategies in the Philadelphia metropolitan area.* West Chester University of Pennsylvania.

Davidson, M., & Dolnick, F. (2004). *A planners dictionary.* Chicago, IL: American Planning Association.

Devas, N. (1993). *Managing fast growing cities: New approaches to urban planning and management in the developing world.* Longman Group United Kingdom.

Dewar, M., & Thomas, J. M. (2013). *The city after abandonment.* Philadelphia: University of Pennsylvania Press.

Donnison, D. (1993). Agenda for the future. In C. McConnell, *Trickle down or bubble up?* London: Community Development Foundation.

Duerksen, C. J. (1997). *Habitat protection planning: Where the wild things are.* American Planning Association.

Eppig, M., & Brachman, L. (2014). *Redeveloping commercial vacant properties in legacy cities: A guidebook to linking property reuse and economic revitalization.* Greater Ohio Policy Center.

ESRI. (2015). *ArcGIS for desktop*. Retrieved from ArcGIS Pro: http://pro.arcgis.com/en/pro-app/tool-reference/spatial-statistics/mean-center.htm

Ewing, R. (2002). *Measuring sprawl and its impact.* Washington, D.C.: Smart Growth America.

Foo, K., Martin, D., Wool, C., & Polsky, C. (2013). The production of urban vacant land: Relational placemaking in Boston, MA neighborhoods. *Cities, 35*, 156–163.

Frey, W. H., & Alden Speare, J. (1992). The revival of metropolitan population growth in the United States: An assessment of findings from the 1990 Census. *Population and Development Review, 18*(1), 129-146.

Friedman, E. (2003). *Vacant properties in Baltimore: Strategies for reuse.* Johns Hopkins University. Abell Foundation Award in Urban Policy.

Gardiner, M. M., Prajzner, S. P., Burkman, C. E., Albro, S., & Grewal, P. S. (2014). Vacant land conversion to community gardens: Influences on generalist arthropod predators and biocontrol services in urban greenspaces. *Urban Ecosyst, 17*(1), 101-122.

Garvin, E. C., Cannuscio, C. C., & Branas, C. C. (2013). Greening vacant lots to reduce violent crime: A randomised controlled trial. *Injury prevention, 19*(3), 198-203.

Genske, D. D., & Ruff, A. (2006). Expanding cities, shrinking cities, sustainable cities: Challenges, opportunities and examples. *The Geological Society of London*, Paper number 82.

Greenberg, M. R., Popper, F. J., & West, B. M. (1990). The TOADS: A new american urban epidemic. *Urban Affairs Review, 25*(3), 435-454.

Grigsby, W., Baratz, M., & Lennon, D. J. (1983). *The dynamics of neighborhood change and decline.* University of Pennsylvania.

Guo, Y.-H. (2008). *Using GIS to examine urban growth pattern in Alachua County, Florida.* Master Thesis, University of Florida, Urban and Regional Planning Department, Gainesville.

Hausner, V. (1993). The future of urban development. *Royal Society of Arts Journal, 141*(5441), 523-533.

Hollander, J. B. (2011). Can a city successfully shrink? Evidence from survey data on neighborhood quality. *Urban Affairs Review, 47*(1), 129-141.

Hollander, J. B. (2009). *Polluted & dangerous: America's worst abandoned properties and what can be done about them.* UPNE.

Hollander, J. B. (2010). Moving toward a shrinking cities metric: Analyzing land use changes associated with depopulation in Flint, Michigan. *Cityscape*, 133-151.

Hollander, J. B., Johnson, M. P., & Whiteman, E. D. (2016). *Supporting shrinkage: Better planning and decision-making for shrinking cities.* University of Massachusetts Boston.

Hollander, J. B., & Nemeth, J. (2011). The bounds of smart decline: A foundational theory for planning shrinking cities. *Housing Policy Debate, 21*(3), 349–367.

Hollander, J. B., Pallagst, K., Schwarz, T., & Popper, F. (2009). Planning shrinking cities. *Progress in Planning, 72*(4), 223-232.

Hoover, E., & Vernon, R. (1959). *Anatomy of a metropolis: The changing distribution of people and jobs within the New York metropolitan region.* Havard University Press.

Investment Property Forum (IPF). (2009). *Urban regeneration: Opportunities for private investment*. London.

Irwin, E. G., & Bockstael, N. E. (2004). Land use externalities, open space preservation, and urban sprawl. *Regional Science and Urban Economics, 34*, 705– 725.

Isakson, H. (1997). An empirical analysis of the determinants of the value of vacant land. *Journal of Real Estate Research, 13*(2), 103-114.

Jackson, K. T. (1985). *Crabgrass frontier: The suburbanization of the United States.* New York: Oxford University Press.

Johnson, M., & Hollander, J. (2012). Residential housing planning in an era of municipal shrinkage: smart growth versus smart shrinkage. *ACSP Book of Accepted Abstracts 2012* (pp. 572-573). Cincinnati: The Association of Collegiate Schools of Planning.

Kim, B., & Newman, G. (2015). The spatial distribution of vacant land in growing cities. *Urban Affairs Association 45rd Annual Conference.* Miami, Florida

Kiwell, P. (1993). *Land and the city: Patterns and processes of urban change.* New York: Psychology Press.

Kotkin, J. (2013, 6 18). *America's fastest-growing cities since the recession.* Retrieved from Forbes: http://www.forbes.com/sites/joelkotkin/2013/06/18/americas-fastest-growing-cities-since-the-recession

Kremer, P., Hamstead, Z. A., & McPhearson, T. (2013). A social–ecological assessment of vacant lots in New York City. *Landscape and Urban Planning, 120*, 218-233.

Kromer, J. (2002). *Vacant-property policy and practice: Baltimore and Philadelphia.* Brookings Institution Center on Urban and Metropolitan Policy.

Laska, S. B., Seaman, J. M., & McSeveney, D. R. (1982). Inner-city reinvestment: Neighborhood characteristics and spatial patterns over time. *Urban studies, 19*(2), 155-165.

Lester, T. W., Kaza, N., & Kirk, S. (2013). Making room for manufacturing: Understanding industrial land conversion in cities. *Journal of the American Planning Association, 79*(4), 195-313.

Lichfield, D. (1992). *Urban regeneration for the 1990s.* London: London Planning Advisory Committee.

Long, J., & Freese, J. (2001). *Regression models for categorical dependent variables using STATA.* College Station, Texas: A Stata Press Publication.

Lucy, W. H., & Phillips, D. L. (2001). *Suburbs and the census: Patterns of growth and decline.* Center on Urban & Metropolitan Policy. Brookings Institution.

Mallach, A. (2004). Abandoned property: Effective strategies to reclaim community assets. *Housing Facts & Findings, 6*, 1.

Mallach, A. (2008). *Managing neighborhood change: A framework for sustainable and equitable revitalization.* National Housing Institute.

Mallach, A. (2012). *Laying the groundwork for change: Demolition, urban strategy, and policy reform.* Metropolitan Policy Program. Washington: Brookings Institution.

Mathey, J., & Rink, D. (2010). Urban wastelands–A chance for biodiversity in cities? Ecological aspects, social perceptions and acceptance of wilderness by residents. *Urban Biodiversity and Design, 7*, 406.

McClintock, N., Cooper, J., & Khandeshi, S. (2013). Assessing the potential contribution of vacant land to urban vegetable production and consumption in Oakland, California. *Landscape and Urban Planning, 111*, 46– 58.

Metzger, J. T. (2000). Planned abandonment: The neighborhood life-cycle theory and national urban policy. *Housing Policy Debate, 11*(1), 7-40.

Napton, D., & Loveland, T. (2004). U.S. land cover and land use change: 1973-2000. In D. G. Janelle, B. Warf, & K. Hansen, *WorldMinds: Geographical Perspectives on 100 Problems* (pp. 261-267). Norwell, MA: Kluwer Academic Publishers.

National Vacant Properties Campaign. (2005). *Vacant properties: The ture costs to communities.* National Vacant Properties Campaign.

Németh, J., & Langhorst, J. (2014). Rethinking urban transformation: Temporary uses for vacant land. *Cities, 40*, 143-150.

Newman, G. (2012). *Urban shrapnel: Theories and measurements of waste landscapes.* Seattle Conference: Environmental Design and Research Association.

Newman, G., Bowman, A. O., Lee, R. J., & Kim, B. (2016). A current inventory of vacant urban land in America. *Journal of Urban Design, 21*(3), 302-319.

Newman, G., & Kim, B. (2014). Linking growth management to urban conservation: Geodesign as a tool for identifying regeneration sites. *Peer Reviewed Proceedings of Digital Landscape*, 128-137.

Newman, G., Lee, J., & Berke, P. (2016). Using the land transformation model to forecast vacant land. *Journal of Land Use Science*, 1-26.

Niedercorn, J. H., & Hearle, E. F. (1964). Recent land-use trends in forty-eight large American cities. *Land Economics, 40*(1), 105-110.

Northam, R. M. (1971). Vacant urban land in the American city. *Land Economics, 47*(4), 345-355.

Oswalt, P., & Rieniets, T. (2007). *Global context.* Retrieved from Shrinking Cities: http://www.shrinkingcities.com/globaler_kontext.0.html?&L=1

Pagano, M. A., & Bowman, A. O. (2000). *Vacant land in cities: An urban resource.* Center on Urban and Metropolitan Policy: Brookings Institution.

Pallagst, K. (2007). *Growth management in the US between theory and practice.* Burlington, VT: Ashgate: Aldershot.

Pallagst, K. M. (2007). Das ende der wachstumsmachine. *Berliner Debatte Initial, 18*(1), 4–13.

Pallagst, K., & Wiechmann, T. (2004). Shrinking smart? Staedtische Schrumpfungsprozesse in den USA. *Jahrbuch Stadtregion, 5*, 105-127.

Park, I. K., & Ciorici, P. (2013). Determinants of vacant lot conversion into community gardens: Evidence from Philadelphia. *International Journal of Urban Sciences, 17*(3), 385-398.

Pearsall, H., Lucas, S., & Lenhardt, J. (2014). The contested nature of vacant land in Philadelphia and approaches for resolving competing objectives for redevelopment. *Cities, 40*(Part B), 163-174.

Pham, H. M., Yamaguchi, Y., & Bui, T. Q. (2011). A case study on the relation between city planning and urban growth using remote sensing and spatial metrics. *Landscape and Urban Planning, 100*, 223–230.

Pierce, J., Martin, D., & Murphy, J. (2011). Relational place-making: The networked politics of place. *Transactions of the Institute of British Geographers, 36*, 54-70.

Popper, D. E., & Popper, F. J. (2002). Small can be beautiful: Coming to terms with decline. *Planning, 68*(7), 20-23.

Popper, D. E., & Popper, F. J. (2010). *Smart decline in post-carbon cities, the Buffalo commons meets Buffalo, New York.* Santa Rosa, CA: Post Carbon Institute.

Rashid, A. A., Rosly, D., & Shamsuddin, S. (2013). Revitalizing urban development in Malaysia through the implementation of. *Urban Affairs Association 43rd Annual Conference*, (p. 2). San Francisco, California.

Regional Data Center. (2014). Retrieved from North Central Texas Council of Governments: http://rdc.nctcog.org/Index.aspx

Roberts, P., & Sykes, H. (2000). *Urban regeneration: A handbook.* SAGE Publications.

Roth, C. (2004). *Guidance on urban rehabilitation.* Council of Europe.

Rusk, D. (1993). *Cities without suburbs.* Baltimore: Johns Hopkins University Press.

Schilling, J. (2002). *The revitalization of vacant properties: San Diego, California case study.* Washington, D.C.: International City Management Association.

Schilling, J., & Logan, J. (2008). Greening the rust belt: A green infrastructure model for right sizing America's shrinking cities. *Journal of the American Planning Association, 74*(4), 451–66.

Schwirian, K. (1983). Models of neighborhood change. *Annual Review of Sociology, 9*, 83-102.

Science Dictionary. (2012). *Definition: Urban redevelopment.* Retrieved from Science-dictionary.com: http://www.science-dictionary.com/definition/urban-redevelopment.html

Silverman, R. M., Yin, L., & Patterson, K. L. (2012). Dawn of the dead city: An exploratory analysis of vacant addresses in Buffalo, NY 2008-2010. *Journal of Urban Affairs*, 1-22.

Singer, J. D., & B.Willett, J. (2003). *Applied longitudinal data analysis.* Oxford University Press.

Smart Growth America. (2016). *Making neighborhoods great together*. Retrieved from Revitalization: http://www.smartgrowthamerica.org/issues/revitalization/

Sperandelli, D. I., Dupas, F. A., & Pons, N. A. (2013). Dynamics of urban sprawl, vacant land, and green spaces on the metropolitan fringe of São Paulo, Brazil. *Journal of Urban Planning and Development*, 274-279.

Stoner, J. (2013). *Engaging urban vacancy.* Retrieved from U.S. Department of Housing and Urban Development: http://www.huduser.org/portal/pdredge/pdr_edge_featd_article_020813.html

Tachieva, G. (2010). *Sprawl repair manual.* Island Press.

Tighe, R., & Ganning, J. (2014). Flexible housing options for legacy cities. *Association of Collegiate Schools of Planning Conference* (pp. 237-238). Philadelphia: Association of Collegiate Schools of Planning.

Transportation Research Board. (1998). *The costs of sprawl: Revisited.* Washington, D.C.: National Academy Press.

United States Census Bureau. (2011). *Housing characteristics: 2010.* U.S. Department of Commerce.

United States Census Bureau. Census Bureau News. (2013). *Residential vacancies and homeownership in the third quarter 2013.* Washington D.C.: U.S. Department of Commerce.

United States Conference of Mayors. (2008). *Vacant and abandoned properties.* Washington, D.C.: City Policy Associates.

United States Conference of Mayors. (2009). *Vacant and abandoned properties: Survey and best practices.* Washington, D.C.: City Policy Associates.

US Environmental Protection Agency. (2006). *Brownfields success stories: From slag to riches.* Retrieved from http://www.epa.gov/swerosps/bf/html-doc/ss_pitts.htm

Vacant Properties Research Network. (2015). *Charting the multiple meanings of blight: A national literature review.* Econsult Solutions, Inc.

Van den Berg, L., Drewett, R., Klaasen, L. H., Rossi, A., & Vijerberg, C. H. (1982). *A study of growth and decline.* London: Pergamon.

Wang, F. (2010). *Quantitative methods and applications in GIS*. CRC Press.

Webber, M. M. (1968). The post-city age. *Deadalus*, 535-539.

Wilson, B. (2009). *Scale effects and the determinants of parcel subdivision: A discrete-time hazard analysis.* Chapel Hill: University of North Carolina.

Wilson, J. Q., & Kelling, G. L. (1989, February). Making neighborhoods safe. *Atlantic Monthly*.

Wood, B. (1998). *Vacant land in Europe.* Lincoln Institute of Land Policy. Cambridge, MA.

Zhang, Y. (2012). Will natural disasters accelerate neighborhood decline? A discrete-time hazard analysis of residential property vacancy and abandonment before and after hurricane Andrew in Miami-Dade County (1991–2000). *Environment and Planning B: Planning and Design, 39,* 1084 – 1104.

Ziegler, E. H. (2009). The case for megapolitan growth management in the 21st century: Regional urban planning and sustainable development in the United States. *Urban Lawyer, 41*(1), 08-24.

Zipperer, W. C., & Pickett, S. T. (2012). Urban ecology: Patterns of population growth and ecological effects. *eLS*, 1-8.

APPENDIX A

EXISTING PLANS AND STUDIES IN FORT WORTH, 2015

In line with the Fort Worth Comprehensive Plan, a total of 45 projects is now ongoing in Fort Worth. These plans address significant policy issues for targeted districts or the city as a whole. In this research, some, which are related to VAP conversion and urban redevelopment, are summarized chronologically (City of Fort Worth, 2015).

Title
▪ Aquatic Master Plan, 2008
▪ Bike Fort Worth Plan, 2010
▪ Botanic Garden Master Plan, 2010
▪ Cavile Place/Historic Stop Six Neighborhood Transformation Plan, 2014
▪ Central City Commercial Corridors Revitalization Strategy, 2002
▪ City of Fort Worth Street Development Standards: Roadway Standards and Master Thoroughfare Plan, 2009
▪ Citywide Historic Preservation Plan, 2003
▪ Comprehensive Economic Development Strategy, 2003
▪ Consolidated Plan (2013-2018), and Annual Action Plan, 2014
▪ Cultural District Master Plan, 1990
▪ Directions Home, 2008
▪ Downtown Fort Worth Strategic Action Plan, 1993, 2003, 2013
▪ Drought Contingency and Emergency Water Management Plan, 2014
▪ Evans & Rosedale Urban Village Master Plan, 2004
▪ Fort Worth Cultural Plan, 2002, 2014
▪ Fort Worth Hazard Mitigation Action Plan, 2009
▪ Fort Worth Linkages, 1997
▪ Gateway Park Master Plan, 1998, 2002
▪ Lake Arlington Master Plan, 2011
▪ Lake Worth Capital Improvement and Implementation Plan, 2007
▪ Lake Worth Development and Management Plan, 1995
▪ Lake Worth Vision Plan, 2011
▪ Library Master Plan, 2011

- Mobility and Air Quality Plan, 2009
- Model Block Plans
- NAS JRB Joint Land Use Study, 2007
- Nature Center and Refuge Master Plan, 2003
- Neighborhood Empowerment Zone Plans
- Northside Economic Development Strategy, 2011
- Parks, Recreation and Open Space Master Plan, 2004, 2015
- Public Art Plan for the 2014 Bond Program
- Public Art Master Plan, 2003
- Public Art Plan (Long Range) for the 2004 CIP, 2005
- Public Art Plan (Long Range) for the Water Fund, 2006
- Southside Medical District Strategic Plan, 1995, 2003
- Sustainability Action Plan, 2010
- Texas Motor Speedway Area Master Plan, 2009
- Transit Alternatives Analysis, 2002
- Trinity River Vision Master Plan, 2003
- Trinity Uptown Plan, 2004
- Trinity River Vision Neighborhood Recreational Enhancement Plan (NREP), 2009
- Urban Village Master Plans, 2007
- Woodhaven Redevelopment Plan, 2006
- Walk Fort Worth Plan, 2014
- Water Conservation Plan, 2014

Downtown Fort Worth Strategic Action Plan, 1993, 2003, and 2013

Implemented in 1993, the purpose of this plan was to capitalize on the vitality of downtown. At that time, this plan was sponsored by the City of Fort Worth, Downtown Fort Worth, Inc., and the Fort Worth Transportation Authority. The strategies of this plan include business development, education, entertainment, housing, land use, open space, public art, transportation, and urban design for creating a healthy downtown. The plan was updated in 2003 and in 2013 once more to reflect changing conditions and new opportunities.

Model Block Plans, since 1993

Since 1993, to identify neighborhoods needing housing improvements and revitalization initiatives, model block plans have been prepared. This plan has been applied annually in a particular place: Eastwood, 1993, Near Southeast, 1994, Jennings, May, St. Louis, Near Northside, and Lake Como, 1995, Fairmount, 1996, Mitchell Boulevard and Poly, 1997, Riverside, 1998, Far Greater Northside, 1999, Greenway, 2000, Worth Heights, 2001, Handley, 2002, Carver Heights, 2003, North Greenbriar, 2004, Stop Six Sunrise Edition and South Hemphill Heights, 2005, and Historic Carver Heights, 2006.

Southside Medical District Strategic Plan, 1995, 2003

Together with issues such as land use, redevelopment opportunities, housing, urban design and open space, transportation, and parking, the city of Fort Worth and an interdisciplinary panel of experts conducted a public planning workshop in 2003, based on the 1995 plan for Fort Worth South, Inc. The final report of this workshop serves as an assessment of opportunities and recommendations for future direction to encourage continued revitalization.

Central City Commercial Corridors Revitalization Strategy, 2002

Under the direction of the mayor-appointed Commercial Corridors Task Force, the city of Fort Worth carried out a two-year study to create economic development opportunities in high-priority central city commercial corridors, particularly in low and

moderate income areas. The outcome can be measured by increases in employment, tax base, business growth, and quality of life improvements. The study includes specific plans for the revitalization of 10 mixed-use areas, or urban villages, along with revitalization strategies that can be applied to other urban villages and commercial districts in the city of Fort Worth.

Citywide Historic Preservation Plan, 2003

This plan identifies a series of goals and strategies for future action relating to historic preservation ordinances, historic preservation incentives, historic resources surveys, historic preservation in city policies and decisions, and public education. The city of Fort Worth adopted this plan in 2003.

Trinity River Vision Master Plan, 2003

The purpose of this master plan is for the improvement of the Trinity River Corridor, a creek corridor, approximately 88 miles which contain the Trinity River Main Branch, and the nine distinct zones in West Fort based on the distinct characteristics of each area. In 1999, a plan was completed for the area from Trinity Park to Gateway Park; and the Trinity River Vision Masterplan was completed in 2003. This plan focuses on improvements to the river's public accessibility to attract more people. Moreover, along with downtown's vibrant improvements, there are plans to develop an urbanized waterfront while maintaining the natural qualities, and increase awareness of its presence

and beauty. Also, the plan promotes the opportunities for conservation, linkages, and open space, enhancing environmental quality, and flood control.

Evans & Rosedale Urban Village Master Plan, 2004

To create a mixed-use, friendly pedestrian-oriented urban village, the CFW established a redevelopment master plan, and design guidelines for Evans & Rosedale Urban Village and the City Council adopted this plan in 2004. Moreover, as a tool for revitalization, the purpose of this plan is to exploit on the rich culture and heritage of the Near Southeast community.

Neighborhood Empowerment Zone Plans

Through the City Council, 19 Neighborhood Empowerment Zones (NEZ) have been designated to guide neighborhoods and development project advocates seeking NEZ incentives. The NEZ was created to promote the development and rehabilitation of affordable housing, an increase in economic development, and an intensification of the quality of social services, education, or public safety provided to residents. The plans describe neighborhood conditions and include design guidelines for residential and commercial projects. The completed NEZ plans are Lake Arlington, 2004; Berryhill-Mason Heights, 2007, Oakland Corners, 2009, and Stop Six Updated NEZ, 2010.

Woodhaven Redevelopment Plan, 2006

Along with the 2004 background data and information related to the area's potential for development and redevelopment, this master plan addresses the current challenges and opportunities in Woodhaven. This plan provides the framework for an action plan that encourages the private and public sectors to partner to make the plan a reality. In 2006, the City Council authorized the master plan; and to implement the goals and objectives, city staff negotiated a public-private partnership directly.

Urban Village Master Plans, 2007

This masterplan was for developing twelve urban villages divided into three geographic clusters: central, southeast, and southwest. The city manager appointed a Citywide Screening Panel and Cluster Interview Panels to assist the Planning and Development Department to select these urban villages. Each of them reflected a balance of interests, including neighborhood groups, economic development organizations, historic preservation groups, appointed boards and commissions, and city departments. The planning process involved three public work sessions and input from various city departments, stakeholders, neighborhood residents, and potential developers.

All of the master plans include common elements containing a conceptual redevelopment plan and recommendations for implementation while each of the master plans reflects the unique identity of the urban village. In 2007, the following urban village master plans were adopted: the Central Cluster includes Historic Handley, Six Points, and South Main. The Southeast Cluster includes Berry/Stalcup, Berry Riverside,

Near East Side, Oakland Corners, and Polytechnic/Wesleyan. The Southwest Cluster includes Berry/Hemphill, Berry/University, Bluebonnet Circle, and Ridglea.

Trinity River Vision Neighborhood Recreational Enhancement Plan (NREP), 2009

The aim of this plan is to identify and enhance the recreational and environmental areas of the Trinity River greenbelt within a ten-year timeframe. Along with the 2003 Trinity River Vision Master Plan, this plan suggests neighborhood trail links, enhance open space, wildflower plantings, new trailheads, enriched trailhead amenities, safety sign, better horse-riding facilities, portage facilities at near to the ground water dams, and trail extensions along the river and its tributaries.

Consolidated Plan (2013-2018) & Annual Action Plan, 2014

This plan identifies housing and community development strategies and programs along with the goals of the U.S. Department of Housing and Urban Development (HUD) to provide decent and affordable housing, support a suitable living environment, and expand economic opportunities. This plan combines four HUD grant programs – the Community Development Block Grant Program (CDBG), Housing Opportunities for Persons with AIDS (HOPWA), the Emergency Solutions Grant Program (ESG), and the HOME Investment Partnership Program.

Cavile Place & Historic Stop Six Neighborhood Transformation Plan, 2014

The Cavile Place Apartments were built in 1954 with mixed-income housing as the foundation for the creation of a vibrant, sustainable community. To improve a comprehensive plan for the Cavile Place Apartments and the surrounding neighborhood, the City and the Fort Worth Housing Authority (FWHA) proposed the replacement of the 300-unit with new neighborhood marketing and business services and programs. These proposals address education for job training, small business development, and healthy lifestyles for residents. This plan was approved in 2014 by the City Council and includes an initial financial plan phased in over a fifteen year period.

APPENDIX B

HISTORICAL LAND USE CHANGE

	1990 (1995 Jan)	2000 (2001 Feb)	2010 (2009 Dec)
1			
2			
3			
4			
5			
6			

7			
8			
9			
10			
11			
12			
13			

14			
15			
16			
17			
18			
19			
20			

APPENDIX C

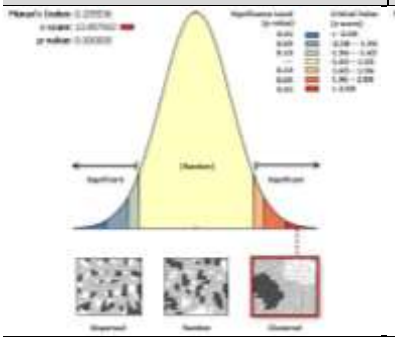
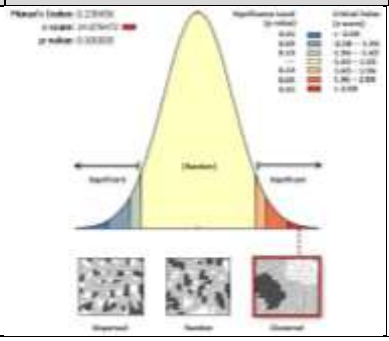
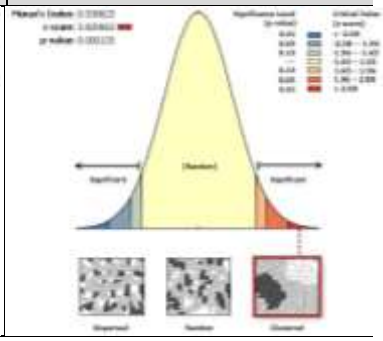
SPATIAL AUTOCORRELATION RESULTS

These figures are results from the spatial autocorrelation analyses. Except, 2010 industrial count ratio result, all others indicates clustered.

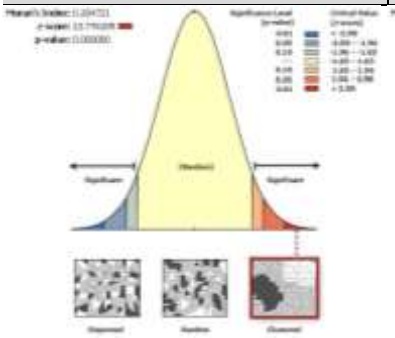
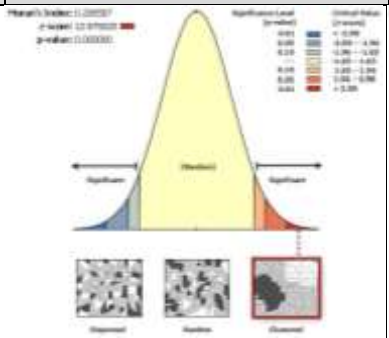
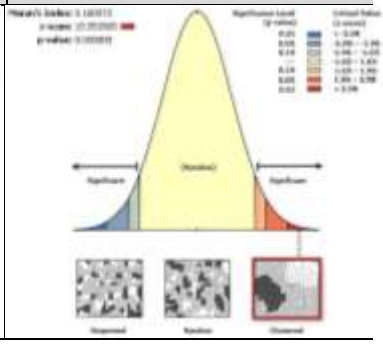
Vacant Parcel

Based on the all of theirs given the z-score; there is a less than 1percent likelihood that this clustered pattern could be the result of random chance.

Count Ratio

1990	2000	2010
		

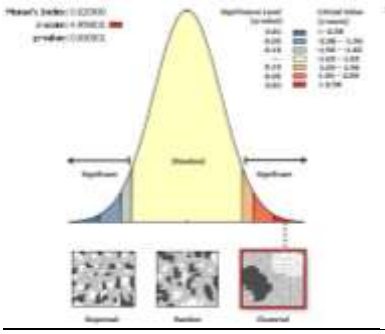
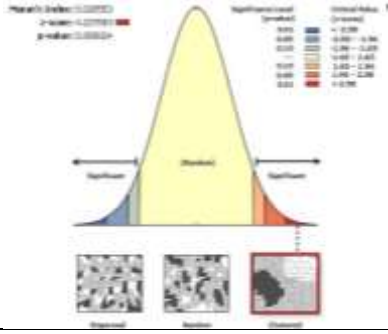
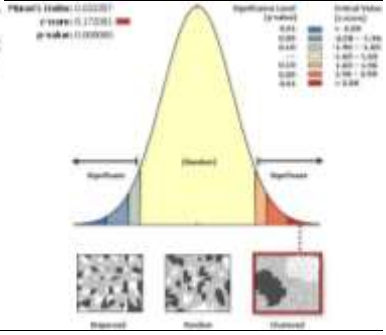
Area Ratio

1990	2000	2010
		

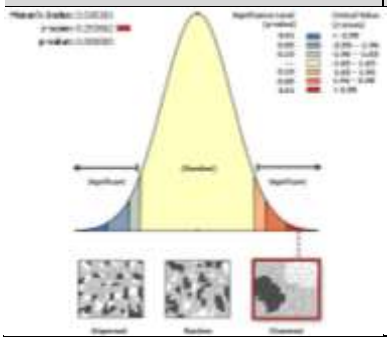
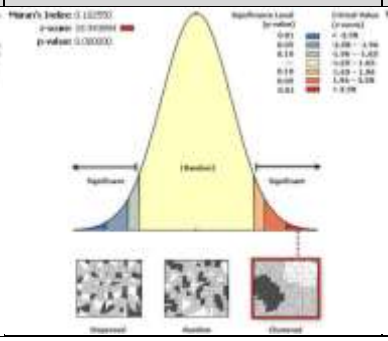
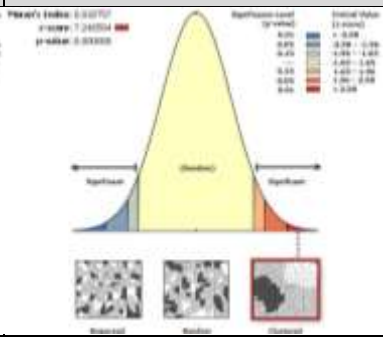
Overall Non-Vacant Parcel

Based on the all of theirs given the z-score; there is a less than 1percent likelihood that this clustered pattern could be the result of random chance.

Count Ratio

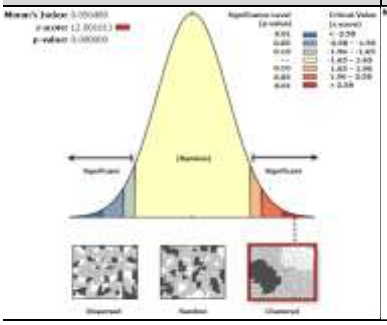
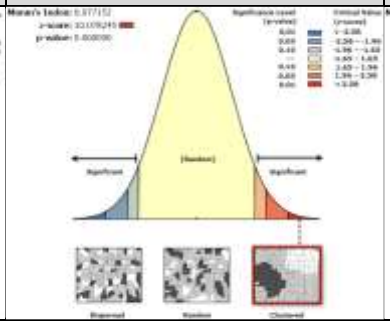
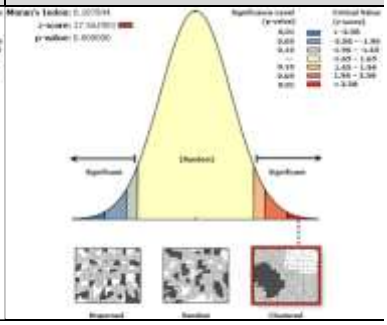
1990	2000	2010
		

Area Ratio

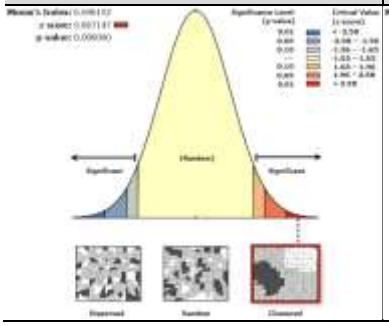
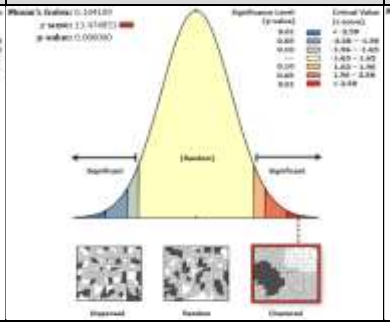
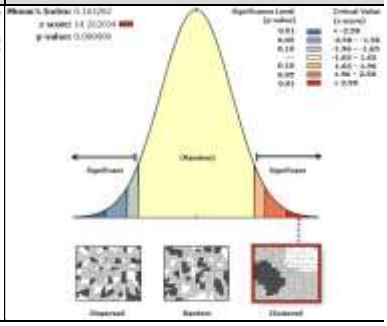
1990	2000	2010
		

Residential Parcel

Count Ratio

1990	2000	2010
		

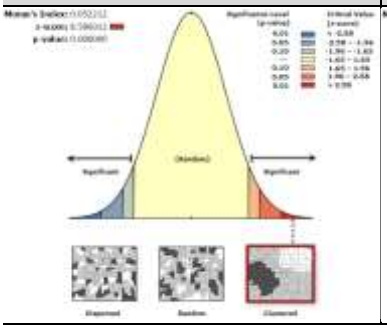
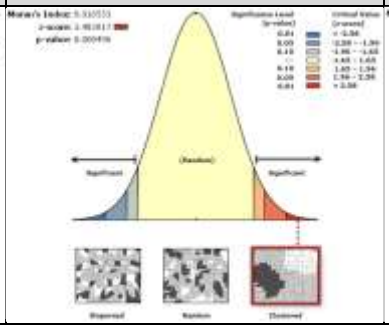
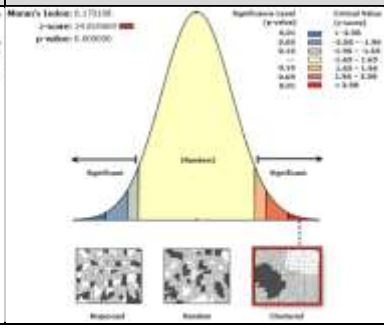
Area Ratio

1990	2000	2010
		

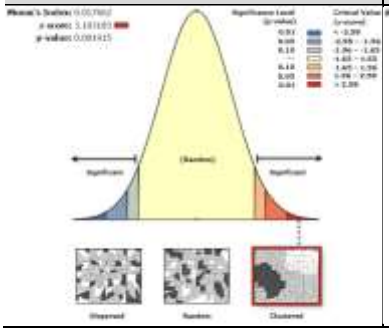
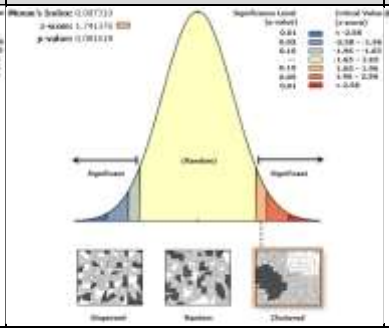
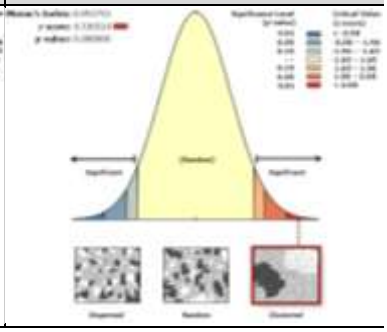
Based on the all of theirs given the z-score; there is a less than 1percent likelihood that this clustered pattern could be the result of random chance.

Commercial Parcel

Count Ratio

1990	2000	2010
		

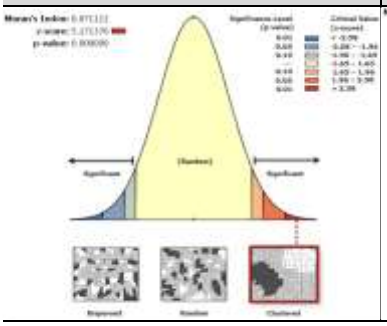
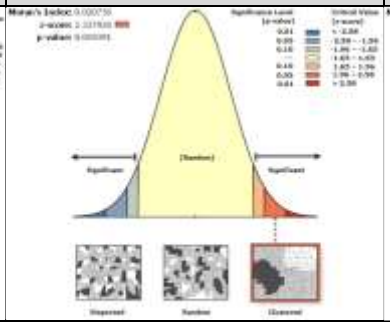
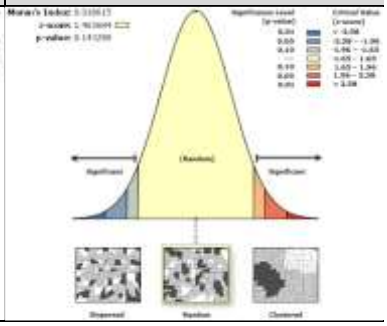
Area Ratio

1990	2000	2010
		

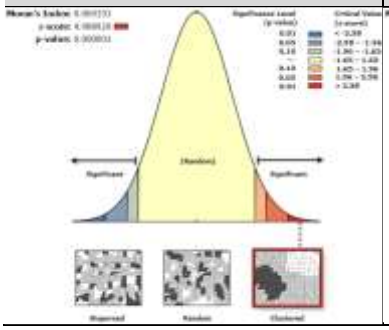
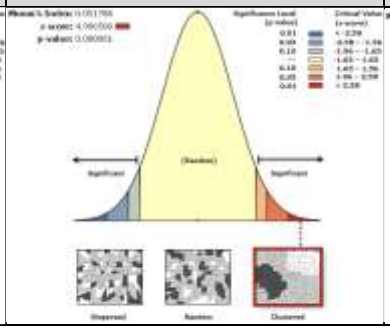
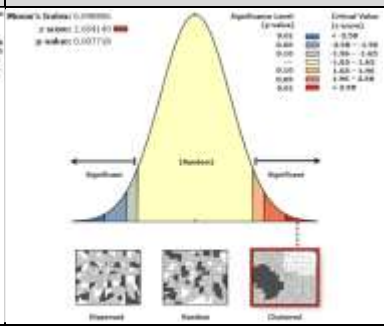
Based on the all of theirs given the z-score; there is a less than 1percent likelihood that this clustered pattern could be the result of random chance, except area ratio in 2000. The 2000 year area ratio of the commercial parcel is a less than 10% likelihood that this clustered pattern could be the result of random chance.

Industrial Parcel

Count Ratio

1990	2000	2010
		

Area Ratio

1990	2000	2010
		

Based on the all of theirs given the z-score; there is a less than 1percent likelihood that this clustered pattern could be the result of random chance, except the count ration in 2000 and 2010.

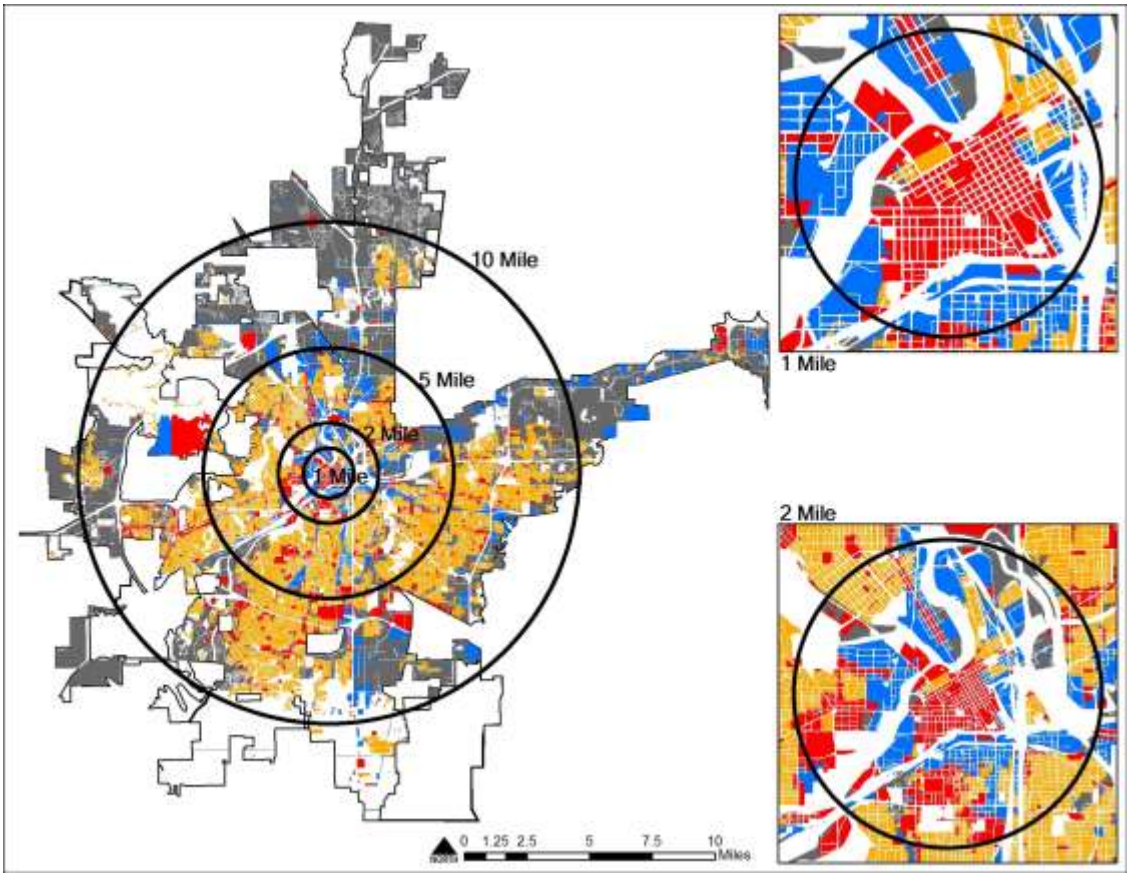
The count ratio of the industrial parcel in 2000, there is a less than 5% likelihood that this clustered pattern could be the result of random chance. Also, the count ratio of the industrial parcel in 2010, the pattern does not appear to be significantly different than random.

APPENDIX D

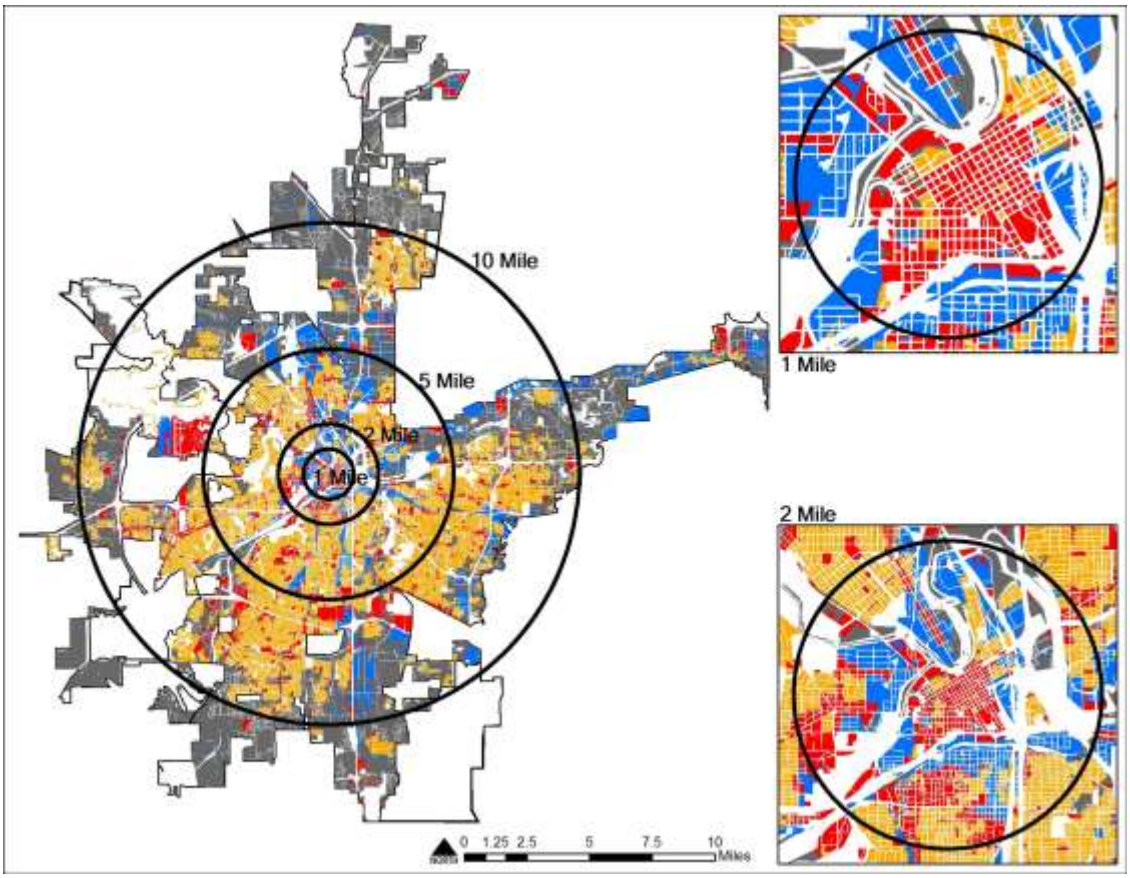
COMPARISONS THE BUFFER ZONE IN CFW, 1990 - 2010

These are the results of the different land use composition within different buffer zones in 1990, 2000, and 2010.

The 1990 Buffer Zone in the City of Fort Worth



The 2000 Buffer Zone in the City of Fort Worth



The 2010 Buffer Zone in the City of Fort Worth