Urban Economic Perspectives on Residential Real Estate: Does Access Matter?

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Authors Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

Abstract

This thesis explores the transportation-land use connection through an investigation of accessibility and residential property values. Accessibility, broadly defined as the ability for locations to interact (Hansen, 1959) is considered a key principle of urban economic theory. This project builds upon the recommendations and conclusions of the literature calling for simultaneous consideration of both the quantitative (measured) and qualitative (perceived) impacts of accessibility on residential property values.

This thesis utilizes a two stage research methodology in order to investigate the influence of access to amenities on residential property values. First, accessibility is quantified via an accessibility calculation for sample properties from three study areas within the Greater Toronto Area. This calculated access value is then correlated to real property sales data in order to explore the association between access and value. Second, a survey of real estate professionals explores the influence of perception and behavioural characteristics of accessibility and amenities in the residential location decision making process.

The quantitative results are statistically significant however, the association between value and access is weak and varying in direction. The qualitative results indicate consistently that homebuyers are willing to pay for access to the amenities that they value. The average value of this access premium is determined to be approximately $10,000 or 3.5% of the average price for a single-detached home in the GTA. Given the methodological challenges experienced in the quantitative measurement of access, the overall results suggest that access does in fact matter.

This research contributes to the literature by considering the impact of perception and behavioural characteristics on accessibility. Further this project serves to inform the debate around transportation-land use interactions.

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DEFINITION OF TERMS

Accessibility – the ability for a location to interact with an opportunity or destination, measured as a cost function of time or distance between a location and that opportunity or destination

Accessibility Premium – the positive impact of access to desired amenities on property values

Amenities – a desired non-work destination (e.g. retail opportunities, schools, recreational facilities, etc.)

CBD – Central Business District

Cumulative Opportunities – a time or distance measure of all destinations from an origin

Closest Facility – a time or distance measure of the nearest destination from an origin

GIS – Geographic Information System

GTA – Greater Toronto Area

Higher Order Public Transit – interregional transit (e.g. Go Transit or subways)

Lower Order Public Transit – local transit (e.g. bus or streetcar service)

Monocentric City – a city or urban region with a single centre of activity (i.e. business and recreational)

Neighbourhood – a collection of two or more abutting census tracts that share similar housing characteristics

Polycentric City – a city or urban region with many centres of activities (multinodal)

Single-Detached Home – a freestanding, unattached dwelling unit

Urban Economics – the study of the spatial organization of cities and urban regions, originally developed based upon the 19th Century concepts of agricultural land use models

1. INTRODUCTION

Cities and urban regions are dynamic, not static, entities (Shaw & Xin, 2003). Physical change in the structure or organization of cities (e.g. a development trend like a condominium boom) is influenced by many forces and factors; however perhaps the most critical is the relationship between the transportation and land use systems. While the nature and strength of this relationship has been debated in the academic literature, most agree that transportation-land use interactions are complex, often misunderstood and require further investigation (Badoe & Miller, 2000; Giuliano, 1989; Shaw & Xin, 2003). At the heart of the transportation-land use discussion is accessibility.

While fiercely debated in the academic literature throughout the 1990s, transportation-land use interactions and accessibility remain hot topics with considerable research energies devoted to furthering our understanding of their complexities. Theoretically, lands with better accessibility (relative to others) should experience an increase in value, an effect that may influence the pattern of development and/or land uses present (Du & Mulley, 2006; Shin, Washington, & Choi, 2007). The land market is in itself characterised by multifarious influences including all levels of the broader economy, zoning practices, other regulatory considerations and of course, the transportation system (a complex entity on its own). Figure 1.1 illustrates the interrelationship between transport and land use systems. Essentially, land use patterns influence where activities occur in a city. These patterns of activities in turn influence the traffic levels on the transportation system which in turn influences the relative accessibility of locations which in turn influences the pattern of land development.

Some have argued that the relationship between transportation and land use has changed to the point that transport systems no longer influence development patterns within cities and urban regions (e.g. Giuliano, 1995). This is argued on the basis that the freeway system in most major cities is “built out” or well established and therefore automobile accessibility is considered to be relatively uniform. Others contend that while the relationship has changed its influence remains an important determinant of land use and development patterns (e.g. Cervero & Landis, 1995). The debate has spread outside of the traditional circles (e.g. integrated transportation-land use modellers) and has received recognition in the Smart Growth and New Urbanist literature, although these bodies are typically focused on pedestrian and transit as opposed to auto accessibility (e.g. Filion & McSpurren, 2007). Even the nature of accessibility has been debated. Recently, differences between quantitative accessibility measures and the way in which accessibility is perceived by individuals has been recognized as an element of accessibility research that, while adding another dimension, may help to further our understanding and add insight to the impact of accessibility on land use and development patterns.

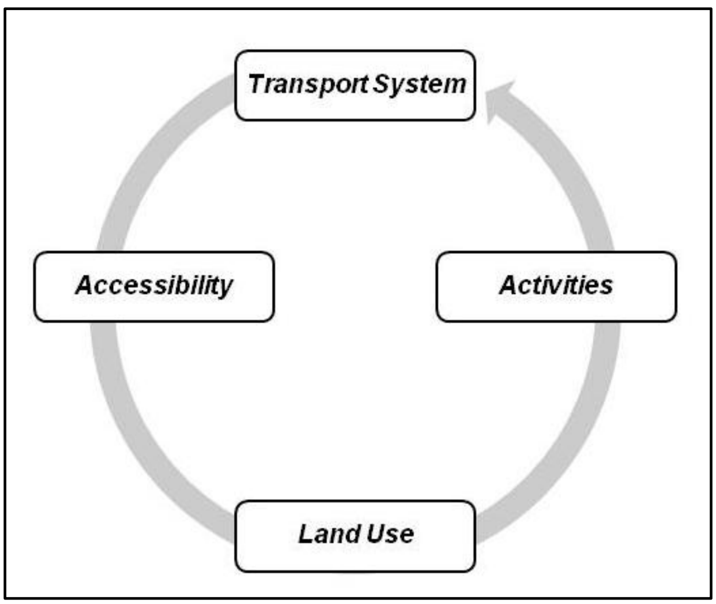

Figure 1.1: The cycle of transportation-land use interactions, adapted from Wegener (2004).

Researchers have investigated the organization of the city from one of two perspectives: the household (residential location); or the firm (industrial location). The perspective typically depends on the discipline within which the research is conducted. In the urban planning context accessibility is generally considered from a broader, more comprehensive point of view (e.g. the entire urban region) as opposed to solely investigating residential or industrial land use impacts (e.g. see integrated modelling literature). Among the ways that accessibility has been incorporated into urban economic analysis is the exploration of land or property values. Previous studies have taken one of two approaches: 1) they measure accessibility in conjunction with property values in order to quantify the relationship; or 2) they investigate choice behaviour (e.g. desirable local amenities) and its resulting impact on property value. This thesis project uses a two stage research strategy in order to tackle both the quantitative and qualitative nature of the relationship between accessibility and property values, and address the shortcomings and recommendations of previous works (Handy & Niemeier, 1997).

1.1. Research Strategy

This thesis seeks to further our understanding of the role of accessibility in residential location decision making and development through an analysis of measured versus perceived accessibility and property value (the land market). The questions that guide this research are:

(1) Can a locational or accessibility premium be identified in the recent sales price of single-detached houses?

(2) What is the importance of these locational attributes in comparison to the traditionally valued characteristics like square footage, lot size, and home improvements?

(3) How does the perception of accessibility differ from the measured accessibility, and in turn, is it reflected in housing sales price?

(4) What locational attributes make a neighbourhood more appealing to homebuyers?

In addition to these questions, this project explores the hypotheses that properties with better accessibility have higher property values and that as accessibility decreases so too does property value.

This research uses a two stage research strategy in order to address the research questions and related hypotheses. The first stage is a quantitative measurement of accessibility which is then correlated to property values for three study areas in the Greater Toronto Area (GTA). The second stage is a survey of real estate professionals, from the same three study areas, in order to compare and contrast how perceptual and behavioural characteristics affect perceived accessibility, property values and residential location decisions for home buyers in comparison to the quantitative accessibility measure.

1.2. Study Areas

Three municipalities from within the boundaries of the GTA were selected as study areas for inclusion in this project, based on their housing characteristics. A short list of potential municipalities was created after compiling data (at the census tract level) for communities with more than 75% of dwellings built after 1975, and more than 75% single detached housing units. These criteria were used in order to keep the housing stock as homogenous as possible. Within each selected municipality, a single neighbourhood is selected for detailed assessment. The selected study areas are: Burlington, ON; Oshawa, ON; and Richmond Hill, ON. Figure 1.2 illustrates their location, relative to one another, within the region. Table 1.1 presents a summary of population and housing characteristics for each of the study areas in comparison to the entire GTA.

The City of Burlington is located to the west of the City of Toronto, at the western most extent of the GTA within Halton Region. In 2006 Burlington's population was approximately 164,000 people, 54% of all dwelling units in the City were single-detached, and the average price of an owned dwelling was approximately $348,000 (Statistics Canada, 2006).

The City of Oshawa is located to the east of the City of Toronto in Durham Region. In 2006 the population of the City was 141,590 people, 53.9% of all dwelling units within the

City were single-detached units, and the average value of owned properties was approximately $231,000 (Statistics Canada, 2006).

The Town of Richmond Hill is located to the north of the City of Toronto within York Region. In 2006 the population of the Town was 162,704 people, 63.6% of all dwelling units within the Town were single-detached, and the average value of owned properties was approximately $466,000 (Statistics Canada, 2006).

When comparing the three study areas to one another there are two main points to consider. First, they are all similar in the size of their population (within 25,000 people). Second, all three study areas are composed of predominantly single-detached housing units. That said the local real estate markets are unique to each of these areas, as is visible in the average home price outlined in Table 1.1. The conditions and causations that lead to the presence of these considerably different markets is not the focus of this project, rather this thesis explores the variances in values for properties within a given neighbourhood. Figure 1.3 illustrates a sample of the housing stock characteristics from each of the neighbourhoods (e.g. medium to large, single detached, suburban homes). Section 3.1 outlines the procedure for the selection of the specific neighbourhoods within each study area for inclusion in this project.

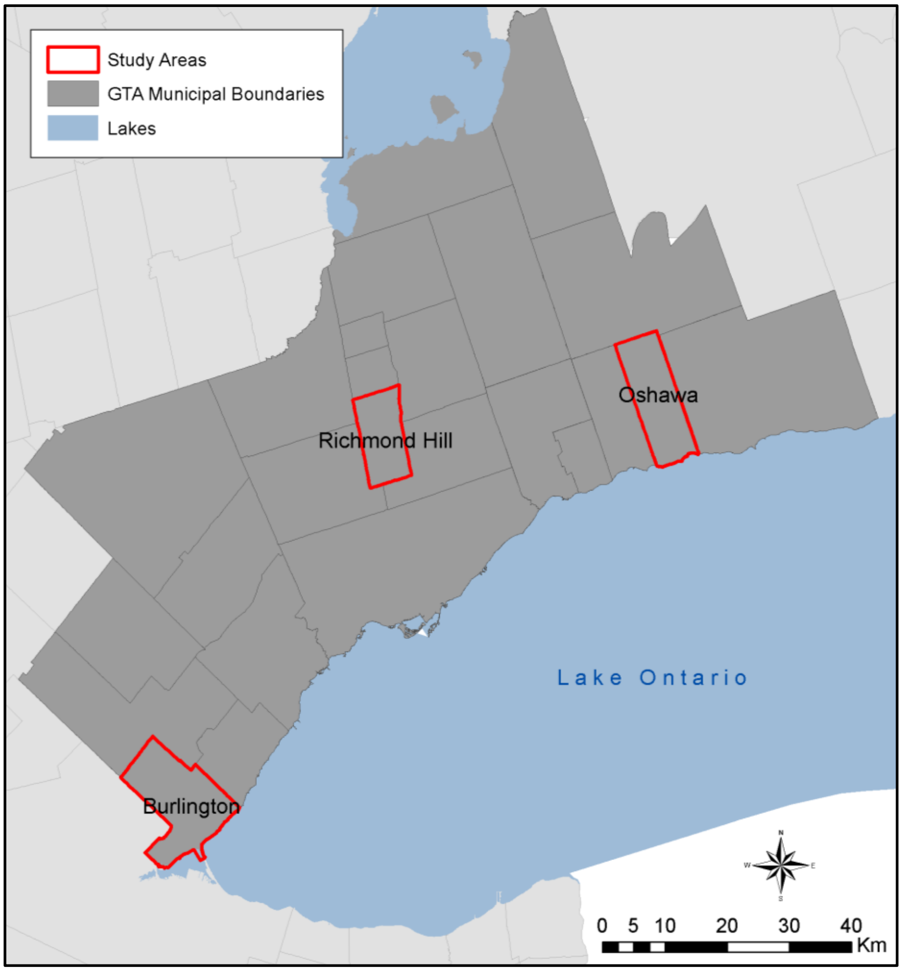

Figure 1.2: Geographic locations of study areas within the Greater Toronto Area.

Table 1.1: Summary of population and housing characteristics for study areas in comparison to the entire Greater Toronto Area.

City	Population	% Single-Detached	Average Dwelling Value
Burlington	164 415	54.0%	$348,041
Oshawa	141 590	53.9%	$231,151
Richmond Hill	162 704	63.6%	$466,376
GTA[1]	5 452 572	65.3%	$313,004 $351,941[2]

Notes:
All data, except where indicated, from (Statistics Canada, 2006)
[1] GTA defined as Toronto CMA + Burlington, Oshawa, Brock, and Scugog
[2] Average single-detached dwelling value for 2006 (Toronto Real Estate Board, 2006)

1.3. Document Overview

This chapter has introduced the reader to a number of basic concepts as well as the research questions, objectives and hypotheses that this thesis project seeks to address. Chapter 2 presents the findings of a comprehensive literature review. Chapter 3 outlines the methods used for each of the two stages of research. Chapter 4 presents and discusses the analytical findings of this project. Chapter 5 summarizes this project and offers conclusions drawn from the findings, discusses the implications for the planning profession, makes recommendations for improvements and identifies areas for further research.

Figure 1.3: Example of housing stock in the study areas: (1) Burlington; (2) Oshawa; and (3) Richmond Hill.

2. LITERATURE REVIEW

Accessibility is a concept that is explored in a number of academic disciplines, while also used in a number of commercial and governmental applications worldwide. While the purpose of this project is to further the understanding of accessibility and property values, we must first survey the literature to ground this study and its methods in firm logic, reasoning, and the recommendations and results of other researchers who have contributed to the relevant literature base.

This chapter introduces a variety of topics relevant to a study of accessibility's influence on residential property values. The literature presented here draws from disciplines including: urban planning; geography; recreation and leisure studies; economics; real estate; geomatics; and psychology. Specific topics addressed in this review include: an overview of urban economic theory (section 2.1); a general discussion of accessibility and its many definitions (section 2.2); techniques and considerations for measuring accessibility (section 2.3); analytical approaches for accessibility research (section 2.4); a review of previous studies dealing with accessibility and property values (section 2.5); and finally a discussion of perceptual and behavioural characteristics that may influence a property's value relative to another (section 2.6).

2.1. Urban Economic Theory

Throughout history there have been various contributions to the body of literature and knowledge referred to as urban economic theory. Traced to its origins, 19th Century economists David Ricardo and J.H. von Thunen developed models of agricultural location that were later applied to urban land by individuals like R.M. Hurd (1903), R. Park and E. Burgess (1925), and R.M. Haig (1926).

In the early 19th Century, David Ricardo recognized that agricultural land whose location is closer to the market, relative to others, incurs lower transportation costs. This affect accrues in the form of increased land rents as a result of economic competition among farmers (Alonso, 1964). Von Thunen (1966) developed this theory further, stating that the rent value of agricultural land is equal to the value of its product (e.g. the market value of its crop) minus the costs of producing and transporting the produce to market (Alonso, 1964). As urbanization increased around the turn of the 20th Century, the agricultural land use model was adapted to explain the variations of value of urban lands (i.e. lands with better access will experience a premium in value).

R.M. Hurd's *Principles of City Land Values* (1903) outlines a theory for the valuation of urban land that closely resembles that of Ricardo and von Thunen's agricultural land use model of the previous century. Hurd focuses largely on industrial land value and location as opposed to urban residential property, which was investigated by sociologists like Park and Burgess (1925) who were interested in understanding the social dynamics of the city. As the 20th Century progressed, and with the advent of city planning as profession in the 1920s, the urban economic literature became voluminous and has been investigated in a variety of disciplines from geography and economics to sociology and psychology (Alonso, 1964).

For the purposes of this study an investigation into the residential location section of the urban economic literature is most relevant. Section 2.1.1 introduces residential location and two models of urban spatial organization: the monocentric city model and the polycentric city model, respectively.

2.1.1. Residential Location and the Spatial Organization of Cities

A household's decision of where to locate is one of the most complex and important decision that one can make. This decision is typically based on a comprehensive set of variables that are typically specific to each household and its preferences and behaviours. For example, is proximity to the workplace more important than proximity to the nearest school or grocery store? In the academic context researchers have sought to understand these decisions in order to draw generalizations that apply to all households. In turn, these generalizations form the basis for constructing models of urban structure and organization. Among these models, the following represent the “classic” contrasting forms often assumed as the basis for subsequent study:

(1) The city is monocentric, with a single core of activities (typically the CBD) where jobs, recreational facilities, and shopping opportunities are concentrated. In this scenario housing values are highest in the city’s core and decline as distance from the core increases (bid rent function – Figure 2.1); or

(2) The city is polycentric (or multinodal), with numerous centres of activities, and thus has a varied gradient of housing values throughout the city (Giuliano, Gordon, Pan, & Park, 2008; Shin, Washington, & Choi, 2007; Waddell, Berry, & Hoch, 1993).

While the monocentric city model dominated the academic literature for decades, more recently the polycentric model has been deemed more realistic given the complexity and size of today’s urban regions (e.g. Greater Toronto Area).

Previous works that have explored the role of accessibility have focused on access to the CBD as a prime determinant of property value. However more recent investigations posit that due to the polycentric nature of modern cities, accessibility to the CBD is less important than access to local amenities, and that these, coupled with physical housing characteristics, are the most important determinants of residential location (Adair, McGreal, Smyth, Cooper, & Ryley, 2000; Giuliano, Gordon, Pan, & Park, 2008).

This section has introduced some of the concepts that are integral to an investigation of urban land values. Prime among these would be the role of transportation costs (distance) as a key foundation on which models of urban form are developed. In the monocentric city, land values are assumed to decrease as distance from the core increases. This is the concept at the heart of the bid-rent function (Figure 2.1). In the Polycentric model, these gradients are more complex as there are multiple centres of high land value. In summary, accessibility has long been regarded as a determinant of land value, and as such has been included in the classical models of urban economics. Section 2.2 investigates the relationship between transportation and land use and introduces accessibility as the concept central to this research project.

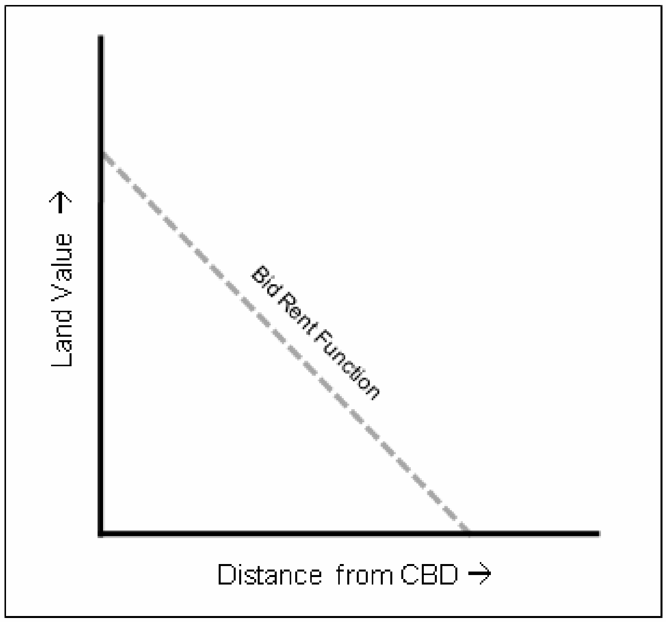

Figure 2.1: Simple bid rent function. As distance from central business district increases, land value decreases.

2.2. Accessibility Defined

An early and seminal work by Hansen (1959) defines accessibility as the ability for locational opportunities to interact and considers accessibility as a characteristic of a location. Recent works, building upon Hansen's research, have produced various definitions, however the central concept remains constant; that is, accessibility is the ability for a location to interact with an opportunity or destination, typically measured as a cost function of time or distance between a location and that opportunity or destination (Du & Mulley, 2006; Guers & Ritsema Van Eck, 2003). Throughout the latter half of the 20th Century the theoretical foundations of accessibility evolved into an economic concept that could be identified in the value of a land parcel, a process referred to as capitalization (Handy, 2005; Srour, Kockelman, & Dunn, 2002).

Accessibility is important for households and firms alike. For example, homeowners may wish to locate close to employment centres, while firms may wish to locate near their workforce (Mills & Hamilton, 1989; Weisbrod & Treyz, 1998). As discussed in section 2.1.1, individual households seek out residential locations that provide accessibility within the urban framework in an effort to maximize personal preferences for neighbourhood and quality of life amenities while minimizing the transportation costs they incur (Fujita, 1989; Shin, Washington, & Choi, 2007). Similarly, firms seek a competitive advantage by trading lower land costs for higher transportation costs, or vice versa (for both their workforce and their inputs/outputs) depending on the nature of their business (Forkenbrock, 2002; Torrens, 2000; Vandenbulcke, Steenberghen, & Thomas, 2008). The attractiveness of a given location is capitalized as a property value premium based on its accessibility, relative to other locations. This capitalization is generally referred to as an “accessibility premium”, established via market forces and representing a purchasers “willingness to pay” (Du & Mulley, 2006; Handy, 2005; Srour, Kockelman, & Dunn, 2002).

While the accessibility literature is voluminous there is no overall consensus among researchers regarding the importance or relevance of accessibility in the context of modern cities and urban regions. This is specifically prominent in the literature that surrounds the transportation-land use relationship, within which accessibility is a central theme (e.g. the transportation network shapes land use via the access it provides, and land use patterns represent the activity locations that generate transportation demand and subsequently influence transportation network performance).

Giuliano (1995) argues that the connection between transportation and land use is weakening, and therefore accessibility has lost its influence for shaping urban form. Giuliano contends that transportation is decreasing in importance because, generally speaking, the network is built out. In other words, most areas have good accessibility, and therefore access now plays a lesser role in the locational decision making process for firms and households alike.

In rebuttal to Giuliano, Cervero & Landis (1995) argue that the connection between transportation and land use, although not as strong as it once was, remains relevant citing extensive elasticity in the relationship. While agreeing with Giuliano's (1995) remarks regarding the level of access already provided by an advanced transportation network, they contend that, while the role of transportation systems has changed over the years, access remains important for channelling growth and development in integrated transportation-land use control strategies.

Other researchers have also contributed to the ongoing debate. Meyer & Miller (2001) agree with Giuliano and conclude that given the level of access provided by existing infrastructure, transportation investments by themselves are not likely to influence land use or development patterns. In contrast, Hesse (2002) argues that the relationship continues to play an integral role in the locational decision making processes of industrial firms. While the debate of the 1990s was centred on automobile accessibility, recent studies are typically focused on walkability and pedestrian accessibility, particularly in the context of the Smart Growth and New Urbanist literature (e.g. Filion & McSpurren, 2007; Handy, 2005; Saelens, Sallis, & Frank, 2003; Song & Knaap, 2004). While this body of literature is outside the scope of this project it is important to recognize the extent of the debate, as well as well as the variety of applications of accessibility analysis. Thus, this project seeks to unravel the complexities of the relationship and contribute to the debate: does access matter? Section 2.3 introduces some of the measures commonly used for analyzing accessibility.

2.3. Measures of Accessibility

Despite a lengthy discourse in the academic literature on the nature and influence of accessibility, a single best measure does not exist (Vandenbulcke, Steenberghen, & Thomas, 2008). Instead the measure must be tailored to the specific situation and purpose at hand. This is particularly important as an improper measure may result in ineffective policy decisions (Handy & Niemeier, 1997). This section will introduce some of the common measures of accessibility, their opportunities, challenges and applications. Generally speaking accessibility measures can be organized into three types: gravity-based measures; cumulative opportunities measures; and utility measures (Handy & Niemeier, 1997).

Gravity-based accessibility measures weight opportunities (e.g. for shopping) by some measure of quality or quantity (e.g. number of stores, type of shopping facility, or services offered), and by some impedance function (typically travel time or cost) (Handy & Niemeier, 1997; Vandenbulcke, Steenberghen, & Thomas, 2008). In this measure the closer the opportunity (i.e. destination) is to the origin the greater its influence on the resulting accessibility value (Baradaran & Ramjerdi, 2001; Handy & Niemeier, 1997). The gravity-based accessibility measure is one of the most frequently used approaches, largely because of its ease of computation and comprehension, and its ability to differentiate between opportunities that are closer than others. It was also one of the first approaches to attempt to incorporate the behavioural element of travel (Baradaran & Ramjerdi, 2001; Handy & Niemeier, 1997). The primary disadvantage of a gravity approach is that it is highly sensitive to the boundaries of the study area (e.g. a census tract) and the opportunities available within it (Baradaran & Ramjerdi, 2001; Bruinsma & Rietveld, 1999). An example where a gravity-based accessibility measure is often used is access to schools where the measure is weighted based on school quality (e.g. average student test scores, or number of students per teacher) (Des Rosiers, Lagan, & Thériault, 2001; Haurin & Brasington, 1996).

Cumulative opportunities measures are similar to the gravity-based measure however rather than using an impedance function this measure is based on some threshold of travel time or distance. This measure calculates the number of destinations available within a travel time threshold and emphasizes the number of opportunities as opposed to their quality or relative nearness (Handy & Niemeier, 1997). The primary advantages of this measure is that it is the simplest to compute, easiest to understand and requires less demanding data (e.g. does not require quality or quantity data for the potential destinations). The challenge of the cumulative opportunities measure is that it neglects the quality of one location over another and thus the attractiveness of that location relative to all others (Weber & Kwan, 2003). A practical application of a cumulative opportunities measure is calculating accessibility to employment opportunities within a given region (Ryan, 1999; Srour, Kockelman, & Dunn, 2002).

Utility based accessibility measures are based on random utility theory which seeks to sort out decisions and preferences for each individual, rather than assigning everyone within a demarcation area the same accessibility value (Baradaran & Ramjerdi, 2001). The primary advantage of this approach is that it recognizes that individuals value locations differently; however this approach is highly complex, and requires extensive data regarding travel behaviour and individual preferences (Baradaran & Ramjerdi, 2001; Handy & Niemeier, 1997). An example of this measure in practice is determining accessibility to grocery stores based on personal preference for the product range offered and the stores atmosphere (Handy & Niemeier, 1997).

Regardless of the measure selected it is crucial that the measure suit the situation. It is important to note that as the complexity of the access measure increases so to does the complexity of the results, and thus the interpretation (Handy & Niemeier, 1997). The emergence of accessibility as a powerful tool for directing policy has only amplified the importance of selecting an appropriate measurement tool (Van Wee, Hagoort, & Annema, 2001; Vandenbulcke, Steenberghen, & Thomas, 2008).

Hewko, Smoyer-Tomic, & Hodgson (2002) calculate accessibility to three publicly funded recreational facilities in the Edmonton, Alberta area in an effort to examine the impact of methodological errors on the resulting accessibility measurement. Their analysis demonstrates that methodological errors can greatly affect the outcome of the accessibility measurement tool, thereby potentially altering the policy recommendations based on erroneous results.

This section has introduced some of the commonly used tools for measuring accessibility, their respective advantages and challenges, and some of their practical applications. Section 2.4 introduces some analytical approaches for investigating real estate and accessibility.

2.4. Analytical Approaches for Access & Real Estate

There is a considerable body of literature relevant to an investigation of accessibility and property values. This section presents a discussion of two of the most popular analytical approaches. Section 2.4.1 discusses GIS applications for accessibility and real estate analysis. Section 2.4.2 introduces hedonic price modelling, a technique widely used in the academic context for determining the property value impacts of accessibility variables relative to physical housing characteristics.

2.4.1. GIS Applications

As geospatial data continues to become increasingly available, and as GIS technologies continue to advance, it is possible to model real world scenarios with an increasing level of accuracy and efficiency (Anselin, 1998; Kwan & Weber, 2003). As such, academics and professionals alike have accepted GIS as a powerful tool that increases efficiency in research and analysis procedures (Thrall & Marks, 1993). This section introduces some practical applications of GIS for accessibility assessment and real estate analysis.

Geertman & Ritsema Van Eck (1995) propose that GIS can be used to integrate models with established accessibility measures to produce a general picture of accessibility for an urban area in the Netherlands. The accessibility model created allows the researcher to determine the access of a specific location in relation to surrounding population, jobs, or services. The output is an “accessibility potential surfaces” extension that builds upon the established analytical tools present in the GIS and incorporates network-based travel times and the diverse character of the study area to provide a valuable accessibility assessment that builds upon the spatial analysis capabilities of an ordinary GIS application.

Liu & Zhu (2004) develop an integrated GIS tool called ACCESS which was created in order to provide decision makers with a flexible and interactive GIS environment in which accessibility analyses are supported for a range of applications. The ACCESS tool was created within the GIS and interoperates with other extensions. This tool was applied to assess access to shopping centres in Singapore, and was found to be a valuable tool for data management, spatial analyses, and data visualization.

Shaw & Xin (2003) present a temporal GIS model that supports exploratory data analysis to examine the impacts of user defined temporal and spatial elements in the outputs. This model uses a speculative and systematic approach to find hidden processes and patterns in the data. In this instance the GIS model complements other modelling efforts and serves as a tool to aid in the data analysis and visualization process, which is facilitated by the functionality of the GIS. The exploratory data analysis as a validation tool, discussed in this article, would have been impossible without the functionality of the GIS environment.

Perhaps the most beneficial characteristic of a GIS when considering accessibility assessment is the ability of a GIS to calculate real world distances and travel times. This is particularly crucial as transportation costs are generally accepted as the most important determinant of relative accessibility (Clapp, Rodriguez, & Thrall, 1997). The functionality of GIS allows for the creation of realistic travel times based on speed limits and impedances like congestion, construction sites, and bridges, while also facilitating internal statistical analysis (Clapp, Rodriguez, & Thrall, 1997). The outputs of the GIS model can then be applied to a variety of applications including hedonic regression analysis, a popular tool for real estate research (Anselin, 1998).

2.4.2. Hedonic Price Modelling

Hedonic modelling is a technique widely used for real estate analysis. Hedonic modelling techniques use regression analysis to evaluate the formulation price of a product, in this case a house or property (Kauko, 2003). Hedonics are considered a valuable tool for explaining the bundle of physical and neighbourhood characteristics that contribute to property values, both positively and negatively (Des Rosiers, Lagana, Thériault, & Beaudoin, 1996; Kauko, 2003; Sirmans, Macpherson, & Zietz, 2005).

Hedonic models have been employed in numerous studies in order to determine the relative impact of accessibility variables versus physical housing characteristics likes lot size or square footage. In these models the accessibility inputs often vary. Simple Euclidean distance measures or dummy variables can be used as inputs to represent the property's accessibility or alternatively, more sophisticated cumulative opportunity or gravity based access measures can be used. For example, Des Rosiers, Lagana, Thériault, & Beaudoin (1996) use the results of a GIS accessibility measurement tool and spatial statistics as inputs in a hedonic model to determine the impact of accessibility to a shopping centre on house prices. Findings indicate that their technique of using access measures as input variables in a hedonic model results in stable price estimates for the impact of accessibility to shopping centres.

While hedonic techniques are widely used they are not without criticisms. First, hedonic models require complex mathematical equations that require extensive datasets of housing characteristics, which can be difficult to obtain and/or create. Second, the hedonic method generally does not consider the spatial relationships between variables and therefore issues of spatial dependency can arise. Third, hedonic models are highly susceptible to multicollinearity (Diao, 2007; Kauko, 2003; Thériault, Des Rosiers, & Dubé, 2006). Therefore, other researchers have recommended that further methodological investigation is required before considering hedonic modelling as an analytical technique (e.g. see Diao, 2007; Sirmans, Macpherson, & Zietz, 2005).

This section has introduced some practical applications of geographic information systems (GIS) for accessibility assessment and real estate analysis, two applications that are crucial to this research project. In addition a discussion of hedonic modelling techniques is presented, as this methodology is widely used in the academic context. Section 2.5 introduces previous work from a variety of researchers who have sought to further our understanding of the relationship between accessibility and real estate.

2.5. Accessibility to Amenities and Real Estate Values: Previous Studies

Accessibility to amenities and the resulting influence on land value is an issue that has been investigated within a number of disciplines, including: sociology; recreation and leisure; urban planning; geography; and economics, among others. With its roots in basic urban economic theory, understanding the complexities of the relationship between accessibility and real estate values (via capitalization) will further our understanding of transportation-land use dynamics as well as the spatial organization of the city.

While many researchers have sought to investigate the relationship between accessibility to urban amenities and the resulting impact on property values, the conclusions of these projects are inconsistent. Some have concluded that access to amenities does in fact have an impact on property values, while others have disputed this claim. Further, where access is argued to in fact influence value, its impact, relative to the impact of housing characteristics, is nominal and insignificant. This section introduces the reader to a variety of studies that have attempted to quantify the relationship between access to amenities and property values; it has been divided into subsections for each amenity that is generally considered to be a prime determinant of value, as identified in the literature.

2.5.1. Retail & Shopping Facilities

Accessibility to retail facilities is presumed to positively influence property values based on the travel time savings provided. While retail may not exert the same attraction as schools or transportation facilities, it is suggested that access to retail will positively influence residential property values (Des Rosiers, Lagana, Thériault, & Beaudoin, 1996; Haider & Miller, 2000). Academic perspectives illustrate a difference in the overall impact depending on the quality and size of the retail facilities, as well as distance factors. Negative externalities associated with shopping centres, including traffic congestion and noise, are argued to cause a decrease in property values for immediately adjacent homes, while nearby properties (likely within some travel time threshold) are expected to experience a positive access premium. Table 2.1 summarizes the literature centred on access to retail and shopping facilities and the resulting implications for property values.

Des Rosiers, Lagana, Thériault, & Beaudoin (1996) analyze the influence of accessibility to shopping centres, as well as the centre's size on surrounding residential property values. Recognizing that an amenity like a shopping centre simultaneously exerts attraction (e.g. low travel costs) and repulsion effects (e.g. congestion and noise), a property's value should reflect the combined impact of the attraction and repulsion variables of a nearby shopping centre. Findings estimate that the size of the shopping centre impacts property value to the amount of approximately $27.00 for each store located within a shopping centre. Further, increasing distance from a shopping centre was determined to correspond with an overall reduction in property values.

Similarly, Colwell, Gujral, & Coley (1985) seek to establish an optimal distance from neighbourhood shopping facilities in order to maximize property value. Their results, although based on Euclidean distance, indicate that a residential property within 1500 feet of a shopping centre experiences a negative impact on the value, while over 1500 feet value increases. This suggests that, when considering accessibility to retail facilities there is a travel time threshold that determines whether the facility offers positive or negative external influences on property values.

Sirpal (1994) investigates the joint influence of distance to as well as the size of a shopping centre on the value of nearby residential properties. The study uses nine neighbourhood or community shopping centres in Gainesville, Florida. Radial distances from the shopping centres of up to 3000 feet are used. In addition to shopping centre variables, the model also tests a number of physical variables (housing characteristics), temporal attributes, and other accessibility variables (schools, parks, and employment) to determine their impact on property values. Findings indicate that the size of a shopping centre has a positive impact on surrounding residential property values. Properties located proximal to a large shopping centre were found to have statistically significant, higher property values than identical properties located proximal to a smaller shopping center. Further, the results also support the notion of a travel time threshold where property values are positively impacted by access to a shopping centre up to a point in space close to the shopping centre where the value then decreases.

Table 2.1: Summary of studies that measure the impacts of access to retail facilities on property values.

Authors	Study Area	Measurement	Results
Des Rosiers, Lagana, Thériault, & Beaudoin (1996)	Quebec City, Quebec	1) Euclidian distance to the nearest shopping 2) Centre and shopping centre size	Property values are positively influenced by proximity to shopping centres. Optimal distances are determined to maximize the value increase. Each additional shop that a centre contains adds $27.00 to the value of residential properties nearby.
Colwell, Gujral, & Coley (1985)	Urbana, Illinois	Euclidean distance to the shopping centre	Properties within 1500 feet of a shopping centre experience a negative impact on the value; while over 1500 feet value increases.
Haider & Miller (2000)	Greater Toronto Area, Ontario	Euclidean distance from census tract centroids to the regions 10 largest shopping centres	Properties located within a 5 km radius have an accessibility premium of approximately $4000, while properties located within a 2.5 km radius experience a $25000 decrease in property value as a result of the negative externalities associated with a shopping centre.
Sirpal (1994)	Gainesville, Florida	Impacts of large versus small shopping centres via radial distances	Properties located near large shopping centre experience a larger positive impact on property value than an identical property located near a smaller shopping centre. Support for the travel time threshold impact on property values.
Mikelbank (2004)	Columbus, Ohio	Network distance to the nearest highway access point	Access to retail was did not return significant results for their impact on residential property values.
Thériault, Des Rosiers, & Dubé (2006)	Quebec City, Quebec	Average travel time by destination	Average travel time to retail facilities in the Quebec area is 6.98 minutes

The housing characteristics and other access variables tested in this study also produced positive impacts on property values.

Haider and Miller (2000) analyze accessibility to a variety of amenities in the Greater Toronto Area (GTA) to determine their influence on property values. Testing a shopping centre variable, the authors determine that properties located within a 5 kilometres radius of the ten regional shopping facilities in the GTA experience an accessibility premium of approximately $4000, while properties located within a 2.5 kilometre radius experienced a $25,000 decrease in property value. This strengthens the argument that there is a definite travel time threshold separating positive and negative externalities associated with retail facilities.

2.5.2. Schools

School accessibility is intuitively considered a crucial element in choice of residential location for defined segments of the residential market. Generally speaking homebuyers, particularly those with small-primary aged children, should want to locate near schools, preferably within walking distance. Therefore houses located proximal to schools should expect to incur a premium for their location relative to those homes that are farther away. The academic literature has analyzed the influence of school accessibility on property values including variables like distance (for walkability), as well as for size and quality concerns. Table 2.2 summarizes the literature that investigates the impact of school accessibility on property values.

Des Rosiers, Lagana, & Thériault (2001) examine the effect of proximity to primary schools and their size on surrounding property values. As with retail facilities, schools are also expected to have both positive and negative effects on the value of nearby properties. A complex hedonic modeling technique is used to understand the total value of 4300 homes based on 43 descriptive variables, ranging from presence of a swimming pool to the primary variables of concern for this project: school size and proximity. Findings suggest that an optimal distance of 300 to 500 meters (or a 9 to 15 minute walk) is positively associated with property values after which values gradually decline, while size was found to be negatively associated with property values in the range of 300 to 450 pupils.

Chin & Foong (2006) hypothesize that parents are inclined to send their children to nearby schools, and that this preference is expected to influence residential location and in turn property values. Therefore, the researchers attempt to relate housing prices and accessibility to both primary schools and junior high schools. Results indicate that home

Table 2.2: Summary of studies that measure the impacts of access to schools on property values.

Authors	Study Area	Measurement	Results
Des Rosiers, Lagan, & Thériault (2001)	Quebec City, Quebec	Proximity and size of schools on residential property values	An optimal distance of 300-500 meters is positively associated with property values, while size was found to be negatively associated with property values in the range of 300-450 pupils.
Chin & Foong (2006)	Singapore	Access to primary and junior high schools	Homebuyers do consider school location and prestige, however more so for primary schools than junior high schools. Physical housing and neighbourhood characteristics are greater determinants of property value than school access.
Clark & Herrin (2000)	Fresno County, California	Impact of school district on residential location and home choice	School quality is a significant determinant of residential property value.
Colwell & Guntermann (1984)	Lubbock, Texas	Access to 8 primary schools	A capitalization identified in land values for access to primary schools is identified.
Thériault, Des Rosiers, & Dubé (2006)	Quebec City, Quebec	Average travel time by destination	Average travel time to a school in the Quebec area is 7.55 minutes
Guntermann & Colwell (1983)	Lubbock, Texas	Distance to 7 primary schools	Access to primary schools is a significant determinant of property value.

buyers do consider the proximity, as well as the prestige, of the nearest school in their home purchase decision. The findings also suggest that parents regard accessibility to primary schools as more important than access to the junior high schools. Despite these findings the authors concede that physical structural and neighbourhood characteristics are more influential in determining residential property values. These results are supported by the observations of other researchers including Clark & Herrin (2000); and Chattopadhyay, Braden, & Patunru (2004). Therefore the notion that access to schools is an important determinant of property value is not quantifiably justified in the academic literature. It may be statistically significant as reported in some studies, but is consistently reported as not being a major influence on property value.

2.5.3. Parks & Open Space

Parks and open space may not inherently be associated with an increase in property values, particularly given safety concerns. However depending on the urban form (e.g.

dense urban versus suburban) in question, parks and open space may provide the only greenspace available for recreation and leisure activities. The empirical literature regarding access to parks and open space on property values exhibits mixed results, largely dependent on the type of facility in question, the activities facilitated (e.g. natural area versus playing fields) and relative distances for nearby homes. Table 2.3 summarizes the academic literature that investigates the impact of accessibility to parks and open space on property values.

Espey & Owusu-Edusei (2001) analyze the impacts of proximity to parks/open space on residential property values in Greenville, South Carolina. The model developed also tested for a variety of physical structure related variables (e.g. garage presence, number of bedrooms, square footage, etc.). Generally speaking, park proximity was determined to be positively correlated with residential property value, with homes selling for approximately 6.5% more, on average, for properties located within 1500 feet of park. That said, more in depth analysis revealed a negative impact (14% reduction in value) for homes located within 300 feet of a park, while properties located between 300 and 500 feet from a park experienced a 15% increase in value. These results illustrate the existence of a threshold like that associated with other amenities; being too close to parks and open space can be a negative influence on surrounding property values while beyond the threshold, there is a positive influence.

Geoghegan (2002) investigates the impacts of developable and permanent open space on residential property values in Howard County, Maryland using a hedonic model. The hypothesis that different types of open space have positive overall effects on residential property values is tested, and validated. Results indicate that while both developable and permanent open space is regarded as a determinant of residential property value, individuals are willing to pay more for properties proximal to permanent open spaces as

Table 2.3: Summary of studies that measure the impacts of access to parks and open space on property values.

Authors	Study Area	Measurement	Results
Espey & Owusu-Edusei (2001)	Greenville, South Carolina	1) Proximity to parks 2) Influence of park size and type	Proximity to parks has a positive influence on property values; however the impact differs depending on the size and type of the park. There is also a negative influence on value for properties located within a 300 foot radius of the park due to the negative externalities (e.g. noise).
Geoghegan (2002)	Howard County, Maryland	Euclidean distance to developable and permanent open space	Properties proximal to permanent open space experience 3 times the benefit of properties located near a developable open space, capitalized as a willingness to pay.
Bolitzer & Netusil (2000)	Portland, Oregon	Euclidean distance to parks, recreation facilities and open space	Proximity to open-space and open-space type were found to have a statistically significant effect on a home's sale price.
Hammer, Coughfin, & Horn IV (1974)	Philadelphia, Pennsylvania	Euclidean distance to the park	A statistically significant rise in property value was correlated to closeness to park. The park accounts for 33% of property values within 40 feet, 9% at 1000 feet, and 4% at 2500 feet.
Irwin (2002)	Washington, D.C. – Baltimore, Maryland Metropolitan Area	Network distance to both developable and permanent open space	A premium for properties located near permanent open space was identified. Developable open space did not provide significant results. Suggests that the value of permanent open space is that it is undevelopable, as opposed to the bundle of amenities that is potentially offered at the site (e.g. recreation)
Schroeder (1982)	Du Page County, Illinois	Impact of parks expenditures and total parkland available to the population	No significant impact on property values was determined for either of the measurement techniques.

opposed to developable ones and determined that access to green space is a significant determinant of land value. That said, Hui, Chau, Pun, & Law (2007) carried out a similar study in Hong Kong and determined that access to green space is an insignificant determinant of land value. The discrepancy between these results illustrates that the degree of importance may be dependent upon housing characteristics and more generally, urban form (e.g. dense, urbanized Hong Kong living versus suburban South Carolina or Maryland).

Bolitzer & Netusil (2000) analyze the impact of open space, including parks and natural areas, on sales prices of homes in Portland, Oregon. By calculating an access to open space variable and comparing the impact of open space relative to the impact of housing characteristics, the authors conclude that proximity to open space does in fact influence property values. That said, results were not consistent for all types of open space and housing characteristics were determined to be better determinants of value relative to the access variables.

2.5.4. Transit

As one of the more frequently studied amenities in light of the recent emphasis on New Urbanism, smart growth and transit oriented development, researchers analyzing accessibility to transit facilities have produced mixed results. While some may argue that a premium is identifiable in the value of nearby properties, there is considerable evidence that the noise and other negative externalities associated with transit facilities result in a decrease in value for properties located within a threshold distance. However this threshold varies from case to case.

Other aspects of the relationship between transit and property values that have been analyzed in the literature include: the impact of local versus regional transit service; size of the station; and auxiliary amenities offered at the station (e.g. retail function). Table 2.4 outlines some of the literature that has focused on the impact of transit accessibility for property values.

Lewis-Workman & Brod (1997) investigate the impact of transit accessibility on property values in three American cities: Portland, Oregon; New York, New York; and San Francisco, California to determine whether the impact of transit access varies depending on the benefits provided. The first benefit of a transit station is the travel cost savings and other use-specific benefits (e.g. reduces vehicle miles travelled, automobile upkeep, etc), while the second relates to the benefits that are unrelated to the use of the transit network, like neighbourhood character or form. It is hypothesized that the user-specific benefits are capitalized into property values, while the neighbourhood benefits of transit access are represented to the extent that residents are willing to pay for them. Results indicate that the importance of access to transit varies depending on location. In Portland the user-specific benefits produced the expected positive impact on property values; however the neighbourhood benefits were minimal. Conversely in New York and San Francisco the neighbourhood benefits outweighed the user benefits of transit accessibility for their overall impact on property values, indicating that the impacts of transit go beyond those simply associated with the use of the system.

Hess & Almeida (2007) investigate the accessibility benefits of rail transit stations in Buffalo, New York. Given that Buffalo is a slow-growth region, the authors expect that the impact may be lower than in other, rapid growth areas (see Table 2.4). A hedonic model is used to test the impact of rail access on property values compared against a variety of physical housing characteristics. Model results indicate that a property located within a quarter mile of radius of a transit station experiences a 2% to 5% increase in property value as a result of the property's accessibility. However, physical housing characteristics, particularly the number of bathrooms and lot size, are more influential predictors of property value than rail transit accessibility.

Habib & Miller (2008) investigate the influence of transportation accessibility on market dynamics and property values in the Greater Toronto Area (GTA). Using nearest facility accessibility measurements for subway and regional transit stations as inputs into a hedonic model the researchers test the transportation variables versus physical dwelling characteristics to determine predictors of residential property values. Findings indicate that properties experience a value premium of 0.70% for subway accessibility, and 0.15% for regional transit accessibility, respectively.

Table 2.4: Summary of studies that analyze the impacts of transit facilities on property values. Table adapted from Hess & Almeida (2007).

Authors	Study Area	Measurement	Results
Lewis-Workman & Brod (1997)	Queens, New York	Network distance to station	Property value decreased $2300 for every 100 feet further from station.
Lewis-Workman & Brod (1997)	Portland, Oregon	Network distance to station	Property value increased $76 for every 100 feet closer (within a one-half to one mile radius) to three stations that were studied.
Voith (1993)	Philadelphia, Pennsylvania	Proximity to rail service measured for census tracts.	Property value of single-family homes with access to rail stations is approximately 8% higher than other homes.
Landis, Guhathakurta, Huang, & Zhang (1995)	Sacramento, California	Network distance to station	No statistically significant effect on home prices.
Hess & Almeida (2007)	Buffalo, New York	Network and Euclidean distances to transit stations	Housing characteristics are better determinants of property value than accessibility. That said the Euclidean distance measure produced a more influential access impact on property values. The premium was determined to be $2.31/foot closer to the station for Euclidean distance, and $0.99/foot for network distance.
Habib & Miller (2008)	Greater Toronto Area, Ontario	Euclidean distance to subway and regional transit stations	Property values are determine to be positively impacted by transit accessibility at 0.70% of a property's value for subway access and 0.15% for regional transit access
Garrett (2004)	St Louis, Missouri	Euclidean distance to station	Property value increased 32% or $140 for every 10 feet closer to station, beginning at 1460 feet.

2.5.5. Freeways

Freeway access has been investigated from a variety of perspectives in the empirical literature. While it is generally assumed that, similar to transit facilities, freeways exert both positive and negative attractions, largely dependent on distance from the network, the overall impact has been investigated using a variety of methodological approaches. Shortest path distance measures to interchanges, tunnels or bridges are perhaps the most applicable to this research project; however researchers have adopted numerous approaches for investigating the impacts of investments and improvements (particularly capacity increases), on property values and development potential of nearby land parcels, both commercial and residential. Table 2.5 summarizes some of the literature that focuses on the development and property value impacts of freeway accessibility.

Kawamura (2001) investigates the role of accessibility for firms in the Chicago, Illinois area. Regression modelling was utilized to determine whether the importance of access to freeways has changed for businesses between 1981 and 1999. Results indicate that in fact accessibility to freeways has changed between 1981 and 1999 and that firms have moved their businesses closer to freeway interchange locations in response.

The authors speculate that this is a result of the rise of the modern polycentric city where interchange locations serve as crucial points in the network for firms in suburban locations. This shift is expected to have directly influenced property values as interchange locations have become more desirable for land development.

Carey & Semmens (2003) examine the impacts of freeway development on property values in the Superstition Freeway corridor near Phoenix, Arizona. Residential and commercial property values were sampled in order to determine the overall affect of the Superstition Freeway. Results indicate that, in general, development of the Superstition Freeway contributed to higher property values; however the impact was not homogeneous across property types. Access to the freeway was determined to have a negative affect on the value of single-detached homes, but had a positive effect on the value of commercial and multi-unit residential properties. Further, the results indicate that the negative impacts on property value were a result of increased traffic on nearby roads as opposed to the actual freeway itself.

Hansen, Gillen, & Puvathingal (1998) investigate the impact of a number of freeway development projects in California's four largest urban centres: San Francisco; Sacramento; Los Angeles/Long Beach; and San Diego, between 1970 and 1988. By analyzing building permit data by land use type, the researchers conclude that increased traffic capacity afforded by a new freeway or by freeway improvements is directly correlated with an increase in building permits for residential and non-residential properties alike. The resulting increase in development pressure is expected to produce rising property values. A conclusion supported by Habib & Miller (2008), who find that property values are higher (a 0.29% premium) for homes located within 2 kilometres of a freeway interchange. This research does not allow for the identification of a travel time or distance threshold as it does not use a quantitative accessibility measure, rather it uses a dummy variable (i.e. yes the property is close to a freeway or no, the property is not close to a freeway).

Mikelbank (2004) analyzes single-family home prices in Ohio in order to determine the influence of three accessibility variables, of which access to a freeway interchange is most relevant for this review. A shortest path accessibility calculation was completed for a series of single-family homes and included in a hedonic price equation in order to determine the impact of the interchange and other variables on the home's value. Findings suggest that homes located within 0.25 miles of the nearest freeway interchange experience a noticeable decrease in housing value as a result of the negative externalities, including noise and pollution, associated with a freeway. Properties located between 0.25 and 6.7 miles experience an access premium, therefore supporting the hypothesis that households value access to a built out freeway network.

This section has sought to quantify this project's main research question: does access to amenities matter? The literature presented in sections 2.5.1 to 2.5.5 is clearly indecisive in its attempt to answer this question. While the general conclusion can be made that in many cases accessibility does in fact influence property values, it is clear that: a) this influence for many amenities is negative up to some threshold distance where it then becomes positive; and b) in general, housing characteristics are better predictors of property values. That said, the emphasis in this research is on the role of accessibility and the research examined thus far has focused on measured accessibility. It is necessary to explore this relationship further.

Table 2.5: Summary of studies that measure the impacts of freeway accessibility on property values.

Authors	Study Area	Measurement	Results
Carey & Semmens (2003)	Phoenix, Arizona	Network distance from freeway	Access to the Superstition Highway generally results in higher property values; however the result was not consistent for all property types.
Kawamura (2001)	Chicago, Illinois	Network distance to nearest freeway interchange	For firm location between 1981 and 1999 there was a noticeable preference for locations with direct freeway accessibility. The increase in desirability for these sites is expected to have influenced property values as a result.
Hansen, Gillen, & Puvathingal (1998)	San Francisco; Sacramento; Los Angeles/Long Beach; and San Diego, California	Influence of freeway capacity increases on building permit activity	Increased freeway capacity as a result of investment produced an increase in the number of building permits issued for both residential and non-residential land uses.
Habib & Miller (2008)	Greater Toronto Area, Ontario	Euclidean distance to freeway interchange	Properties located within 2km of a freeway had a 0.29% premium in value.
ten Siethoff & Kockelman (2002)	Austin, Texas	Network distance to the freeway corridor	Freeway capacity improvements that increase the accessibility of proximal properties were found to have a positive impact on the value of residences.
Mikelbank (2004)	Columbus, Ohio	Network distance to the nearest highway access point	Property values increase to a threshold of approximately 7km from the access point, at which time they begin to decrease. The negative externalities associated with being too close to a freeway are identified as a 7% decrease in value for properties located within 0.25 mile of the network.
Mohring (1961)	Seattle, Washington	Network distance	Residential property values are positively affected by the transportation cost savings attributed to freeway investment.

The challenge of accessibility research is not to understand the impact of actual or measured distances (and subsequently accessibility), but instead, the impact of the psychological variables at play that influence how individuals, including homebuyers, perceive a location and its accessibility based on their own daily behaviours and travel patterns (Handy, 1996). These individual perceptions and behaviours are expected to influence the willingness of individuals to live near, and in turn pay for, accessibility to amenities (Chen, Chen, & Timmermans, 2008; El-Geneidy & Levinson, 2006).

2.6. Individual Accessibility: Perceptions and Behaviours

Conventional measures of accessibility, like those reviewed in sections 2.3 and 2.5, are typically geographical measures that are often based on zonal systems within cities and urban regions (e.g. census tracts, or transportation zones). However by investigating accessibility based on these macro scales of measurement, it is difficult to capture the complexities of modern cities and the processes that shape them (Kwan & Weber, 2003).

Kwan & Weber (2003) identify four broad areas of recent change as support for their argument that conventional accessibility measures are no longer suitable for understanding the complexities of accessibility and its implications. These four areas of change are: (1) the processes that shape urban form and contemporary cities and urban regions; (2) the issue of individual preferences and behaviours related to spatial organization; (3) the availability of new technologies and data availability (notably advanced GIS applications); and (4) the increasing importance of communication technologies in the everyday lives of average citizens. As a result of these changes the authors consider a variety of techniques that may be used for investigating individual accessibility, shaped by travel behaviour, as a more suitable approach for measuring accessibility in the 21st Century. Similarly other researchers have also recognized the increasing importance of individual behaviours and perceptions as determinants of accessibility, however there is a small body of academic evidence to review on this subject and no single analytical approach.

Mondschein, Blumenberg, & Taylor (2008) investigate the role of cognitive mapping and an individual's perception of distance as determinants of accessibility. In order to explore this relationship the authors employ a survey of residents in three Los Angeles, California neighbourhoods. Findings suggest that an individual's perception of their accessibility to destinations is cognitively shaped by a combination of factors including demographic, social, and cultural characteristics as well as their primary mode of transportation. For example, an individual whose primary mode of travel is an automobile is likely to consider destinations that are geographically farther on a daily basis, as opposed to someone who walks or cycles for their primary mode of transportation. Therefore the authors conclude that mode specific variations combined with socio-demographic factors influence an individual's cognitive mapping processes and impact how individual's perceive their own accessibility to destinations. These findings are supported by Weber & Kwan (2003) who propose that individual's shape their own accessibility based on the activities and destinations they choose on a daily basis, thereby creating a "personal city" of accessible opportunities.

McCormack, Cerin, Leslie, Du Toit, & Owen (2008) suggest that conventional accessibility measures that measure accessibility to nearby amenities are inadequate as individuals may consider destinations that are farther away as more accessible based on their perception of distance, the quality of the destination, or the services offered there (e.g. a neighbourhood grocer versus a big box grocery store). The authors develop a research method to test objective versus perceived accessibility of destinations using a survey tool within two neighbourhoods of varying walkability in Adelaide, South Australia. Respondents were asked to estimate travel times from their homes to a variety of local amenities (e.g. post office, library, and supermarket) based on walking times. Respondents were stratified based on their level of physical activity as well as socio-demographic characteristics. Results indicate that individuals overestimated travel times to destinations located near their homes, and underestimated the travel times for more distance destinations. Residents of the high-walkability neighbourhood consistently overestimated distances to the nearest amenities to their homes, compared to the residents of the low-walkability neighbourhood. As the residents of the low-walkability neighbourhood are assumed to depend on auto travel as their primary mode it is assumed that their perceived accessibility to amenities is greater (as supported by the fact that they consistently underestimated walking times), and thus they perceive accessibility differently than the residents of the high-walkability neighbourhood. A similar study by (Leslie, Saelens, Frank, Owen, Bauman, Coffee, & Hugo (2005) found comparable results to those of McCormack, Cerin, Leslie, Du Toit, & Owen (2008). This evidence further supports the argument that mode choice is a direct determinant of an individual's perceived accessibility.

Chattopadhyay, Braden, & Patunru (2004) combine housing market research with a survey of homeowner preferences in order to investigate the role that the perception of various amenities and environmental characteristics play in the real estate market in Waukegan, Illinois. Using distance to the harbour as a proxy variable, the authors seeks to unravel the impact that perceptions regarding the value of the public amenity and safety, have on nearby property values. The housing market research utilizes hedonic model to unravel the various determinants of property values which is then coupled with the survey data to estimate the perceived value of the harbour as a public amenity. The results indicate that homeowners significantly differ in the way in which they value and perceive access to the harbour, reflected as a willingness to pay. This finding validates the hypothesis that an individual's perception plays a critical role in determining accessibility, and in turn property values.

Thériault, Des Rosiers, & Joerin (2005) seek to determine whether accessibility is perceived similarly by everyone or whether perceived access varies depending on the amenity in question, and whether a difference in perceived accessibility results in differences in property values. Perceived accessibility is measured by analyzing the travel behaviour of individuals incorporating sensitivity to travel times between the trip's origin and destination, and compared to an objective access measure. The travel behaviour data consists of real trips made by residents of the Quebec City area to destinations like places of work, retail and shopping facilities, schools, and recreation and leisure facilities, among others. The researchers apply fuzzy logic in order to complete micro level spatial-analysis of trip patterns and travel times in order to measure residents' willingness to travel to certain destinations, and as a result their perceived accessibility to those destinations. Results indicate that accessibility is perceived differently among individuals depending on the destination and the profile of the household (e.g. age and other socio-demographics). The results also suggest that the perceived access measure described provides better insight the behaviour of individuals compared to the objective accessibility measure. Further the results support the hypothesis that individuals are willing to pay for increased accessibility based on their own needs, preferences and perceptions.

As mentioned previously, numerous researchers have investigated accessibility from a variety of perspectives and disciplines, each with their own methodology, results and recommendations. Many of these studies have concluded that the development of qualitative, subjective measures based on an individual's behaviours and perceptions is necessary in order to fully appreciate the relationship between accessibility and residential location (Baradaran & Ramjerdi, 2001; El-Geneidy & Levinson, 2006; Handy, 1996). That said few researchers have sought to build upon the results and recommendations outlined by these previous projects. Therefore this section has introduced the modest literature base that investigates the role of individual behaviours and perceptions as determinants of accessibility.

2.7. Summary

The literature presented in this review has laid the foundation for a study of the impact of accessibility on residential property values. Section 2.1 grounded this study in urban economic theory, traced to the work of 19th and 20th Century economists. Section 2.2 discussed and defined accessibility as a concept central to a variety of academic disciplines and practical applications. Section 2.3 introduced some measurement techniques and challenges to consider when attempting to quantify accessibility. Section 2.4 outlined the advances in geographic information science (GIS) applications in real estate and accessibility analysis. Section 2.5 reviewed numerous studies that have attempted to quantify the impact of accessibility variables on property values, notably: retail and shopping facilities; schools; parks and open space; public transit; and freeways. However based on the recommendations of many researchers, a more subjective accessibility measurement tool is required in order to further our understanding of how individual perceptions and behaviours affect location decisions. Hence section 2.6 reviewed the literature that investigates the psychological and behavioural variables that may influence residential location, and an individual's willingness to pay to have access to amenities.

This chapter has presented a comprehensive review of the literature on the topics of urban economics and accessibility. Chapter 3 discusses the methods used to answer the research questions outlined in Chapter 1, in order to investigate the combined impact of measurable (objective) and perceived (subjective) accessibility, and resulting implications for property values and residential location.

3. METHODS

The primary objective of this research project is to further our understanding of the relationship between accessibility and real estate values. The literature review (Chapter 2) introduced a variety of issues that have been addressed in previous academic works which shape and guide the methods used here. A two stage quantitative research method has been developed in an effort to address these concerns and answer the research questions posed at the onset of this thesis.

The first stage of the research involves the calculation of accessibility to desired amenities for three study areas within the Greater Toronto Area (GTA). The study areas consist of a single neighbourhood within each of the following municipalities: Burlington, ON; Oshawa; ON; and Richmond Hill, ON (section 3.1). The amenities considered in the accessibility calculation are: schools; public transit stations, parks, and freeway interchanges (section 3.3). The calculated accessibility value is then correlated with real estate sales data (section 3.4) in order to investigate the relationship between access and property value. The accessibility calculation is separated into two stages, and is discussed in sections 3.5 and 3.6 respectively. Section 3.7 outlines a sensitivity analysis procedure used to analyze the sensitivity of the accessibility indices.

The second stage of the research investigates the impact of individual home buyer's behaviours and perceptions, and how they may influence property sales values (e.g. perceived accessibility to desired amenities; or behavioural characteristics like preferred mode of travel). This investigation is aided by the development of a web based survey of real estate professionals within each of the three GTA study areas in order to determine how accessibility and amenity characteristics of an individual property influence the home buyer's purchasing decision (section 3.8).

3.1. Municipal & Neighbourhood Selection

Municipalities within the GTA are identified as potential study areas for this project based on housing characteristics (housing type and period of construction) at the census tract (CT) level. Municipalities are considered for inclusion if they possess CTs that meet the requirement of having at least 75% of all dwellings identified as single-detached houses, and at least 75% of all dwellings built between 1976 and 2006. The rationale behind these criteria is that in order to correlate property values to an accessibility value, the housing stock must be as homogeneous as possible, as it has been shown by various researchers that aesthetic and physical housing characteristics (e.g. number of bedrooms or bathrooms) are often better explanatory factors for the variance in property values as opposed to accessibility variables (Adair, McGreal, Smyth, Cooper, & Ryley, 2000; Giuliano, Gordon, Pan, & Park, 2008; Molin & Timmermans, 2003). Once potential CTs within each GTA municipality have been identified three additional criteria are considered. These included: (1) population characteristics, (2) relative geographic location, and (3) interregional transportation system of each short listed municipality.

(1) The size and distribution (within the municipality as a whole as well as within the CTs) of the population within each of the potential municipalities are considered, however socio-demographic variables (including income) are not. Socio-demographic characteristics are not considered as a selection criteria as they are deemed largely irrelevant based on the research objectives and questions. The one socio-demographic characteristic that may be helpful is average income, however it is assumed that this is likely be captured and reflected in the real estate sales data (i.e. local market characteristics).

(2) The relative geographic location of each short listed municipality relative to the City of Toronto's core is also considered. The monocentric city theory which states that a city (or in this case an urban region) has a single core within which the jobs and activities

are located and therefore is the most desirable location for firms and households alike (Alonso, 1964; Mills, 1967; Muth, 1969). While the notion of a monocentric city has been debated and dispelled in favour of a polycentric city theory (Giuliano, Gordon, Pan, & Park, 2008; Waddell, Berry, & Hoch, 1993), it is determined to be a useful criteria in order to narrow the list of potential municipalities and explore the currency of the monocentric theory.

(3) Finally the interregional transportation network within each municipality is considered. Each municipality is required to have some level of access to interregional public transit (e.g. Go Transit), as well as the 400 series freeway network.

Upon review of these criteria three study areas are selected, they are: Burlington, ON; Oshawa, ON; and Richmond Hill, ON. Once municipal selection is complete a single study neighbourhood is chosen from within each municipality based on the CT level housing characteristics discussed earlier in this section. Figures 3.1 to 3.3 show the location of each study neighbourhood within its respective municipality.

It is important to note that the term "neighbourhood" is difficult to define and holds no regional or universally recognized definition or boundaries. Therefore, for the purpose of this project, a neighbourhood consists of two CTs that abut at a border and fall within the confines of a definable road network hierarchy. For example the Burlington neighbourhood is bordered by Dundas Street to the north, Guelph Line to the west, Walker's Line to the east, and the freeway (403/QEW) to the south (Figure 3.4).

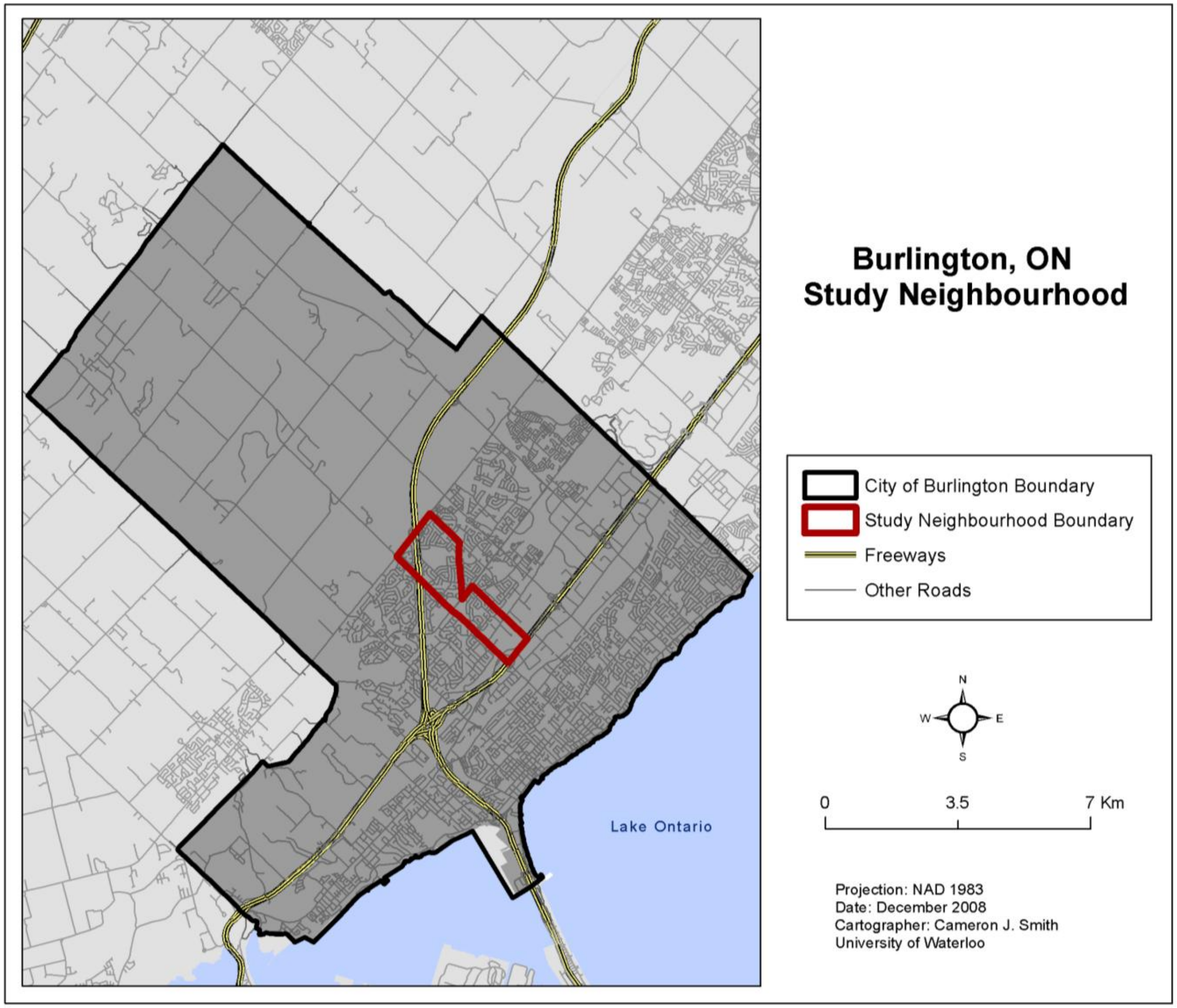

Figure 3.1: Location of study neighbourhood within Burlington, ON.

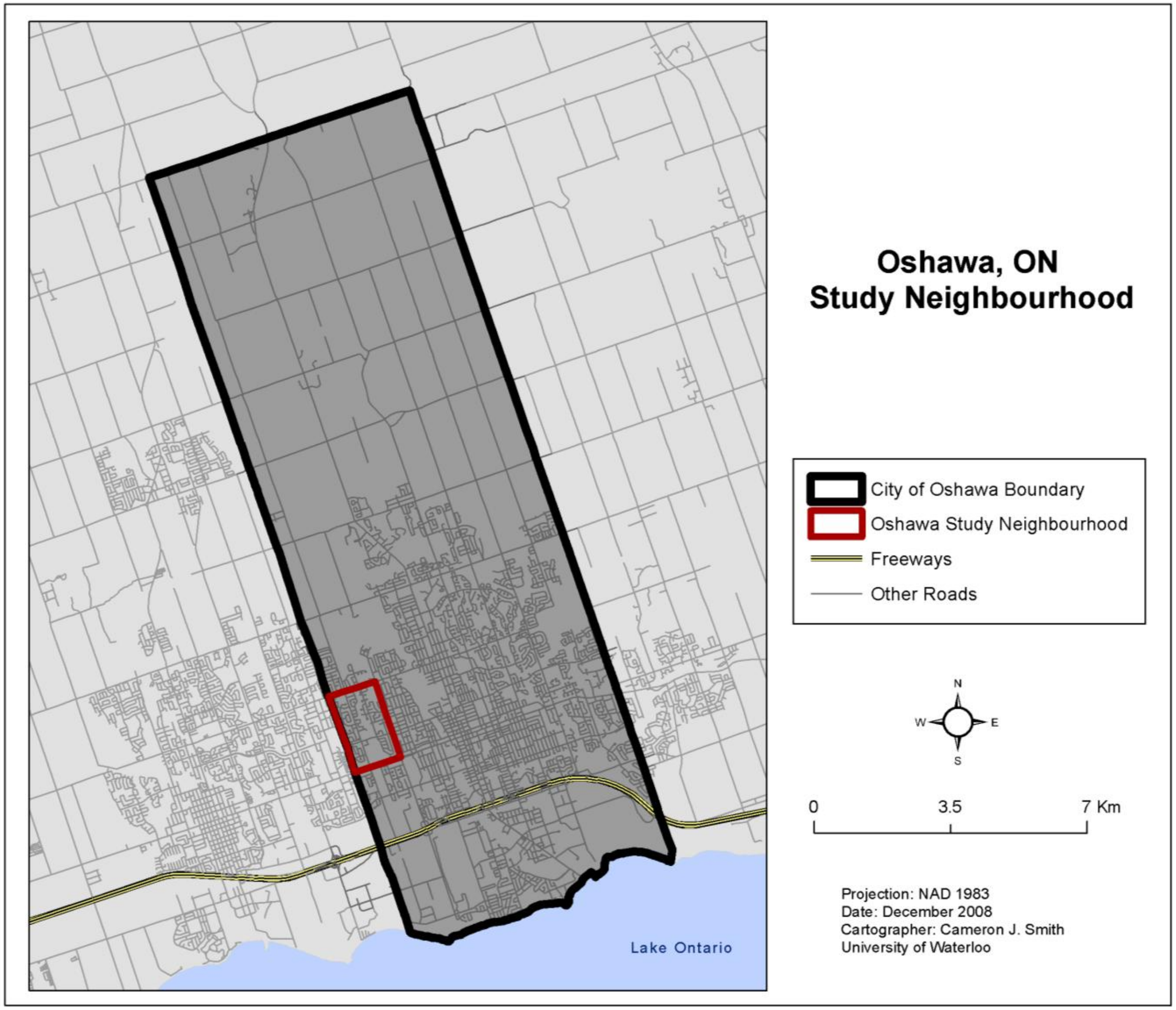

Figure 3.2: Location of study neighbourhood within Oshawa, ON.

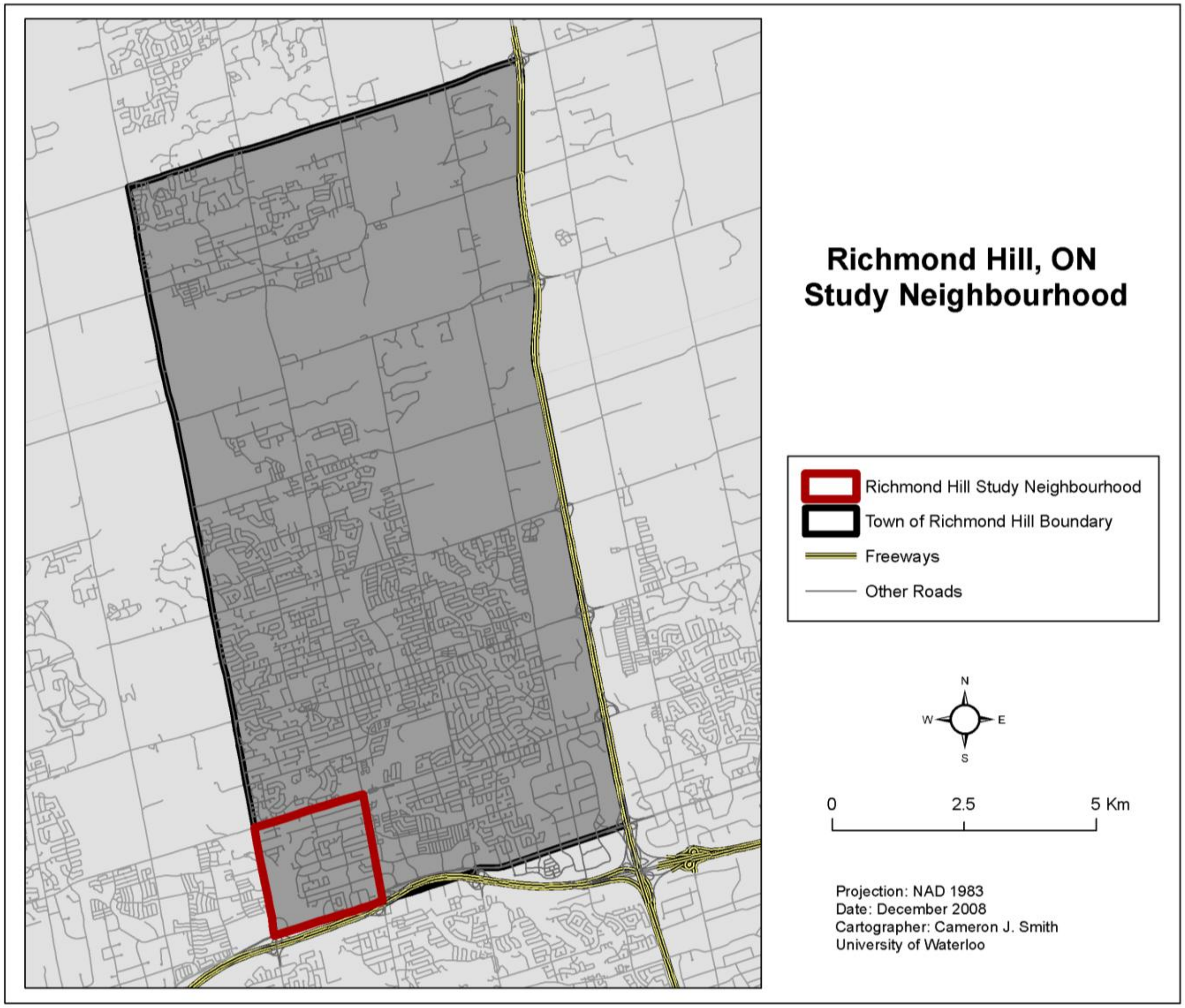

Figure 3.3: Location of study neighbourhood within Richmond Hill, ON.

3.2. Parcel Data Collection

Geospatial parcel data is collected for the entire GTA. The data, created by Teranet Inc. was received in cooperation with the map libraries at the Universities of Guelph and Toronto in 2008. An example of this data is illustrated in Figure 3.5. The most important feature of the parcel data is the PIN attribute field. Every property in Ontario has a PIN, short for Property Identification Number, regardless of its land use. This field serves as a unique identifier for which all future GIS table joins are facilitated.

3.3. Amenity Data Collection

The amenities included in this project were selected based on their importance in the realm of residential location (i.e. their assumed effect on property values) and the availability of geospatial data (e.g. freeway interchange location point data).

The accessibility and real estate literature tests a variety of amenities in order to gauge their relative importance and influence on residential property values. Some of the amenity variables included in these tests have included: retail opportunities (Des Rosiers, Lagana, Thériault, & Beaudoin, 1996; Habib & Miller, 2008); waterfront view (Benson, Hansen, Schwartz Jr., & Smersh, 1998); and open space (Chen, Chen, & Timmermans, 2008; Dökmeci, Önder, & Yavas, 2003). That said, this project analyzes four amenities that are frequently cited as important determinants of residential location and in turn housing value: schools; parks; public transit stations and freeway interchanges. Section 3.3.1 discusses the procedures of geospatial data collection for each of these amenities.

3.3.1. Amenity Location Data

DMTI Spatial (Digital Mapping Technologies Inc.) provides geospatial data within their CanMap Route Logistics (2006) package for each of the four amenities considered in this study (i.e. schools, public transit, parks, and freeway interchanges). However upon reviewing this data it is clear that the school and public transit data is incomplete and do not

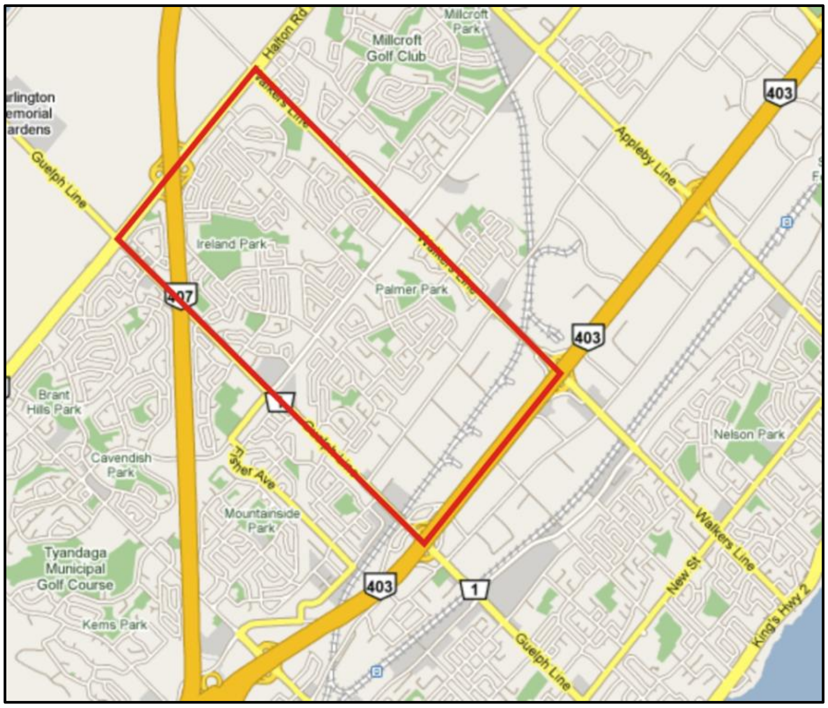

Figure 3.4: Burlington study neighbourhood, bounded by: Dundas St. to the north; Guelph Line to the west; Walkers Line to the east; and 403/QEW to the south (Source: Google Inc.).

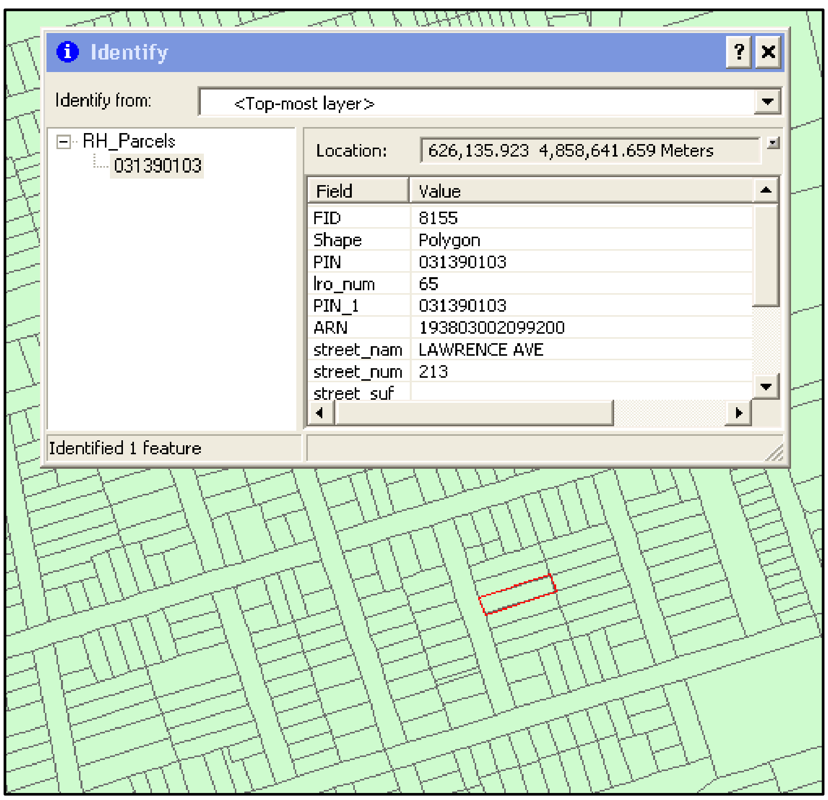

Figure 3.5: Sample of geospatial parcel data and attributes (Source: Teranet Inc.).

meet the project's needs. Therefore addresses for all schools and public transit stations (Go Transit only) must be manually collected via the Ontario Ministry of Education's and the Go Transit website. These addresses can then be matched to their respective locations in the parcel data. Where the parcel data is missing address information manual site identification is required. Once all respective school sites and transit station are identified they must be converted to point geospatial data. The CanMap Route Logistics (2006) data for park locations and freeway interchanges is sufficient to meet the needs of this project and as such requires little refinement. Figure 3.6 illustrates a sample of Oshawa's amenity point locations.

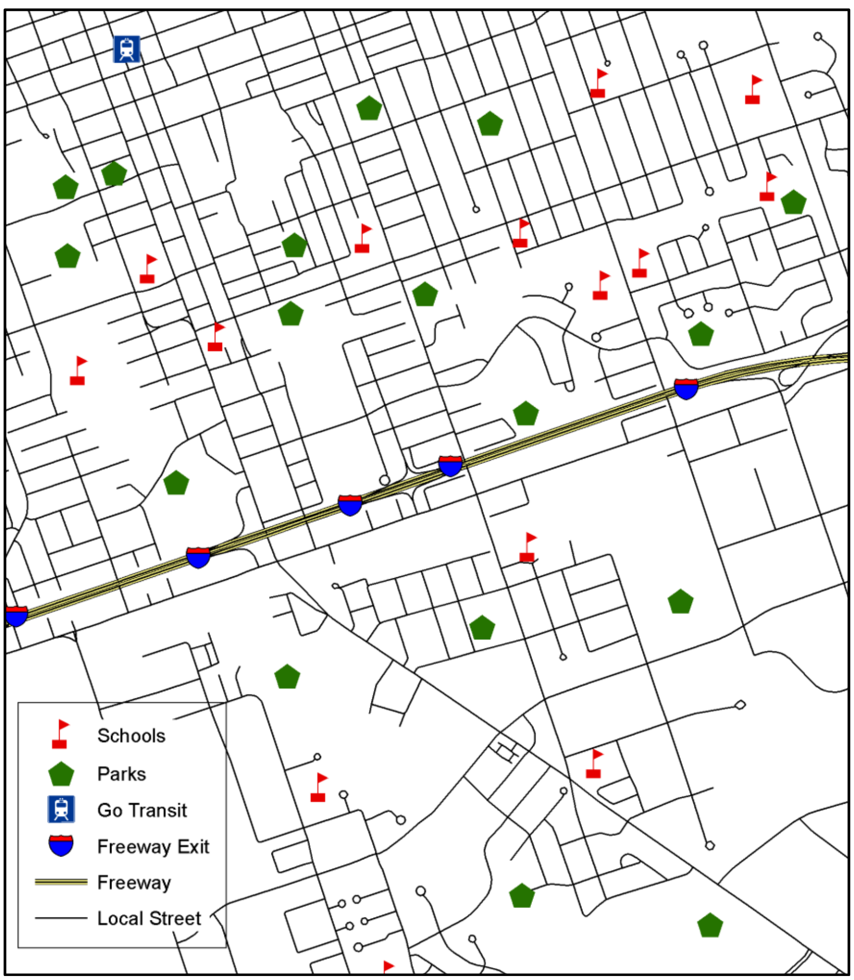

Figure 3.6: Example of amenity locations in Oshawa, ON neighbourhood.

3.4. Sales Data Collection

Property sales data has been purchased from Teranet Inc. in the form of an online subscription to the GeoWarehouse database of land registry property information. A non-disclosure agreement pertaining to personal identifiers has been signed in order to gain access to the database and use its contents for academic purposes.

The GeoWarehouse system is used in order to collect sales data for properties within each of the three study neighbourhoods between the dates of January 1, 2005 and December 31, 2007. A neighbourhood sales report is generated for all properties that sold between the specified dates within a 1 kilometre radius buffer of the queried address (Figure 3.7). The search process must be repeated until data for the entire neighbourhood has been collected. The sales data is then entered into a spreadsheet where the distribution can be examined and anomalies removed. Examples of anomalies in the data include a sale value $1.00 or $2.00 which represent a transfer of title from one family member to another (e.g. in the case of death or divorce). In addition any property with a sale value of less than $100,000 is determined to be an instance of refinancing on the homeowners part, and are therefore removed. Similarly any property with a sale value over $1,000,000 must be manually verified to determine whether in fact the property is a residence or a commercial establishment (especially in Oshawa and Burlington where the average single-detached home price is well below $1,000,000).

Upon completion of the sales data collection, all sale values must be corrected to 2006 dollars using the percent change in the price of an average single-detached home in the Greater Toronto Area. A sample of properties can then be taken for each study area. This sample is random and includes 10% of the total number of dwelling units within the neighbourhood. Table 3.1 shows the total number of units and the 10% sample for each of the three study areas. Figures 3.8 to 3.13 show the statistical and geographical distribution of the sales data for each of the three study areas' 10% sample of residences. The selected properties can then be joined to the geospatial parcel data and converted to point features (referred to throughout as residences).

Table 3.1: The sample size for each study area is 10% of the total number of parcels within the neighbourhood. While there were many sales in each neighbourhood the 10% sample size was selected in the interest of addressing the assumption of independence in the sample.

Study Neighbourhood	Number of Parcels[1]	Sample Size[2]
Burlington	3014	301
Oshawa	2234	223
Richmond Hill	2328	233

Notes:
1 Number of parcels = Parcels that fall within the defined neighbourhood boundary
2 Sample size = 10% of total parcels within study area

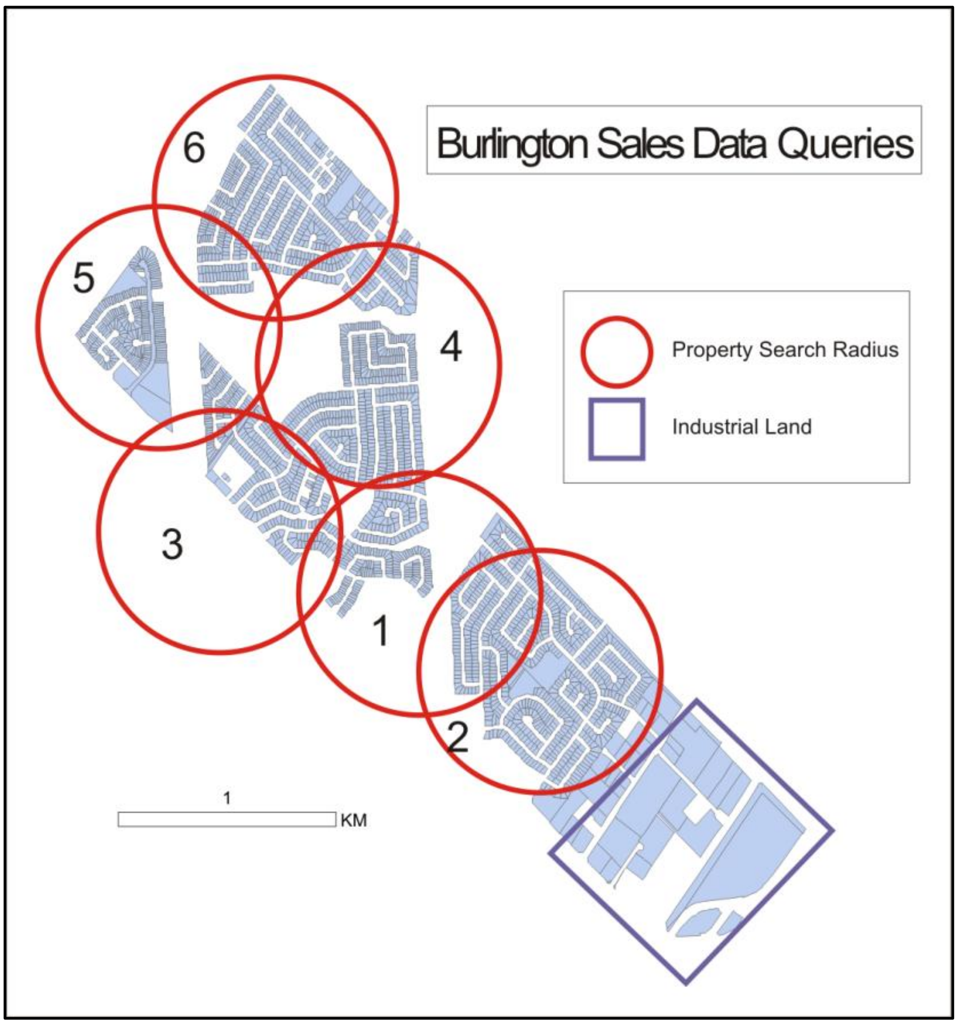

Figure 3.7: Example of sales data queries for Burlington, ON.

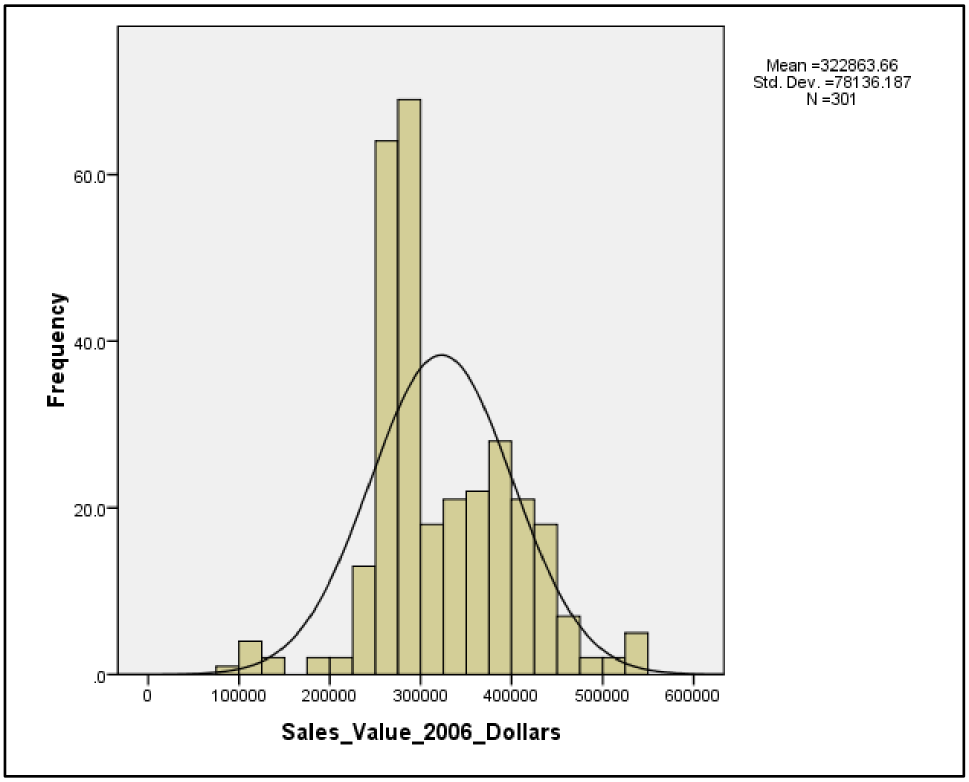

Figure 3.8: Statistical distribution of housing sales values, corrected to 2006 dollar value, for the Burlington study area.

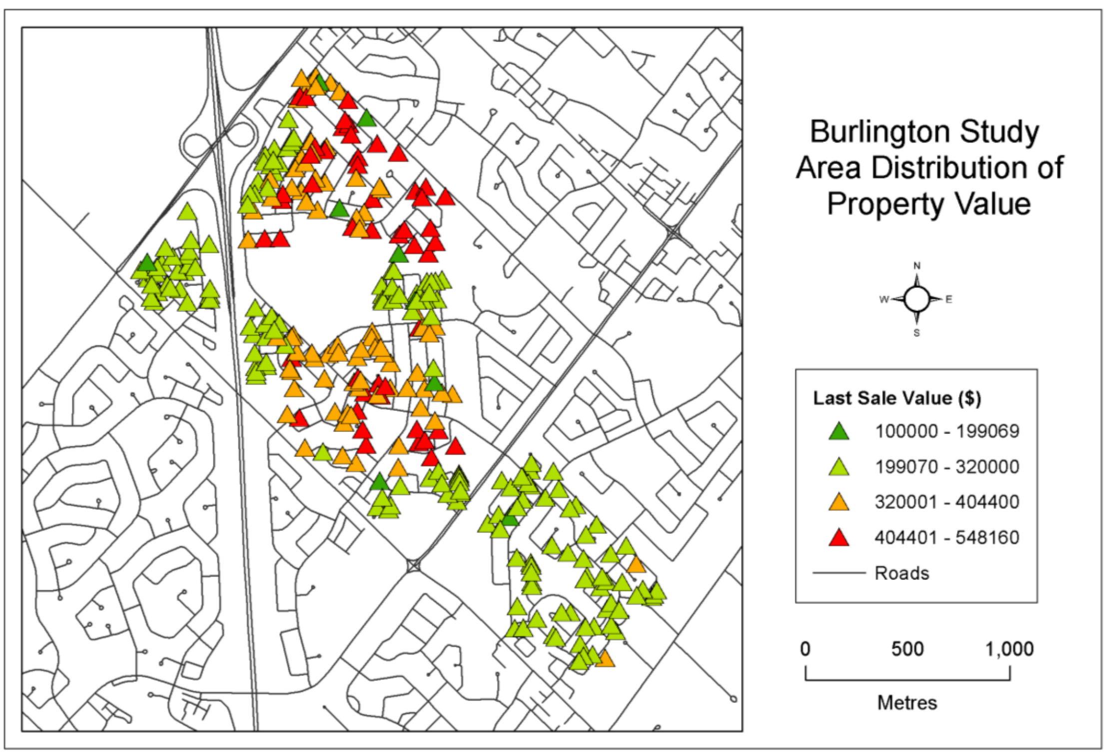

Figure 3.9: Geographic distribution of housing sales values for the Burlington study area.

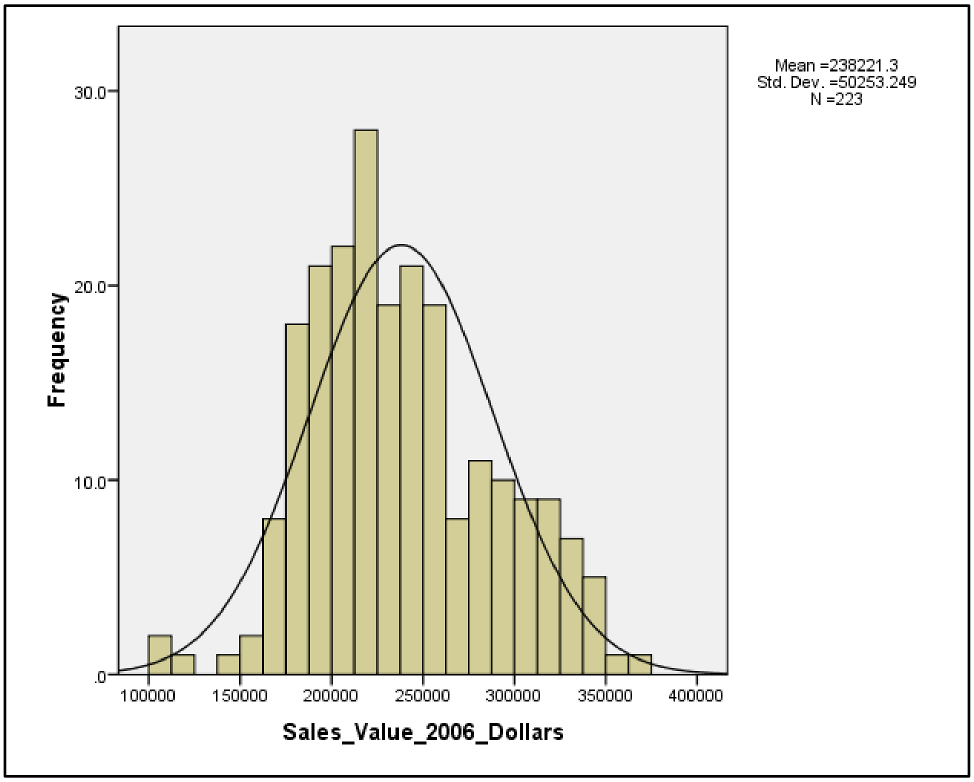

Figure 3.10: Statistical distribution of housing sales values, corrected to 2006 dollar value, for the Oshawa study area.

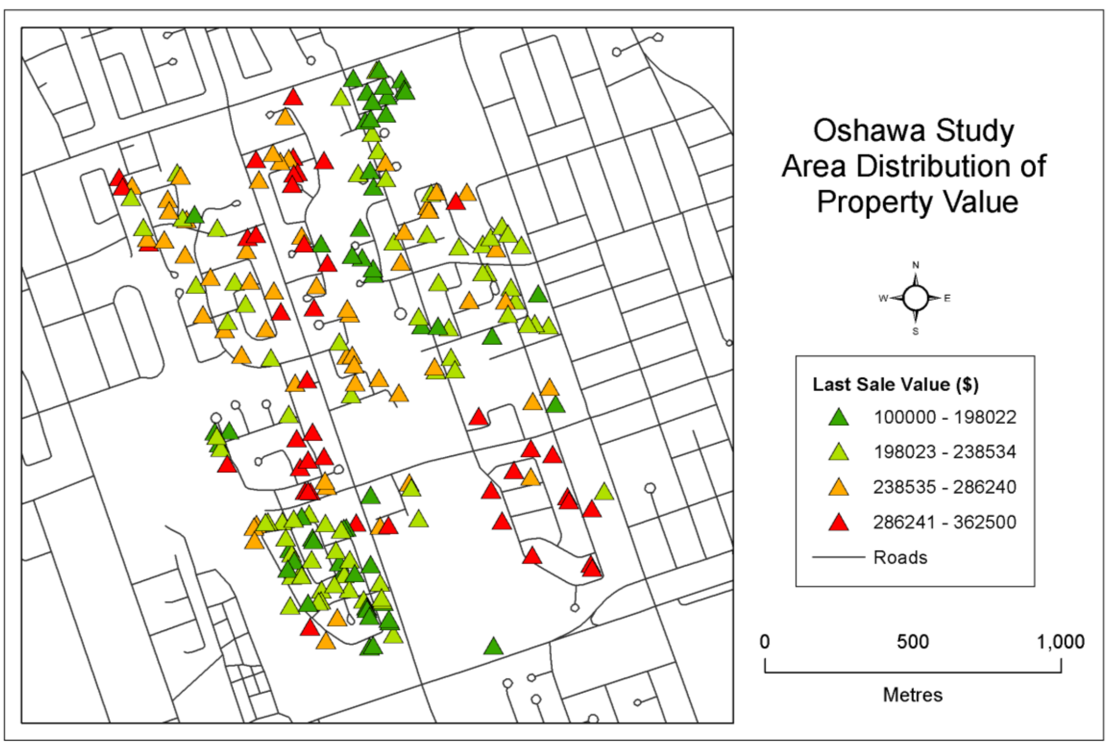

Figure 3.11: Geographic distribution of housing sales values for Oshawa study area.

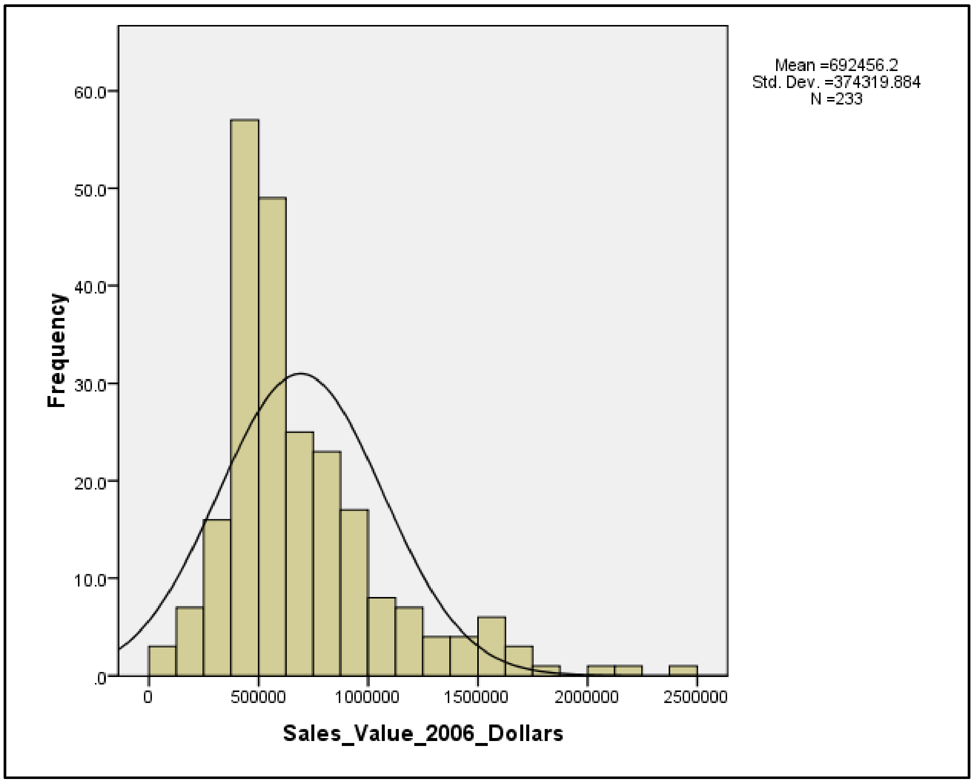

Figure 3.12: Distribution of housing sales values, corrected to 2006 dollar value, for the Richmond Hill study area.

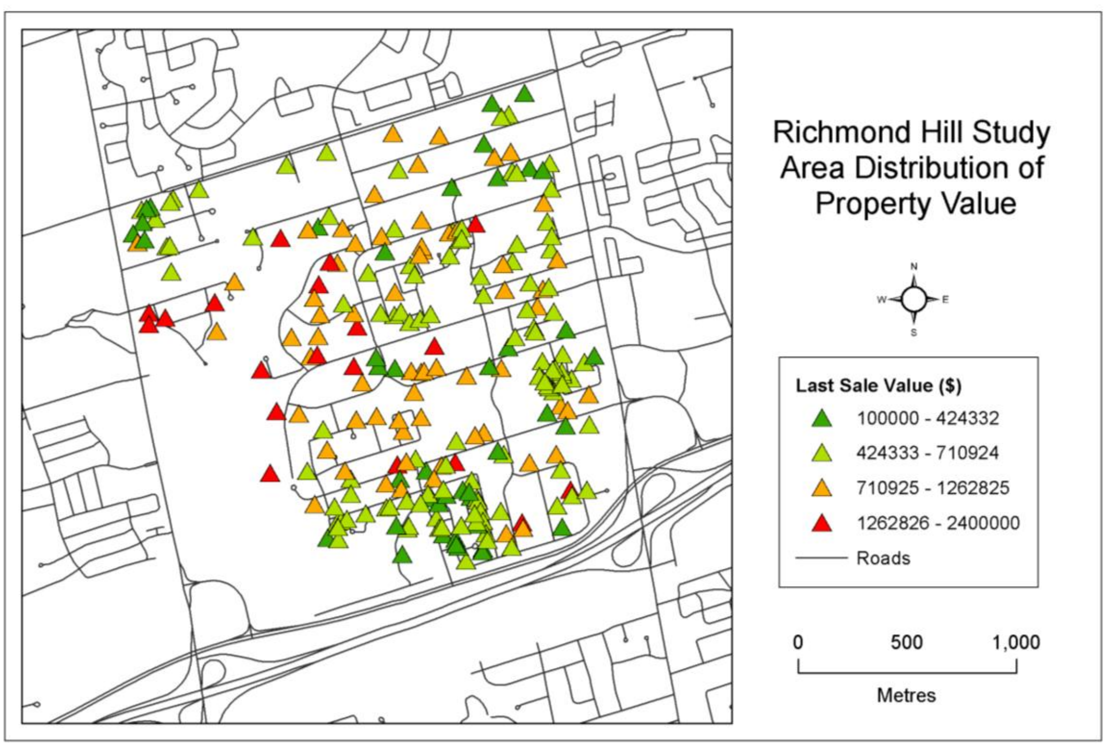

Figure 3.13: Geographic distribution of housing sales values for the Richmond Hill study area.

3.5. Calculating Travel Times

Travel times are calculated in ArcGIS using the Network Analyst extension. A road network is developed using DMTI CanMap Route Logistics street files. Elevation fields are added based on the road link's hierarchy (as defined by DMTI). Turn restrictions are built into the network based on the elevation fields. Using the OD Cost Matrix function of the Network Analyst extension travel times can then be created from origins (residences) to the destinations (each amenity location) based on fields within the built network (e.g. speed of travel, turn impedances, etc.). A simplified OD cost matrix can be seen in Table 3.2.

It is important to note that these travel times are based on the assigned speed of travel for automobiles on each link within the built road network. Therefore, these travel times are automobile based travel times. While walking times would be beneficial for some of the amenities, particularly public transit and schools as they lend themselves to pedestrian travel, walking travel times are not computed due to network data limitations. As a pedestrian network of sidewalks and paths is not available, walking travel times would have to be created using the road network (by multiplying the distance by an estimated walking speed of 4 kilometres per hour) under the assumption that pedestrians and automobiles travel along the same routes. This is determined to be an unnecessary step as, due to the network configuration, the difference in relative accessibility between properties remains constant regardless of the mode of travel. In other words, using pedestrian travel times as opposed to automobile travel times would not affect the relative accessibility of a residence in this project. Table 3.3 shows the descriptive statistics for the travel times for each residence to the three Go Transit stations in Burlington. Appendix 2 contains descriptive statistics for travel times to each amenity in each of the three municipalities.

Table 3.2: Sample origin-destination cost matrix for 5 Richmond Hill residences. The origins are residences, and the destinations are Go Transit stations.

Origin	Destination	Travel Time (minutes)
R001	Richmond Hill Centre	2.81
R001	Richmond Hill GO	5.09
R002	Richmond Hill Centre	3.18
R002	Richmond Hill GO	5.46
R003	Richmond Hill Centre	3.03
R003	Richmond Hill GO	5.30
R004	Richmond Hill Centre	4.70
R004	Richmond Hill GO	5.96
R005	Richmond Hill Centre	2.74
R005	Richmond Hill GO	5.01

3.6. Calculating Accessibility

The accessibility calculation is completed for each residence within the sample at two scales. The first, discussed in section 3.6.1 is a calculation of access to each of the amenity locations. The second, discussed in section 3.6.2 uses the individual access values calculated in 3.6.1 to create a composite accessibility rating for each property to all of the amenities. All calculations are completed in Microsoft Access.

3.6.1. Calculating Accessibility to Individual Amenities

The travel times generated using Network Analyst in ArcGIS are used in order to calculate accessibility under two different scenarios for each residence within the three study areas. The two accessibility scenarios are: (1) cumulative opportunities; and (2) closest facility.

(1) The cumulative opportunities accessibility measure calculates an accessibility value for each origin (residence) to each destination for a given amenity (Figure 3.14). For example, in Burlington there are 2 Go Transit Stations and 301 residences within the sample. In this case the cumulative opportunities equation uses the 602 travel times (2 x 301 = 602) to determine a property's accessibility to all of the Go Stations, expressed as a single value per residence (Equation 1).

(2) The closest facility accessibility measure calculates an accessibility value for each origin (residence) to the nearest destination for a given amenity using the same equation utilized for the cumulative opportunities measure. For example, in Burlington there are three Go Transit stations. In this case the closest facility equation calculates a value for each residence based on its travel time to the nearest Go Transit station (Figure 3.15).

Once all calculations are complete the access values (under all scenarios) are normalized (Equation 2). Normalized accessibility is represented as a value between 0 and 1 (i.e. 0 = minimum possible relative access, and 1 = maximum possible relative access). This step is completed in order to ensure equality between the variables in the composite accessibility calculation (section 3.1.1). The resulting tables can then joined to the geospatial residence data for each study area, classified by natural breaks, and visually inspected to verify validity.

Equation 1:

$$A_i = \sum_{j}^{n-1} \frac{1}{D_{ij}}$$

Where:
A_i= Accessibility at origin *i*
D_{ij}= Distance between origin (*i*) and destination (*j*)

Equation 2:

$$AccNm_i = \frac{A_i - \min}{\max - \min}$$

Where:
$AccNm_i$= Normalized accessibility for *i*
A_i= Accessibility value for *i*
$\min$= minimum of travel times
$\max$= maximum of travel times

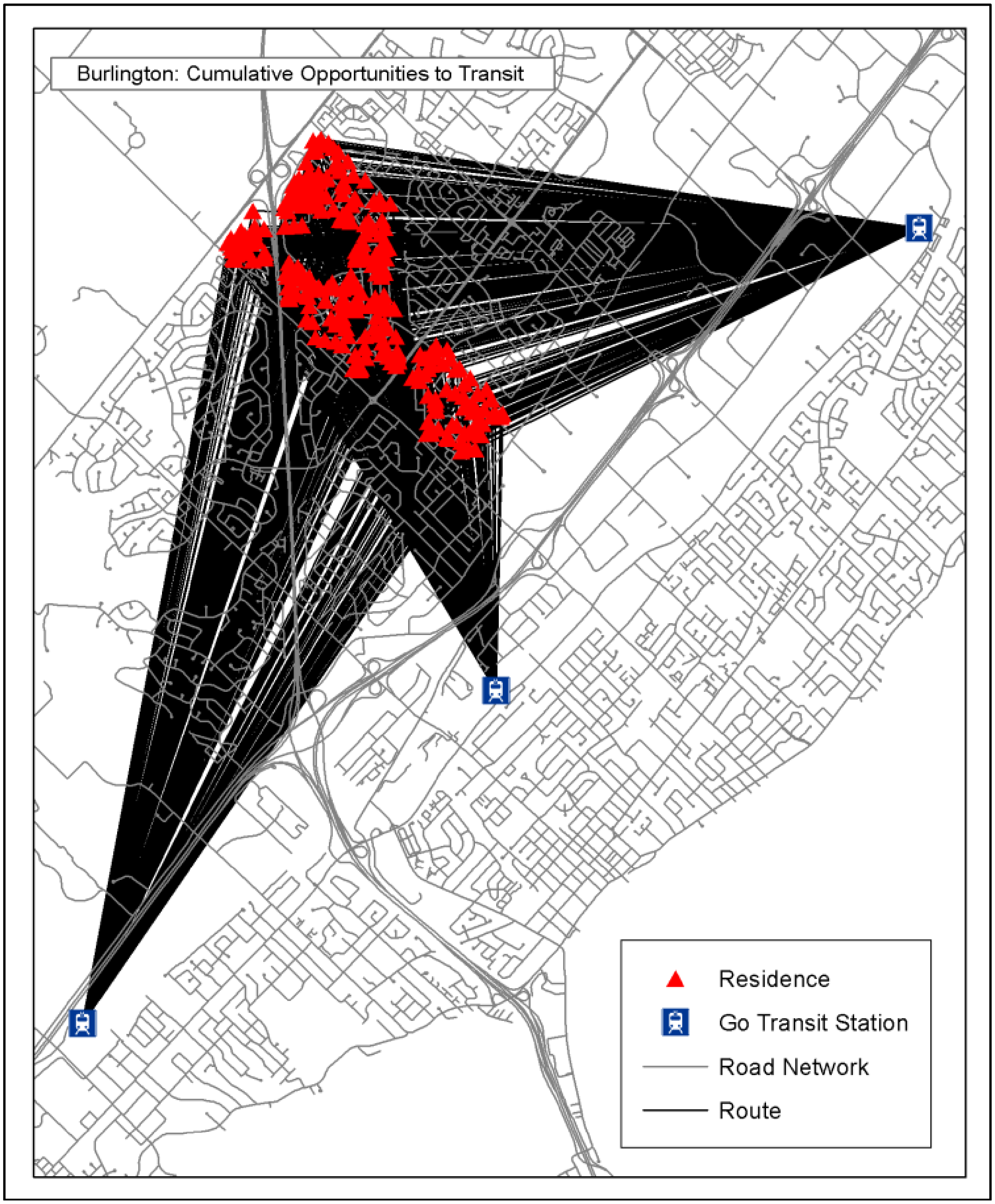

Figure 3.14: Sample of cumulative opportunities route generated in ArcGIS for Burlington study neighbourhood. Although the routes shown here depict Euclidian distance, travel times are in fact generated via network distance.

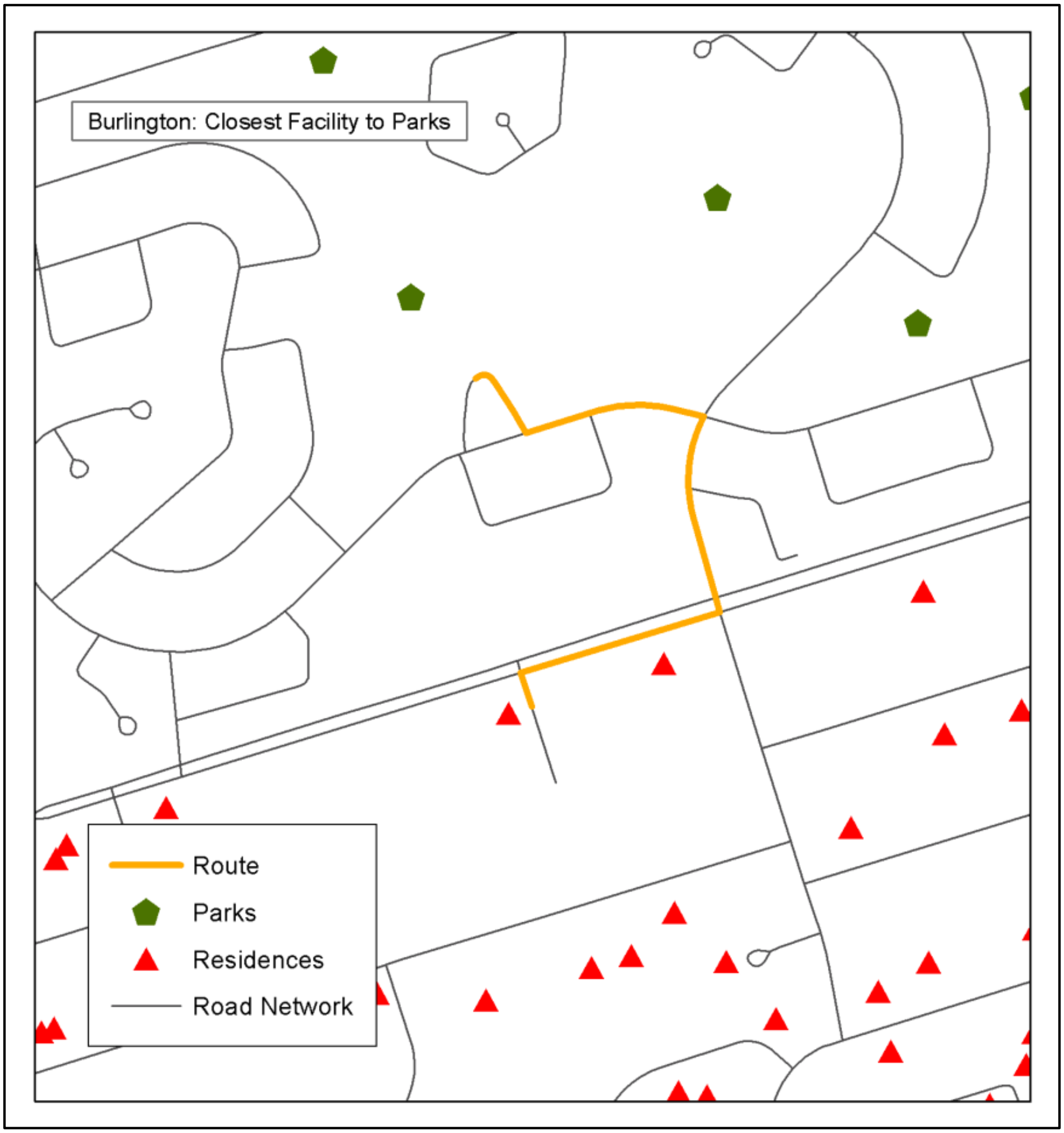

Figure 3.15: Sample of closest facility route generated in ArcGIS for Richmond Hill study neighbourhood.

Table 3.3: Sample of summary statistics table for travel times to Go Transit stations in Burlington, ON.

Burlington: Go Transit Travel Times in Minutes	
Descriptive Statistics	
Mean	6.94
Standard Error	0.05
Median	7.36
Mode	7.97
Standard Deviation	1.43
Sample Variance	2.04
Kurtosis	-0.52
Skewness	-0.56
Range	6.54
Minimum	3.29
Maximum	9.83
Sum	6269.40
Count	903.00

Although this calculation was completed for both of the accessibility measures (i.e. cumulative opportunities and closest facility), it is determined that, given the nature of the amenities included in this project, a closest facility measure is most appropriate. This decision is based on the assumption that individuals and households value residing close to a single amenity location as opposed to residing close to all amenity locations (e.g. a single freeway interchange versus all of the interchanges within a community).

3.6.2. Calculating the Composite Accessibility Index

The second accessibility calculation creates a composite index of accessibility to amenities for each residence. Equation 3 illustrates how the index is generated and Table 3.4 shows the 4 different weighting schemes that are applied. Each scheme weights the amenities differently, either increasing or decreasing their significance on the final calculation. The composite accessibility index is calculated for each of the two scenarios (i.e. cumulative opportunities; closest facility), as described in section 3.6.1.

Equation 3:

$$CompAcc^1 = [GoAccNm_i]Wt_1 + [HwyAccNm_i]Wt_2 + [ParkAccNm_i]Wt_3 + [SchoolAccNm_i]Wt_4$$

Where:
$CompAcc^1$= Composite accessibility scheme 1
$GoAccNm_i$= Normalized accessibility value for Go stations
$HwyAccNm_i$= Normalized accessibility value for freeway exits
$ParkAccNm_i$= Normalized accessibility value for parks
$SchoolAccNm_i$= Normalized accessibility value for schools
Wt_1= weighting value for each amenity (see Table 3.4)

Table 3.4: Schemes used for weighting each of the variables in the calculation of the composite accessibility index. The (Wt#) refers to the weight number in equation 3.

	Amenity	Weight		Amenity	Weight
CompWt1	Schools (Wt4)	0.25	**CompWt2**	Schools (Wt4)	0.3
	Parks (Wt3)	0.25		Parks (Wt3)	0.3
	Hwy Exit (Wt2)	0.25		Hwy Exit (Wt2)	0.2
	Go (Wt1)	0.25		Go (Wt1)	0.2
	Total	**1**		**Total**	**1**
	Amenity	**Weight**		**Amenity**	**Weight**
CompWt3	Schools (Wt4)	0.4	**CompWt4**	Schools (Wt4)	0.7
	Parks (Wt3)	0.2		Parks (Wt3)	0.1
	Hwy Exit (Wt2)	0.2		Hwy Exit (Wt2)	0.1
	Go (Wt1)	0.2		Go (Wt1)	0.1
	Total	**1**		**Total**	**1**

The resulting composite accessibility indices (i.e. cumulative opportunities, closest facility) can then joined to the geospatial residence data for inspection. A sensitivity analysis is then performed in order to determine how sensitive the composite index is to the amenity weightings. Section 3.7 discusses the sensitivity analysis procedures.

3.7. Sensitivity Analysis

Sensitivity analysis is used frequently as a verification tool for a number of GIS applications within which weighting criteria are a source of uncertainty (Feick & Hall, 2004). In this instance it is utilized to determine how sensitive the composite accessibility measure is to the four weighting schemes (see Table 3.4). This step is deemed as a necessary verification tool for this project as the weights, although based on previous studies, were subjectively defined and therefore could result in controversy regarding the validity of the results (Feick & Hall, 2004).

A summary of the results of the sensitivity analysis can be seen in Appendix 3. It is determined that the composite accessibility measure is most sensitive to the weightings for the Go Transit stations and freeway interchanges. A likely explanation is that all properties have good access to parks and schools, and therefore the accessibility index is most heavily influenced by the Go transit and freeway interchange accessibility values.

3.8. Survey of Real Estate Professionals

The goal of the survey of real estate professionals is to gain insight into how their clientele (e.g. the homebuyer) value access to amenities and the role that access plays in the process of purchasing a home. To achieve this goal emails are sent to real estate professionals in each of the three study areas (Burlington, Oshawa, and Richmond Hill) inviting them to participate in an online survey regarding real estate and amenities in the communities within which they work on a daily basis. Appendix 4 contains a copy of the email invite sent to each potential participant.

The online survey instrument is considered by this researcher as the most appropriate method for contacting the potential survey respondents. This decision is based on the understanding that email and internet use are necessary marketing and research tools for professionals in the real estate industry today. Furthermore, the email and online survey method is cost effective for the researcher and allows rapid communication with a large number of individuals at once. There are also a number of important challenges to using an email invite and/or online survey instrument that must be recognized from the onset. For example real estate professionals are constantly on the move from location to location, and therefore depend on handheld devices for email and internet access (e.g. BlackBerrys, or Palm Pilots). Therefore if the potential respondent receives and views the email while away from the office it is unlikely that they will re-read that email and participates at a later and more convenient date.

The remainder of this section discusses the procedures for the development of the online survey instrument (section 3.8.1), as well as potential respondent identification (section 3.8.2) and the administration of the survey (section 3.8.3).

3.8.1. Development of the Survey Instrument

Based on the requirements outlined by the University of Waterloo's Office of Research Ethics, the survey instrument is developed as a web based questionnaire hosted by SurveyMonkey.com. The questions are developed in collaboratively by this researcher and Dr. Clarence Woudsma (University of Waterloo, School of Planning). Appendix 5 contains a copy of the survey instrument. Survey questions are created based on assumptions, questions and recommendations extracted from the academic literature, in order to determine whether, in fact, access to amenities influences a homebuyer's final location decisions, or whether the importance of, or preference for amenities are outweighed by housing characteristics (e.g. number of bathrooms, lot size, etc). Once the survey instrument is complete, and has received clearance from the Office of Research Ethics, it can be tested in a pilot study of real estate professionals in order to determine whether it achieves its primary goal of offering insight into the importance of accessibility to amenities in a homebuyer's purchasing decision. Section 3.8.2 discusses the process by which potential survey participants were identified.

3.8.2. Potential Survey Respondent Identification

Potential survey respondents are identified as real estate professionals in the field of property sales, appraisal, development, and/or planning. That said, the primary respondent group consists of real estate sales representatives and brokers, as these individuals are continuously involved in the home buying process and deal with client's needs and wants on a daily basis. Potential survey respondents' email addresses are retrieved from company websites after a Yellow Pages search of real estate agencies in each of the three study areas (i.e. Burlington, Oshawa, and Richmond Hill). Individuals who work for companies that do not publicly advertise their sales representative and broker's email addresses are not included in the sample. This process is completed until a database of 400 potential participants for each of the three study areas (1200 total potential respondents) has been identified.

3.8.3. Administration of the Survey

The online survey was administered for a period of six weeks, stretching from early September to mid October, 2008. An introductory email, sent to the potential respondents, invited them to participate by following a hyperlink included in the email. The link directed them to the survey website. The link has been kept active for the six week administration period. Within these six weeks there were three phases of emails sent to invite potential respondents to participate. The sample was split into three waves in order to gauge the response rate. However, after contacting 600 of the 1200 total potential respondents the number of responses was lower then the expected 10% response rate, therefore the third phase required inviting all remaining potential respondents to participate. Of the 1200 total emails sent approximately 200 "bounced back" due to various server errors (e.g. participant's mailbox was full, detected as spam, or address no longer exists). Therefore the final sample was 57 survey respondents, and the response rate was 5.7%.

This chapter has introduced the methods used in each of the two stages of this research project. Chapter 4 presents the results of this project and discusses them in relation to the research objectives, questions and hypotheses.

4. RESULTS & DISCUSSION

This section presents and discusses the results of each of the two research stages of this project – measured and perceived accessibility. Sections 4.1 to 4.3 present the analysis tools, results and general conclusions for the individual amenity accessibility calculation as well as the composite accessibility index. Sections 4.4 to 4.6 present the analysis tools and findings of the professional survey for the individual behaviour and perceived accessibility assessment. Section 4.7 discusses the findings of these two research stages collectively in order to address this project's research questions.

As discussed in Chapter 3, an accessibility value was calculated for each residence in each of the three municipalities (process described in section 3.6.1). While this calculation was completed using two different accessibility measures (i.e. cumulative opportunities and closest facility), it is determined that, given the nature of the amenities included in this project, a closest facility measure was most appropriate as individuals and households value residing close to a single amenity location as opposed to residing close to all amenity locations (see section 3.6.1.). Therefore the results presented in the remainder of this chapter focus solely on the closest facility accessibility calculation.

4.1. Measured Accessibility – Analysis Tools

Accessibility is calculated for all of the sample residences in each of the three study areas to each of the individual amenity locations (i.e. schools; parks; public transit; and freeway interchanges). In addition to the individual amenity accessibility analysis, four composite accessibility indices are also calculated, as discussed in section 3.6.2. Table 4.1 illustrates an example of the raw and normalized accessibility values generated for one of the accessibility scenarios. The accessibility values for each residence are then correlated to the sale value of that property in order to investigate the association between accessibility and value. It is important to note that the accessibility values calculated for each property are relative only to the other properties within that study area. In other words, each study neighbourhood acts as an independent case study and comparisons of the calculated accessibility values cannot be made between study areas.

Table 4.1: Example of raw and normalized accessibility values calculated for each residence.

Residence ID	Raw Access Value	Normalized Access Value
R001	0.51996	0.02136
R002	1.03038	0.11264
R003	1.32173	0.16474
R004	0.88768	0.08712
R005	1.46856	0.19100
R006	0.51010	0.01959
R007	0.51505	0.02048
R008	1.22656	0.14772
R009	1.43235	0.18452
R010	1.05655	0.11732

The correlation between property value and accessibility is investigated using two statistical tests, a Pearson correlation coefficient and a Spearman's Rho. Each of these statistical tests are completed in order to test the hypothesis that homes with better access benefit in the form of a premium in property value or are associated with higher property values. The Pearson correlation coefficient measures the strengths of the association between the values of two variables, in this case the value of a property versus its accessibility, using the calculated values for the two input variables. This test however is greatly affected by data outliers and requires a normalized distribution (De Veaux, Velleman, & Bock, 2008). However, as seen Figures 4.1 to 4.3, (and in Figures 3.5 to 3.7) the data for property value and accessibility exhibit normalcy and linearity issues. Therefore the non-parametric Spearman's Rho test is used as it has less restrictive assumptions concerning the distribution. This test ranks the values for each variable and then compares the ranks to determine a correlation coefficient (De Veaux, Velleman, &

Bock, 2008). Section 4.2 presents the results of the correlation statistics between measured accessibility value and property value.

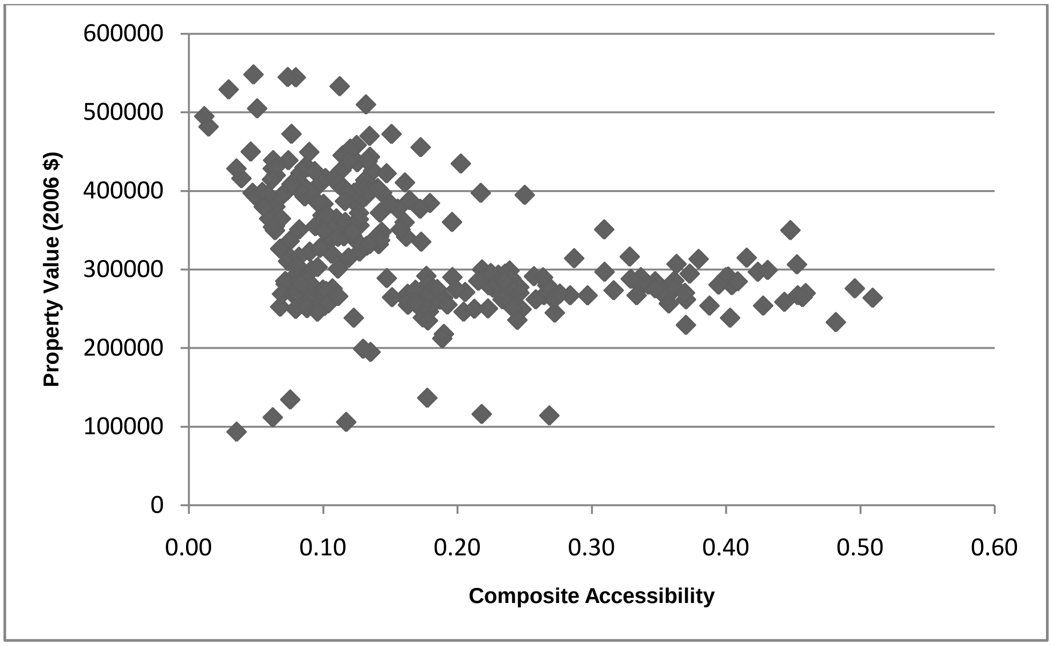

Figure 4.1: Burlington study area – distribution of closest facility composite accessibility (CompWt1: all equal weighting scheme) and property values.

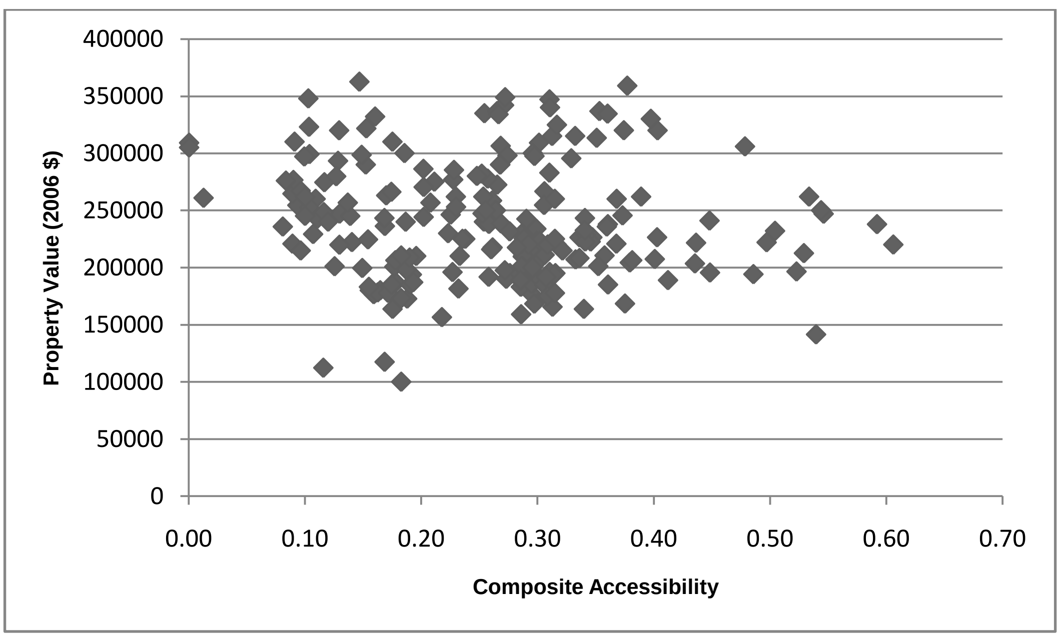

Figure 4.2: Oshawa study area – distribution of closest facility composite accessibility (CompWt1: all equal weighting scheme) and property values

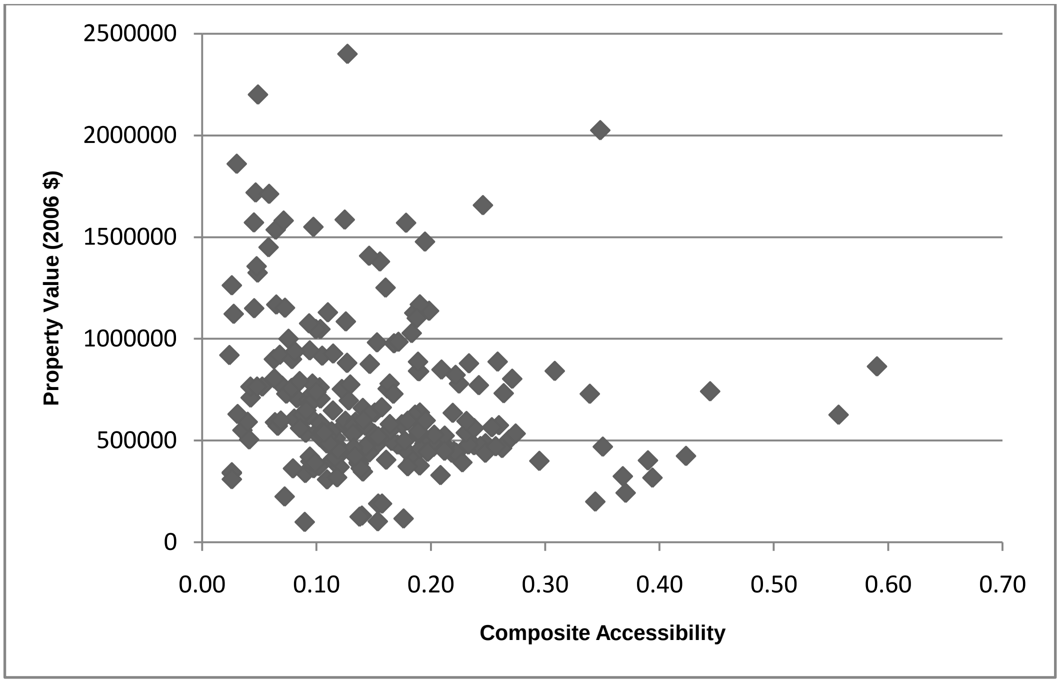

Figure 4.3: Richmond Hill study area – distribution of closest facility composite accessibility (CompWt1: all equal weighting scheme) and property values.

4.2. Measured Accessibility – Results

The Spearman's Rho test is based on a null hypothesis that there is no correlation between the two variables and therefore the Rho is equal to zero, while the alternative is that the correlation is not equal to zero, and is therefore significant. Generally speaking, the results of the Spearman's Rho correlation in this study are significant but weak for the majority of the amenity variables, as well as the composite weighting schemes. Furthermore, they illustrate a negative relationship between property value and accessibility. Table 4.2 presents the results of the Spearman's correlation for all of the amenities and composite weighting schemes in each of the three study areas. While the actual measured accessibility values for each property are relative only to the rest of the properties in that respective study neighbourhood, the R-value generated in the Spearman correlation represents the strength of the association between value and accessibility and can therefore be compared across the study areas. Sections 4.2.1 to 4.2.8 present the results of the correlation for all amenity variables as well as the composite weighting schemes in consideration of the research objectives and questions laid out at the onset of this document.

Table 4.2: Results of the Spearman's Rho correlation between accessibility and value for each study neighbourhood.

Correlation: Closest Facility Accessibility & Property Value			
Spearman's Rho (R value)	**Burlington**	**Oshawa**	**Richmond Hill**
Public Transit	-0.271	-0.155	-0.220
Freeway Interchange	-0.311	-0.151	-0.194
Parks	-0.197	0.191	-0.422
Schools	-0.142	-0.080[1]	0.061[1]
CompWt1	-0.406	-0.131	-0.233
CompWt2	-0.401	-0.126	-0.209
CompWt3	-0.412	-0.089[1]	-0.180
CompWt4	-0.414	-0.076[1]	-0.062[1]
Notes: [1] insignificant at the 0.05 level All other values are significant at the 0.05 level			

4.2.1. Schools

The literature provided confounding results regarding the influence of accessibility to schools on property values, primarily due to the presence of a threshold effect in a number of the reviewed cases. The results of the correlation between value and school accessibility in this project indicate that schools are not significantly related to property value in the Oshawa or Richmond Hill study neighbourhoods (insignificant R value) and that the relationship is negative in the Burlington study area, indicating that property values decrease as accessibility to schools increases, although the strength of the relationship is weak (Table 4.2). This negative influence on property value is likely due to the sample properties being too close to the school sites, and thus they are impacted by negative externalities like noise and traffic congestion.

It is further possible that this result is due to a relative uniformity in accessibility to schools. This point is illustrated in the Oshawa and Richmond Hill study areas. As most properties have good access to schools, it cannot be identified as having a relationship, either positive or negative, with property value.

4.2.2. Parks

Accessibility to parks is found to have mixed results on property values depending on the location in question (refer to Table 4.2). The correlation results for this project find that there is a significant, negative relationship between accessibility to parks and property values in the Burlington and Richmond Hill study areas. This relationship is strongest in Richmond Hill. This indicates that increases in access to parks results in decreases in property values. That said, park access is positively related to property values in the Oshawa study neighbourhood. The relationship between accessibility and value is strongest in Richmond Hill, followed by Burlington and then Oshawa, however it is important to keep in mind that overall the correlation coefficient is weak for all of the study areas

Similar to school accessibility, park access is relatively uniform in all three study areas, therefore the negative impact on property values for the Burlington and Richmond Hill neighbourhoods may be related to the negative externalities of being too close to a park, particularly effects like crime or noise. The positive impact on value in the Oshawa case could be a result of most properties being beyond the travel time threshold of being too close, however these properties remain close enough to enjoy the positive impacts of access to parks.

4.2.3. Public Transit Stations

Access to public transit stations is negatively associated with property values, indicating that as accessibility to a transit station increases, property value decreases. This result holds true for all three study neighbourhoods. While the overall strength of the relationship is weak, (refer to Table 4.2) it does exhibit variation among the three communities. The negative association between access to transit and property value is supported by the findings of Habib & Miller (2008) who explore the influence of access on property value in an investigation of regional accessibility in the Greater Toronto Area. While the findings of this project appear to conflict with the objectives of Smart Growth and regional transit initiatives, other evidence from the literature contradicts these findings and supports the notion that property values are positively influenced by transit accessibility (Landis, Guhathakurta, Huang, & Zhang, 1995).

4.2.4. Freeway Interchanges

Access to a freeway interchange produces significant and negative results for all three study areas, indicating that as accessibility to an interchange increase, property values decrease. The relationship is strongest in the Burlington study area, followed by Richmond Hill and then Oshawa. While the correlation indicates a weak relationship between the variables the results are negative and statistically significant and therefore conflict with general conclusions made by other researchers (e.g. Habib & Miller, 2008; Mikelbank, 2004; ten Siethoff & Kockelman, 2002).

These results could potentially be explained as capturing the negative effects associated with being too close to a freeway interchange, however even in the instances where residences could be negatively affected by being too close (Richmond Hill and Burlington neighbourhoods – see Figures 4.4 and 4.5), the majority of the sample properties are beyond the 0.25 mile (400 metres) threshold associated with negative impacts like congestion, noise, and air pollution and are within the 6.7 mile (10.8 kilometres) zone within which properties are positively affected by freeway access, as identified by Mikelbank (2004). Therefore it is presumed that the discrepancy between the results of this project and the literature (i.e. Mikelbank, 2004) is an issue of scale. This project is a small scale look at accessibility (i.e. neighbourhood); while the reviewed works are typically a city or regional analysis of accessibility. The difference between good access and poor access in this small scale analysis is minimal with little differences in auto based travel times within neighbourhoods. As a result, higher valued properties are often those that have lower access to respective amenities, a finding that contributes to the debate surrounding New Urbanism and concepts of street design.

In summary, the results of the accessibility measurement for each of the individual amenities produce predominantly weak and negative correlations between accessibility to amenities and residential property values. These results may be due to issues with the input data for the amenities and the property value variables, as well as the challenge of isolating the influence of accessibility within the complex pricing factors that affect a property's value. That said, the correlation between access and value for this project is a measure of the association between the variables and is not a precise estimate (e.g. dollar value) of the influence of access on value as would be created in a hedonic model.

4.2.5. Composite Accessibility: Weighting Schemes 1 & 2

Composite accessibility weighting scheme 1, within which all of the amenities are weighted equally, and composite accessibility weighting scheme 2, within which schools and parks are weighted slightly more than freeways and transit, produce very similar results (refer to Table 4.2). In both cases the correlation between accessibility and property value is negative and significant for all three study areas. Burlington has the strongest negative correlation, followed by Richmond Hill and Oshawa.

These findings are logical as the results of the sensitivity analysis (see section 3.7) show that the composite weighting schemes are most sensitive to changes in the values for the public transit and freeway amenity variables, which, as discussed in sections 4.2.3 and 4.2.4, also have the strongest relationship with property value.

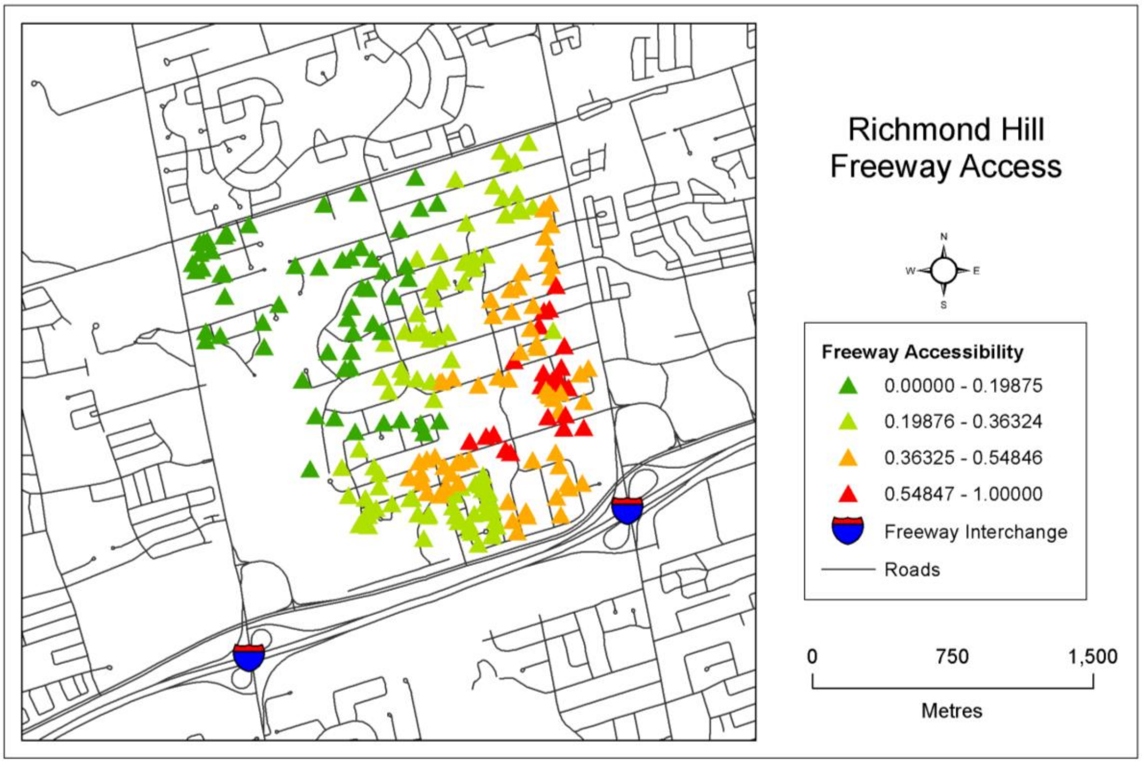

Figure 4.4: Freeway access for sample residences in Richmond Hill neighbourhood.

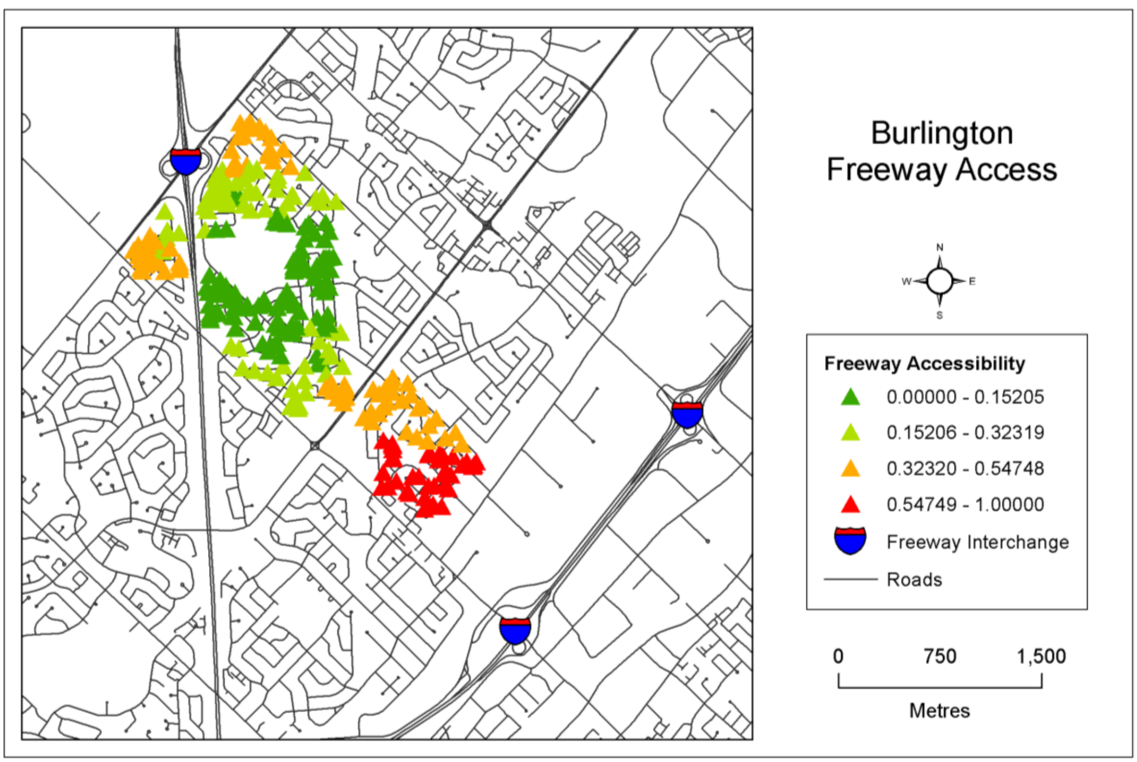

Figure 4.5: Freeway access for sample residences in Burlington neighbourhood.

4.2.6. Composite Accessibility: Weighting Schemes 3 & 4

Composite accessibility weighting scheme 3, within which schools are weighted just slightly higher than the remaining three amenities, and composite accessibility weighting scheme 4, where schools are weighted considerably higher than the other amenity variables, produce similar results (refer to Table 4.2). The Burlington study area has the strongest negative correlation between accessibility and value for both weighting scheme 3 and 4, while the correlation results from Oshawa are statistically insignificant for both weighting schemes. The correlation results for the Richmond Hill study area are negative and statistically significant for weighting scheme 3, and are insignificant for scheme 4. These findings are consistent with the expected, as both schemes weigh schools heavily, an amenity that yielded insignificant results in the individual amenity correlations for both the Oshawa and Richmond Hill neighbourhoods.

4.3. Measured Accessibility – General Conclusions

At this point some general conclusions can be drawn from the results of the measured accessibility research stage presented in sections 4.1 and 4.2. First, the results of the Spearman's Rho correlation between accessibility and property value for the sample of residences in each of the study neighbourhoods are predominantly weak; however they signify a negative relationship between a property's accessibility and its value. In other words, as a property's accessibility increases its value decreases. This may be due to relatively uniform accessibility within the neighbourhood, a result of the small and localized scale of measure. Further contributing to the mixed results are methodological challenges, including the lack of housing characteristic information for each of the sample properties, and the resulting range of property value data. This exemplifies the primary challenge of this project – attempting to isolate accessibility in the set of complex variables that influence the value of a property. Second, the correlation results are generally weak. This may be due to: (1) a uniformity in accessibility caused by the relative proximity of the sample properties to one another; or (2) the heterogeneity of the physical housing characteristics of the sample properties, a result of the broad selection (period of construction and dwelling type) criteria required due to data availability. Finally, while generally speaking the correlation results are weak, the correlation is strongest in the Burlington and Richmond Hill study neighbourhoods for all tested variables and composite weighting schemes. Therefore the relationship between access and property value is strongest in these neighbourhoods.

Sections 4.4 to 4.6 discuss the second stage of this research project: the impact of perceived accessibility and individual behaviours on the locational decision making of homebuyers, and in turn property values.

4.4. Perceived Accessibility – Analysis Tools

As discussed in section 3.8 a survey of real estate professionals is used in order to gain insight into how homebuyers perceive accessibility based on their own individual behaviours and experiences. This methodology has been developed based on gaps identified in the literature, as previous works have analyzed the relationship from either a quantitative or qualitative approach, and therefore a more comprehensive approach based on the actual perceptions and behaviours of individuals. Survey responses are analyzed using a variety of descriptive statistics, including frequency counts and mean scores, as well as cross tabulations in order to answer the research objectives and questions outlined in Chapter 1. Section 4.5 presents the results of the survey.

4.5. Perceived Accessibility – Results

This section presents the result of the survey of real estate. The survey is divided into two distinct sections. The first asks individual about their experience in the industry (e.g. years of practice, and geographical location). The second section asks respondents to consider the general behaviours, perceptions, and attitudes of their clientele while answering a number of questions related to accessibility to amenities, mode of travel and preferred destinations. The presentation of the results from this stage of the project is divided into two subsections. Section 4.5.1 discusses respondent characteristics and professional experience, and section 4.5.2 presents the findings of the questions related to homebuyer perception of access to amenities.

4.5.1. Respondent Characteristics

The purpose of this line of questioning is to gain insight into to the experience level and the primary location of practice for the survey respondents. As discussed in section 3.8.1 the potential survey respondents are selected from the municipalities that served as the study areas for the measured accessibility stage of this project. In addition all potential respondents are identified as either real estate sales representatives or real estate brokers of record. The summary of respondent characteristics is as follows:

- 81% of survey respondents were Real Estate Sales Representatives, and 19% were Real Estate Brokers of Record.
- The average number of years of experience for respondents is 12 years (in the real estate industry).
- 38.6% of respondents practice in Burlington; 45.6% of respondents practice in Oshawa; and 15.8% of respondents practice in Richmond Hill.

4.5.2. Homebuyer Perceptions and Behaviours

The second section of the survey included a variety of questions related to homebuyer’s perceptions of accessibility to amenities, mode choice and travel times as well as the most important amenities for their clientele.

Results indicate that 83% of respondents believe that homebuyers consider a property’s access to non-work amenities (e.g. recreational facilities or shopping opportunities) as a component in their location choice decision. Further, 80% of respondents believe that homebuyers are willing to pay a premium in order to be near the amenities that they, as individuals or families, value. When asked to put a dollar figure on this "willingness to pay" respondents believe that accessibility to the amenities is worth, on average, $10,000 of a $350,000 home, or approximately 3%. However the range of values offered by professionals was $0.00 (accessibility does not influence final sale price) to $50,000.

Respondents are also asked to rank a series of amenities in their order of importance in the decision making of homebuyers. Table 4.3 lists the amenities and the percentage of respondents that felt they were important or very important to homebuyers in their locational decision making. In addition to the listed amenities, respondents are also given the option to add other amenities that they felt were important determinants of household location for their clientele.

Table 4.3: List of amenities that survey respondents were asked to rank in order of importance for their clients to be near. Respondents were also given the opportunity to add their own amenities to the list.

Amenities	Ranked "Important" or "Very Important"
Local Shopping (e.g. Neighbourhood store or local downtown)	61%
Regional Shopping (e.g. Large shopping mall)	42%
Lower Order Transit Stop (e.g. Bus stop)	35%
Higher Order Transit Stop (e.g. GO or subway station)	**65%**
Parks/Open Space (e.g. Playing fields, neighbourhood park)	**84%**
Bicycle or Walking Trails	30%
Freeway (e.g. 400 series highway)	**70%**
Place of Worship	14%
Elementary Schools	**82%**
High Schools	**84%**
Colleges or Universities	19%
Other[1]	N/A

Notes:
[1]Respondent recommended amenities included: swimming pool; hockey/skating arena; and family members.

These additional amenities include: swimming pool; hockey/skating arena; and family members. Further, when asked to list the one amenity that homebuyers typically wish to locate near, schools were the overwhelming favourite (47%), followed by shopping (18%) and freeway access (16%).

Perhaps the most important question of the survey asks respondents to provide travel times by mode choice to the amenities listed in Table 4.3 based on their understanding of how homebuyers perceive distance. In other words, what travel time makes an amenity close? And how does transportation mode choice affect this relationship? Appendix 5 contains the results of a cross tabulation completed between transport mode and travel time for all of the amenities listed in Table 4.3. Tables 4.4 to 4.8 show the findings for the amenities in question for this project, namely schools, parks, public transit, and freeways. An interesting point to note from these results is that survey respondents generally do not consider cycling or transit as a viable transportation option that contributes to a property's accessibility. A Chi-Square test is then completed on the entire dataset (all amenities) in order to investigate the relationship between mode choice and travel time.

Results indicate that the amenities generally associated with walking, specifically schools (both elementary and high schools) and parks, do in fact receive the highest frequencies of responses for walking as the travel mode (Tables 4.4 and 4.5). Further, high order transit (e.g. Go station or subway), as well as freeway interchanges produce high frequencies for automobile travel. These findings validate the expected result for each of the amenities.

A cross tabulation with a Chi-Square test is computed for the entire list of amenities in order to quantify the relationship between mode of travel and travel time. In other words, is trip length related to mode choice? And, if so how? Appendix 6 contains the Chi-Square results and indicates, as expected, that these two variables are related and that travel time is dependent on mode choice. This confirms the expected, that individuals do not perceive walking and automobile trips equally, and that automobile travel is generally associated with longer travel times.

4.6. Perceived Accessibility – General Conclusions

There are three main conclusions that can be drawn from the results of the survey of real estate professionals. First, it is apparent that, in general, consumers do in fact consider accessibility to amenities in their household location decision making and are willing to pay in order to live near those amenities that they value. Second, the amenities analyzed in the measured accessibility stage of this research project are typically considered to be the most important for households, based on the opinions of the real estate professionals. Finally, the results of the travel time and mode choice questions indicate that travel mode is dependent upon perceived travel times for accessibility to desired amenities.

Section 4.7 discusses the findings of the two stage research approach collaboratively in an attempt to answer the research questions and objectives of this project.

Table 4.4: Results of the cross tabulation between mode of travel and travel times for elementary schools, as indicated by survey respondents.

Elementary Schools		**Travel Time in Minutes**					
		Under 5	*5-9*	*10-14*	*15-20*	*Over 20*	Total
Travel Mode	*Automobile*	1	3	2	0	0	**6**
	Public Transit	0	1	0	0	0	**1**
	Bicycle	0	0	0	0	0	**0**
	Walking	14	23	9	4	0	**50**
Total		**15**	**27**	**11**	**4**	**0**	**57**

Table 4.5: Results of the cross tabulation between mode of travel and travel times for higher order transit, as indicated by survey respondents.

High Schools		**Travel Time in Minutes**					
		Under 5	*5-9*	*10-14*	*15-20*	*Over 20*	Total
Travel Mode	*Automobile*	1	1	3	1	1	**7**
	Public Transit	0	0	2	0	0	**2**
	Bicycle	0	0	3	4	0	**7**
	Walking	4	5	18	14	0	**41**
Total		**5**	**6**	**26**	**19**	**1**	**57**

Table 4.6: Results of the cross tabulation between mode of travel and travel times for parks, as indicated by survey respondents.

Parks		**Travel Time in Minutes**					
		Under 5	*5-9*	*10-14*	*15-20*	*Over 20*	Total
Travel Mode	*Automobile*	1	3	1	0	0	**5**
	Public Transit	0	0	0	0	0	**0**
	Bicycle	1	1	1	0	0	**3**
	Walking	23	16	8	2	0	**49**
Total		**25**	**20**	**10**	**2**	**0**	**57**

Table 4.7: Results of the cross tabulation between mode of travel and travel times for higher order transit, as indicated by survey respondents.

High Order Transit		**Travel Time in minutes**					
		Under 5	*5-9*	*10-14*	*15-20*	*Over 20*	Total
Travel Mode	*Automobile*	0	19	18	7	1	**45**
	Public Transit	1	3	2	1	0	**7**
	Bicycle	0	0	0	0	0	**0**
	Walking	2	0	1	1	1	**5**
Total		**3**	**22**	**21**	**9**	**2**	**57**

Table 4.8: Results of the cross tabulation between mode of travel and travel times for freeways, as indicated by survey respondents.

Freeway		**Travel Time in Minutes**					
		Under 5	*5-9*	*10-14*	*15-20*	*Over 20*	Total
Travel Mode	*Automobile*	2	26	23	3	3	**57**
	Public Transit	0	0	0	0	0	**0**
	Bicycle	0	0	0	0	0	**0**
	Walking	0	0	0	0	0	**0**
Total		**2**	**26**	**23**	**3**	**3**	**57**

4.7. Discussion of Findings

To this point, this chapter has presented the findings and general conclusions from each of the two stages of this research project. This section discusses the results of this project in the context of modern cities and urban regions in order to answer the following research questions:

(5) Can a locational or accessibility premium be identified in the recent sales price of single-detached houses?

(6) What is the importance of these locational attributes in comparison to the traditionally valued characteristics like square footage, lot size, and home improvements?

(7) How does the perception of accessibility differ from the measured accessibility, and in turn, is it reflected in housing sales price?

(8) What locational attributes make a neighbourhood more appealing to homebuyers?

In addition to these questions this project has sought to test the hypothesis that residential properties with better accessibility, relative to other locations, will experience a premium in its value (Du & Mulley, 2006; Handy, 2005; Srour, Kockelman, & Dunn, 2002). However, as discussed previously, there is no consensus among researchers on the strength or validity of the relationship between accessibility and value.

The remainder of this chapter is divided into four subsections, each to answer one of the respective research questions.

4.7.1. Can a locational or accessibility premium be identified in the recent sales price of single-detached houses?

Previous works that seek to untangle the complex relationship between residential location and value have produced mixed results. While many have suggested that a premium can be identified for residential properties with good accessibility (e.g. Du & Mulley, 2006; Srour, Kockelman, & Dunn, 2002), others have suggested that the negative externalities associated with an amenity (e.g. noise and pollution for a freeway interchange) may counteract the positive affect that access to these amenities may have. While others have succeeded in identifying a premium for properties with good accessibility, it is generally accepted that housing characteristics are stronger determinants of value, and in turn location choice (e.g. Adair, McGreal, Smyth, Cooper, & Ryley, 2000; Bolitzer & Netusil, 2000; Chattopadhyay, Braden, & Patunru, 2004; Giuliano, Gordon, Pan, & Park, 2008; Hess & Almeida, 2007; Zondag & Pieters, 2005).

According to real estate professionals surveyed in this project, homebuyers do in fact consider a property's accessibility to amenities and are willing to pay in order to be close to the amenities that they value. However the quantitative measurement of accessibility to amenities used in this research has failed to capture this premium due to three factors: (1)

the variance in housing characteristics of the sample properties; (2) the scale of analysis; and (3) the fact that this project's scope is restricted to automobile based accessibility as opposed to pedestrian or transit accessibility.

The variance of housing characteristics, and in turn property values within the neighbourhood, is a result of using census tract (CT) level selection criteria as all of the sample residences for each study area were selected based on CT housing characteristics. Therefore the probability of selecting properties that do not represent the intent of the selection criteria is high. The decision to use CT level selection criteria was made as a result of data availability. Ideally the property selection process would have considered parcel specific housing characteristics, like number of bedrooms, lot size and square footage in an attempt to select a more homogenous sample of residences. As this data is unavailable, census variables by CT, specifically period of construction and dwelling type (minimum 75% for both criteria) were used in order to identify neighbourhoods with uniformity in their housing stock. As can be expected, a neighbourhood is not made up of identical properties and therefore this approach resulted in the selection of dissimilar properties for the sample of residences. The primary concern of using a heterogeneous housing sample is that it produces outliers for the property value data. In other words, if one compares a $150,000 single storey bungalow to a $1.3 million three story home, in an effort to identify a value premium, the correlation between value and location (access) becomes muddled. Alternatively if one compares accessibility and value for two single storey bungalows in different locations it leads to a clearer depiction of the relationship between value and access, from which stronger conclusions can be made.

The scale of analysis is also a contributing factor to the weakness of this project's quantitative results as accessibility's impact on property values is analyzed within neighbourhoods, as opposed to cities or urban regions. This approach has been developed in response to the recommendations of previous researchers who warn of the complexity and extent of accessibility analysis (Handy & Niemeier, 1997). That said the muddled results of this investigation has shed light on the importance of fine grained data collection and data comprehensiveness when carrying out accessibility analysis at such a fine scale. Future work should seek to resolve these data challenges.

Finally, this project has been restricted to automobile based accessibility as opposed to pedestrian access, walkability, or transit. While outside the scope of this project, an expanded analysis that would include walkability and transit would provide a more complete picture of the role of access and would complement the Smart Growth and New Urbanist literature.

4.7.2. What is the importance of these locational attributes in comparison to the traditionally valued characteristics like square footage, lot size, and home improvements?

One of the primary reasons for including a survey of real estate professionals in this project's research methodology is to determine the importance of accessibility related characteristics of a property for real world homebuyers. While the literature generally argues that accessibility to amenities is an important element in the locational decision making of households, it is clear that physical housing characteristics remain the most important considerations for most individuals. The results of this project's survey indicate that a property's accessibility is in fact considered by most potential homebuyers and that these individuals are willing to pay a premium for properties located near the amenities that they value. However this premium is generally considered to be less than 4% of the property's total value, which suggests that housing characteristics and other neighbourhood elements (e.g. tenure and prestige) are responsible for the remaining 96% of the property's value. While the strength of this suggestion is uncertain it is fair to conclude that a 4% premium is largely insignificant when considering the average purchase price of a single-detached home in the Greater Toronto Area was approximately $350,000 in 2006 (Toronto Real Estate Board, 2006).

4.7.3. How does the perception of accessibility differ from the measured accessibility, and in turn, is it reflected in housing sales price?

The findings of the quantitative analysis of accessibility suggest that as accessibility increases, property values decrease. This conclusion disproves the primary hypothesis of this project that a property with good relative accessibility will experience a locational premium in its value. That said, one of this project's critical research questions, as derived from the literature, remains unanswered: How does the perception of accessibility differ from the measured accessibility, and in turn, is it reflected in housing sales price? In an effort to resolve this question the survey asks respondents to rate the importance of a given amenity and then estimate a travel time for defining what is "close," based on a selected transportation mode. Recognizing that the real estate professionals are acting as a proxy for the homebuyers that represent their clientele, from this series of questions it is possible to identify how close individuals want to be to a specific amenity. For example, referring to Tables 4.4 to 4.8, 65% of respondents believe that homebuyers wish to locate within a ten minute walk of elementary schools, while 68% of respondents believe that homebuyers want live within a ten minute walk of a park, and 86% of respondents believe that homebuyers want to live between five and fifteen minutes (driving time) of a freeway interchange. Interestingly, only 3.5% of respondents believe that homebuyers wanted to be live closer than a five minute drive to a freeway interchange. In addition, according to the real estate professionals, homebuyers are willing to pay a premium in order to be near the amenities that they value. This premium is worth, on average, $10,000 of a $350,000 home, or 3.5% of the total value of a home. These results introduce a topic that is discussed heavily in the academic literature – travel time thresholds.

While travel time thresholds have been extensively used in previous studies such a threshold is not included in this project's accessibility measurement for two reasons. First, these previous works have been completed at larger scales of analysis. While a threshold is a practical parameter for a measurement of regional accessibility, it is less practical for a neighbourhood scale analysis. Given the number of amenity locations present within a neighbourhood, and the fact that negative externalities are associated with being too close to many of these locations, threshold rings of travel time or distance for each of these locations would overlap and conflict with the calculation of the composite accessibility index. Therefore the second reason for excluding travel time thresholds is that while a property may be too close to a school or a park, it may be too far from a freeway interchange or transit station which would prohibit the calculation of a composite accessibility value for each property and provide a view of that property's composite accessibility to all of the amenity locations considered in this project.

Thresholds lead to one of the most difficult issues to address in regards to residential location and amenities: how close is close? how close is too close? and how far is too far? As discussed in Chapter 2 there are a variety of negative externalities associated with most amenities, in which it is not desirable to live directly adjacent to, or within a specific travel time of an amenity. An example of an amenity with specific negative affects is freeway interchange sites, where there is presumably a lot of noise, pollution and congestion. Some authors have identified, or attempted to identify, a travel time or distance threshold that maximizes the value associated with that amenity without capturing the negative affects. For example, Mickelbank (2004) identifies a 0.4 kilometre distance threshold from a freeway interchange as having a negative impact on property value, while properties located farther than 0.4 kilometres, and within 10 kilometres experienced a value premium. The dollar value of this premium is based on the consumer's willingness to pay, which is largely dependent on that individual's perceptions and behaviours. However in the academic context, Habib and Miller (2008) determine that a 0.29% premium is applied to properties located within 2 kilometres (Euclidean distance) from a freeway interchange location. Thus conflicting results permeate the literature.

This project has sought to quantify the decisions that individuals make in order to maximize their satisfaction with where they live. The questions related to mode choice, travel times and preferred amenities have validated the intuitive understanding of these relationships. The findings indicate that homebuyers perceive amenities differently depending on their behaviours. For example an individual who commutes on a daily basis is likely to value freeway accessibility more than someone who works from home. Similarly parents with small children will likely value access to elementary schools differently than parents with high school aged children. The results also solidify the expectation that individuals perceive transportation modes differently, specifically walking and automobile trips. Walking trips are generally considered for destinations within ten minutes, while automobiles are generally associated with longer trips. While the research approach presented here has validated and extended our current understanding of the relationships between mode choice, travel times and locational premiums, additional research, and perhaps a different approach (e.g. surveys of recent homebuyers) is required to strengthen these findings.

4.7.4. What locational attributes make a neighbourhood more appealing to homebuyers?

This project has predominantly focused on four amenities for analysis: schools; parks; public transit; and freeway interchanges. While these amenities were selected based on their prevalence in the academic literature, the professional survey was designed in order to determine which locational attributes are most greatly valued by homebuyers. The findings of this section of the survey verify the importance of the four amenities included in this project, as they scored the highest for their importance in homebuyer location decisions. While this project's quantitative measurement of accessibility has failed to strengthen the results of the survey, the significance of access to: schools; parks; transit; and freeways is supported in the literature (refer to section 2.5).

It would be presumptuous to assume that the amenities discussed here represent the total spectrum of desirable locations for all homebuyers. Certainly there is a myriad of potential destinations that could influence a homebuyer's decision. The challenge of this project has been to unravel the complexities of residential location and generalize across socio-demographic market segments. That said, based on a review of the literature and the professional survey employed in this project, the most influential amenities in the residential location decision making process are generally schools, parks, higher order public transit and freeway interchanges.

Chapter 5 provides a general synopsis of this research project and makes recommendations and draws conclusions based on the findings the two stage research method, and the respective strengths and challenges associated with them.

5. CONCLUSIONS & RECOMMENDATIONS

This thesis has presented a two stage research methodology in order to investigate the influence of measured and perceived accessibility on residential property values in three study areas within the Greater Toronto Area. The results of this project are mixed. The quantitative measurement of accessibility has failed to prove the hypothesis that better access to amenities is reflected in higher property values for properties with good relative access and lower values for poor relative accessibility. These findings are corroborated by the literature including: Colwell, Gujral, & Coley (1985); Shroeder (1982); Landis, Guhathakurta, Huang, & Zhang (1995); and Hess & Almeida (2007). Given that it is commonly recognized that housing characteristics are better determinants of property value than accessibility (see Adair, McGreal, Smyth, Cooper, & Ryley, 2000; Giuliano, Gordon, Pan, & Park, 2008; Molin & Timmermans, 2003), the lack of available housing characteristic data in this research is largely responsible for these mixed results.

The second stage analysis of the real estate professionals survey results suggests that homebuyers are willing to pay a premium for perceived better access to the amenities that they value. This finding validates the intuitive understanding of the relationship between location and value (location, location, location), a finding supported by Chen, Chen, & Timmermans; (2008) Du & Mulley (2006); El-Geneidy & Levinson (2006); and Srour, Kockelman, & Dunn; (2002).

These findings are considered in the context of the research questions outlined in Chapter 1 of this thesis. The general conclusions are as follows:

(1) A locational or accessibility premium could not be quantitatively isolated in the sale price of properties located within the study areas, however this finding may be due to methodological issues and/or constrained by data availability.

(2) Survey results indicate that locational attributes do in fact matter, however their importance relative to physical housing characteristics like lot size, square footage, and home improvements remains an area that requires further research.

(3) Perceptions of distance, travel times and transportation mode choice coupled with the individual behaviours of homebuyer's impacts how accessibility is associated with property values

(4) Survey results indicate that the amenities considered in the quantitative measure of accessibility (schools; parks; transit; and freeway interchanges) are the most valued by homebuyers, and that they are willing to pay in order to live near these amenity locations.

Before proceeding to a discussion of recommendations and opportunities for future research related to accessibility, it is important to point out the value of this research project's methods and findings. This value relates to practical applications of accessibility measurement, particularly in the context of government and long range planning decisions.

This project has contributed to filling a gap in the literature by investigating access both quantitatively and qualitatively. By merging these two research approaches into a single exploration of accessibility and property values the ambiguous quantitative assessment of access is balanced by the more qualitative results which fit more in line with the intuitive expectations of the role of access. In addition, it is apparent that perceptual characteristics are critical factors in residential location decisions and that how a location, amenity or travel mode is perceived can have a direct and significant impact on behaviours and decision making. For example, these perceptions can affect one of the most critical decision - how and where individuals choose to live. In addition to the methodological significance, this project has also highlighted a need for increasing data availability, particularly with regards to housing data. The lack of housing characteristic data that this project suffers from ultimately had direct implications on the ability to quantify the association between value and access and illustrates the need to make this type of data available for academic purposes, as it is in the United States and Europe.

Further implications of this research apply to public sector planning efforts, particularly in the context of long range transportation infrastructure investments in the Greater Toronto Area and Greater Golden Horseshoe regions of Ontario. While a regional analysis of accessibility may be more applicable to these long range efforts than the neighbourhood scaled access analysis utilized in this project, it is important to consider the impacts that differences in relative accessibility for land parcels can have on shaping land use and development decisions at the regional scale and property values and taxation at the city and neighbourhood scale. In addition, municipal and/or provincial governments, concerned with providing equitable accessibility to public and/or private amenities, should consider accessibility measurement as an important information tool which can inform policy decisions. While the literature suggests that access measures must be selected with caution, particularly when used for directing public policy, the application of accessibility analysis, both quantitative and qualitative, may be a valuable tool for a variety administrative bodies in Ontario such as: Metrolinx (formerly the Greater Toronto Transportation Authority); the Ministry of Transportation; as well as all levels of government.

5.1. Recommendations & Future Research

While the results of this project, in response to the outlined research questions, are mixed, it is clear that methodological refinement is required for future accessibility analysis. This is particularly true as it is evident that the overall value of accessibility is driven largely by household decision making, behaviours and preferences. Therefore, it may be necessary to involve previously underutilized branches of transportation research in order to consider the decision making process in accessibility analyses. Incorporating activity modelling approaches, household level characteristics (e.g. number of members, ages, access to auto, etc.) and related research into accessibility investigations may strengthen our understanding of the complex relationship between people, their perceptions and the value they place on non-physical characteristics of a location. Further, specific recommendations based upon the shortcomings of this project's research methodology can also be made. The remainder of this section is divided into two subsections, one for each of the research methods that this thesis has applied: the quantitative measurement of accessibility to amenities (section 5.1.1); and the qualitative survey of real estate professionals (section 5.1.2).

5.1.1. Quantifying Accessibility

Based upon the recommendation of Handy (2005) a simple accessibility measure was deemed appropriate for this project. However the selected measure, its inputs, as well as the housing sales data, resulted in a muddled picture of accessibility and its impact on property values. While this result corroborates findings from half of the literature base (i.e. access doesn't affect value), it contradicts the other half. Therefore future quantitative accessibility research should focus efforts on determining the most appropriate measure for the local circumstances (e.g. types of amenities and number of opportunities). In addition, this thesis selected residences as origins from within a given neighbourhood; however accessibility to amenities for these properties is relatively homogenous, especially using a closest facility measure. Therefore future research should consider identifying a more appropriate scale of analysis that is a balance between the larger scaled regional investigations and the smaller scaled neighbourhood investigations.

Perhaps the most critical recommendation that can come from this research is in regards to the collection of property value data, which in this case was the last sale price for properties purchased between 2005 and 2007 in the respective study areas. While the effort was made to keep the housing stock as uniform as possible, data availability restricted this effort. Future research should seek a dataset with housing information (e.g. square footage, lot size, number of bedrooms) in order to standardize the residence sample. This would allow for further testing of the hypothesis that, when housing characteristics are held constant, properties with greater accessibility to amenities have higher property values.

This research may also be expanded to include alternative transport modes (pedestrian and transit) and how they influence the behaviours and perceptions of home owners. This would contribute to both the traditional urban economic literature as well as the Smart Growth and New Urbanism research that is interested in alternative transportation and its influence on property values, home ownership, and resident behaviours. Methodologically, this would require addressing the issue of pedestrian networks, as pedestrian routes typically differ from automobile routes (i.e. people can go places that cars cannot), and as such would require a larger, more comprehensive network dataset. Similar differentiation would be required in order to include transit routes and networks.

A final recommendation for improving the quantitative accessibility analysis approach utilized in this project is in regard to the use of a composite accessibility index. In this project the composite index was created in order to evaluate the complete effect of access to amenities on property values. The argument presented is that people consider access to many amenities when making a home purchase. However, upon reviewing the results and conclusions, analyzing the impacts of each individual amenity separately may provide a clearer picture of the association between property value and amenities.

5.1.2. Improving the Analysis of Homebuyer Perceptions and Behaviours

This project has used real estate professionals as a proxy for homebuyers in order to gauge their how their behaviours and perceptions play a role in their home purchase decision. This method was adopted as a result of its relative ease of administration and is based on the assumption that real estate brokers and sales representatives have a sound understanding of their clientele. That said, a survey directed at real homebuyers may produce different results, or it may validate the findings presented here.

In addition to the survey respondents themselves, future research should seek to address the issue of residential location in relation to the workplace. The professionals in this project's survey were asked to consider only non-work amenity locations in their valuation of the impact of accessibility on property value; perhaps the inclusion of workplace location would produce different results. Workplace accessibility is a large area of research, and outside the scale of this project, however one cannot ignore its impact on residential location decision making. Future research would benefit from further understanding of its importance for residential location in relation to the amenity destinations considered in this project.

5.2. Final Remarks

In this project the Greater Toronto Area has served as the study area, and three neighbourhoods were selected in order to test the hypothesis that residential properties with good accessibility experience a value-added premium in price as a result of the homebuyer's willingness to pay for accessibility to the amenity locations that they value. The two stages of research included a quantitative measurement of accessibility coupled with a qualitative survey of real estate professionals in order to address the issues and concerns of other researchers, and build upon the findings of the literature. Further, this mixed method approach has addressed a gap in the literature and highlighted the need to consider qualitative methods in conjunction with quantitative measures in applications where they may not have been considered in the past. While the methodology can be improved upon, this research project has contributed to the literature base and has furthered our understanding of the relationship between accessibility and residential property values, and more broadly the relationship transportation and land use interactions. While these relationships are complex and challenging to disentangle this project has contributed to the broader research base, and has strengthened our understanding of the transportation-land use interactions.

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APPENDICES

APPENDIX 1

Descriptive Statistics for Travel Times to Amenities (All Municipalities)

The tables in this appendix show the descriptive statistics for the cumulative opportunities travel times generated in ArcGIS using the Network Analyst extension. In order to determine the closest facility for each residence a Microsoft Access equation selected the shortest travel time to each amenity for each residence.

Table 1A: Descriptive statistics for travel times to all amenities in Burlington.

Burlington: Travel Times				
Descriptive Statistics	***Go***	***Freeway***	***Park***	***School***
Mean	6.94	4.79	6.25	5.51
Standard Error	0.05	0.02	0.01	0.02
Median	7.36	4.93	6.32	5.75
Mode	7.97	5.78	0.96	7.17
Standard Deviation	1.43	1.42	2.40	2.35
Sample Variance	2.04	2.02	5.76	5.52
Kurtosis	-0.52	-0.34	-0.26	-0.82
Skewness	-0.56	-0.38	0.08	-0.12
Range	6.54	7.40	13.73	11.31
Minimum	3.29	0.64	0.03	0.01
Maximum	9.83	8.04	13.77	11.32
Sum	6269.40	28861.79	195544.06	77978.45
Count	903.00	6020	31304	14147

Table 1B: Descriptive statistics for travel times to all amenities in Oshawa.

Oshawa: Travel Times				
Descriptive Statistics	***Go***	***Freeway***	***Park***	***School***
Mean	4.77	5.18	5.61	5.48
Standard Error	0.06	0.03	0.02	0.02
Median	4.80	5.09	5.52	5.66
Mode	4.67	5.16	4.56	1.99
Standard Deviation	1.26	1.02	2.60	2.19
Sample Variance	1.58	1.04	6.78	4.78
Kurtosis	-1.13	-0.39	1.89	-0.75
Skewness	0.09	0.29	0.78	-0.19
Range	5.89	6.08	16.49	10.45
Minimum	2.12	2.61	0.02	0.27
Maximum	8.01	8.68	16.51	10.72
Sum	2129.63	8093.11	107631.17	65957.36
Count	446	1561	19178	12042

Table 1C: Descriptive statistics for travel times to all amenities in Richmond Hill.

Richmond Hill: Travel Times				
Descriptive Statistics	***Go***	***Freeway***	***Park***	***School***
Mean	3.66	6.33	6.61	7.40
Standard Error	0.09	0.04	0.04	0.04
Median	3.95	5.54	5.43	7.18
Mode	3.87	8.03	4.60	6.05
Standard Deviation	2.04	3.36	4.27	3.72
Sample Variance	4.14	11.27	18.24	13.81
Kurtosis	-1.57	0.39	1.27	0.00
Skewness	0.03	1.09	1.32	0.55
Range	6.76	14.81	21.72	16.86
Minimum	0.13	1.11	0.05	0.17
Maximum	6.89	15.93	21.78	17.02
Sum	1704.03	35375.34	67727.91	75823.00
Count	466	5592	6.61	10252

APPENDIX 2

Summary of Sensitivity Analysis

This appendix summarizes the results of the sensitivity analysis completed in order to determine how susceptible the composite accessibility calculation was to variations in the individual accessibility values for each of the amenities.

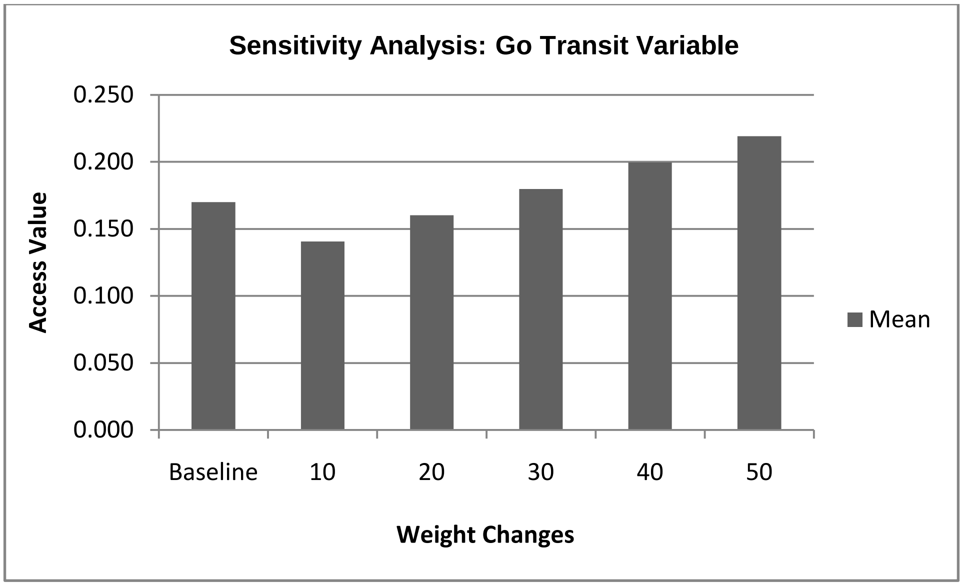

Figure 2A

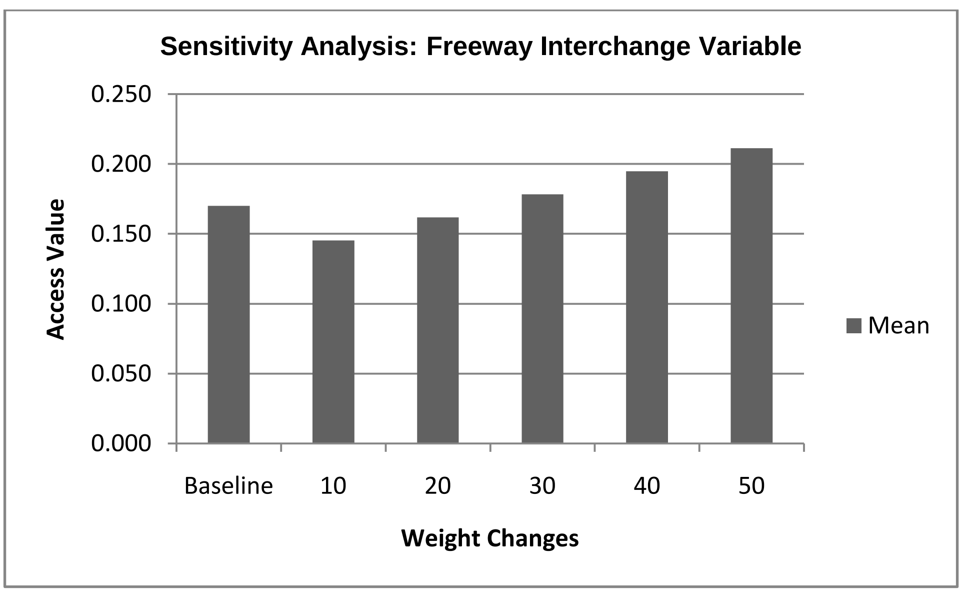

Figure 2B

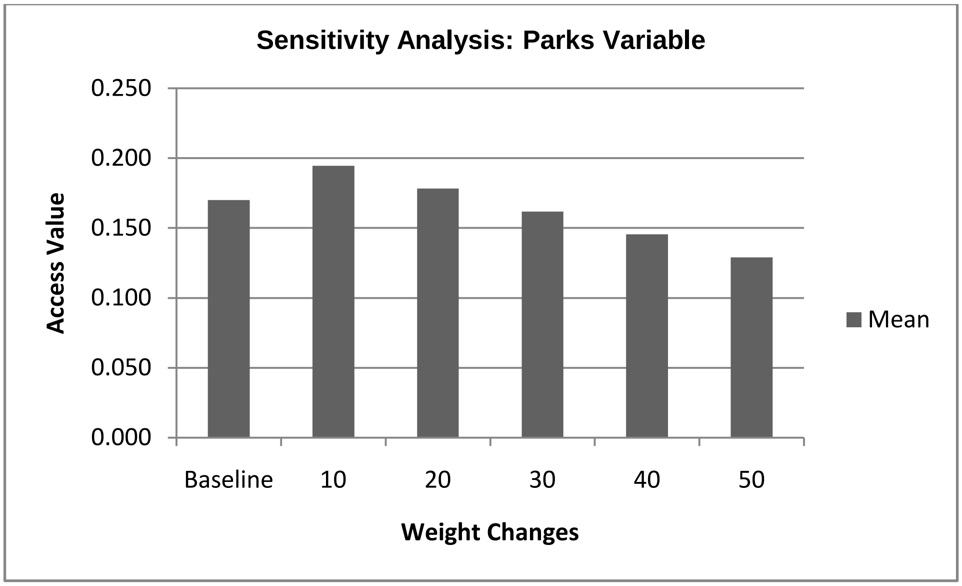

Figure 2C

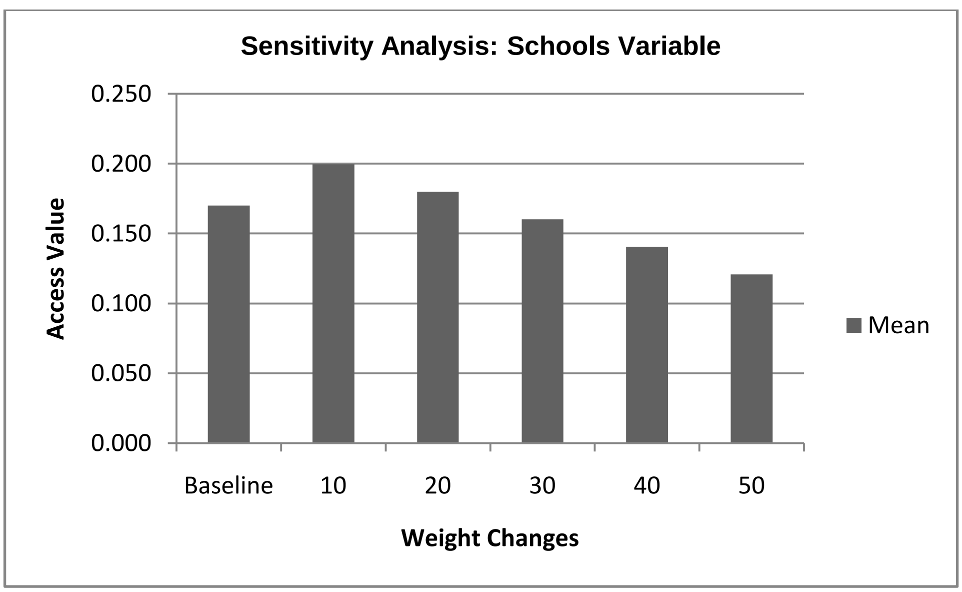

Figure 2D

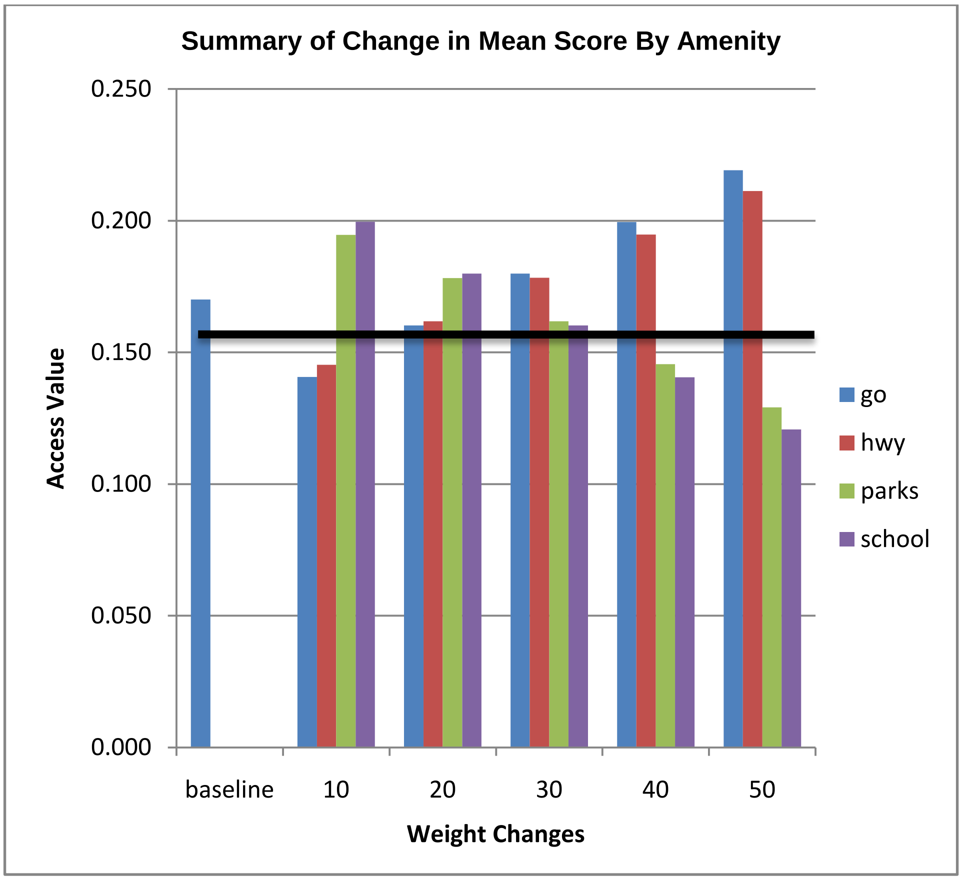
Summary of Change in Mean Score By Amenity
0.250
0.200
0.150
0.100
0.050
0.000
Access Value
baseline
10
20
30
40
50
Weight Changes
go
hwy
parks
school

Figure 2E

APPENDIX 3

Email Invitation to Potential Survey Respondents

This appendix contains the email sent to each of the 1200 potential survey respondents inviting them to participate in this project.

Greetings,

My name is Cameron Smith and I am a Master's student in the School of Planning at the University of Waterloo conducting research under the supervision of Dr. Clarence Woudsma. You have been identified as a potential participant for this project based on your expertise as a real estate professional focusing largely on residential properties, and based upon the communities within which you actively work.

The nature of this research project is to further our understanding of the role of transportation and accessibility in the real estate and property markets. While most would intuitively agree that location matters, the goal of this project is to further our understanding of the complexities of the relationship, specifically the potential impacts that an individual's perception of location may have.

I have set up an online survey which will take approximately 10 minutes of your time. Questions are related to the themes of; the purchasing process, what is important to your clients, and how your clients value the nearness/proximity of desirable amenities or destinations. It is important to note that you will not be asked to provide any personal information by which you or your responses could potentially be identified.

If you wish to participate, please visit the following link:
http://www.surveymonkey.com/s.aspx?sm=Me5%2f1JQe0t9J4DYMqhUFsg%3d%3d

From the main page, read the consent statement, select 'I Agree' and click on the 'Continue' button to complete the questionnaire.

If you have any general questions or comments about this survey, or would like a copy of the results of this project upon its completion, please feel free to contact me at the address provided below.

Thank you for taking the time to consider this request. The contributions of volunteers like yourself are what makes this type of research possible.

Regards,

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*** PLEASE NOTE:
Participation in this study is voluntary. You may decline to answer any questions that you do not wish to answer and you can withdraw your participation at any time by not submitting your responses. There are no known or anticipated risks from participating and any information that you provide will be kept strictly confidential. All of the data will be summarized or abstractly referenced and therefore individual responses cannot be identified. Furthermore, the web site is programmed to only collect responses to the questions asked in the questionnaire. That is, the site will not collect any information that could potentially identify you.

APPENDIX 4

Survey Instrument

This appendix contains the survey instrument in its entirety.

ACCESSIBILITY AND RESIDENTIAL PROPERTY VALUES IN THE GREATER TORONTO AREA

By selecting the 'I Agree' button below you agree to give consent for the answers you provide to the forthcoming questions to be used in the research project "Accessibility and Residential Property Values in the Greater Toronto Area." This project has received clearance from the University of Waterloo's Office of Research Ethics (see: http://iris.uwaterloo.ca/ethics/) If at any time you feel your answers may put you at risk you may exit the survey tool by selecting the 'Quit' button. Once you have completed the survey please select the 'Done' button to submit. Thank you for your participation.

I Agree
I Do Not Agree

1. What is your profession? Please select only 1 response.

Real Estate Broker
Real Estate Agent
Property Developer
Property Appraiser
Urban Planner
Other (please specify) ___________________________

2. How many years have you been practicing in your field? (as selected in question 1)

____

3. In what geographic areas do you typically work? Please list a maximum of 3 areas.

City 1 _____________________________
Neighbourhood 1 (if applicable) ____________________________

City 2 _____________________________
Neighbourhood 2 (if applicable) ____________________________

City 3 _____________________________
Neighbourhood 3 (if applicable) ____________________________

4. Based on your professional experience do buyers of single-detached homes consider the property's access to non-work locations or amenities (e.g. recreation facilities, shopping, etc.)?

Yes
No

5. Based upon your professional experience please rank the following amenities on a scale of 1 (not important) to 5 (very important). Please feel free to add any amenity that does not appear in the list.

	Not Important				Very Important
Regional Shopping (Large shopping mall)					
Lower Order Transit Stop (Bus stop)					
Higher Order Transit Stop (GO or subway station)					
Parks/Open Space (Playing fields, neighbourhood park)					
Bicycle or Walking Trails					
Freeway (400 series highway)					
Place of Worship					
Elementary Schools					
High Schools					
Colleges or Universities					
Other (name below)					

Other: ______________________________

6. In your experience, what travel time to the most important amenities (as listed in question 5), makes them "close"? (e.g. a 10 minute drive to the mall)

	Travel Time	Mode
Regional Shopping (Large shopping mall)		
Lower Order Transit Stop (Bus stop)		
Higher Order Transit Stop (GO or subway station)		
Parks/Open Space (Playing fields, neighbourhood park)		
Bicycle or Walking Trails		
Freeway (400 series highway)		
Place of Worship		
Elementary Schools		
High Schools		
Colleges or Universities		
Other (as listed above)		

7. In your experience are buyers of single detached homes willing to pay a premium for a property with good access to the amenities listed in questions 5 and 6?

Yes
No

8. If you answered yes to question 7, how much on average would that premium be? For example consider 2 similar properties that differ only in terms of their proximity to amenities (access), would their price differ by $5,000 $10,000, more? What is your estimate of the average premium (in dollars)?

____

9. What single amenity do your clients typically wish to reside "close" to?

____

Thank you for taking the time to complete this questionnaire. The results will help us further our understanding of the importance of access to amenities in the purchasing process of residential property. If you would like further information regarding this project or the results of this survey please contact:

Cameron J. Smith
MA Planning (Candidate)
University of Waterloo
c24smith@uwaterloo.ca
519-755-8848

Please select the **DONE** button to submit this questionnaire.

Thank you.

APPENDIX 5

Cross Tabulation between Mode Choice and Travel Times (All Amenities)

The tables in this appendix contain the results of the cross tabulation between mode choice and travel times for all of the amenities that the survey respondents were asked to consider. This test was completed in SPSS.

Table 5A

Local Shopping		Travel Time					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	20	18	7	2	0	**47**
	Public Transit	0	0	1	0	0	**1**
	Bicycle	0	0	0	0	0	**0**
	Walking	1	3	5	0	0	**9**
Total		**21**	**21**	**13**	**2**	**0**	**57**

Table 5B

Regional Shopping		Travel Time					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	0	12	27	15	1	**55**
	Public Transit	0	0	0	2	0	**2**
	Bicycle	0	0	0	0	0	**0**
	Walking	0	0	0	0	0	**0**
Total		**0**	**12**	**27**	**17**	**1**	**57**

Table 5C

Low Order Transit		Travel Time					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	0	1	0	0	0	**1**
	Public Transit	2	3	0	0	1	**6**
	Bicycle	0	0	0	0	0	**0**
	Walking	34	13	2	1	0	**50**
Total		**36**	**17**	**2**	**1**	**1**	**57**

Table 5D

High Order Transit		**Travel Time**					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	0	19	18	7	1	**45**
	Public Transit	1	3	2	1	0	**7**
	Bicycle	0	0	0	0	0	**0**
	Walking	2	0	1	1	1	**5**
Total		**3**	**22**	**21**	**9**	**2**	**57**

Table 5E

Parks		**Travel Time**					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	1	3	1	0	0	**5**
	Public Transit	0	0	0	0	0	**0**
	Bicycle	1	1	1	0	0	**3**
	Walking	23	16	8	2	0	**49**
Total		**25**	**20**	**10**	**2**	**0**	**57**

Table 5F

Walking and Bicycle Trails		**Travel Time**					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	0	0	5	3	0	**8**
	Public Transit	0	0	0	0	0	**0**
	Bicycle	4	9	4	2	1	**20**
	Walking	12	9	6	2	0	**29**
Total		**16**	**18**	**15**	**7**	**1**	**57**

Table 5G

Freeway		Travel Time					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	2	26	23	3	3	**57**
	Public Transit	0	0	0	0	0	**0**
	Bicycle	0	0	0	0	0	**0**
	Walking	0	0	0	0	0	**0**
Total		**2**	**26**	**23**	**3**	**3**	**57**

Table 5H

Place of Worship		Travel Time					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	3	20	17	9	4	**53**
	Public Transit	0	0	0	0	0	**0**
	Bicycle	0	0	0	0	0	**0**
	Walking	0	2	2	0	0	**4**
Total		**3**	**22**	**19**	**9**	**4**	**57**

Table 5I

Elementary Schools		Travel Time					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	1	3	2	0	0	**6**
	Public Transit	0	1	0	0	0	**1**
	Bicycle	0	0	0	0	0	**0**
	Walking	14	23	9	4	0	**50**
Total		**15**	**27**	**11**	**4**	**0**	**57**

Table 5J

High Schools		**Travel Time**					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	1	1	3	1	1	**7**
	Public Transit	0	0	2	0	0	**2**
	Bicycle	0	0	3	4	0	**7**
	Walking	4	5	18	14	0	**41**
Total		**5**	**6**	**26**	**19**	**1**	**57**

Table 5K

University or College		**Travel Time**					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	0	0	6	10	14	**30**
	Public Transit	0	0	0	0	0	**0**
	Bicycle	0	0	1	0	0	**1**
	Walking	0	0	6	5	15	**26**
Total		**0**	**0**	**13**	**15**	**29**	**57**

APPENDIX 6

Chi Square Test Results

The tables in this appendix contain the results of the cross tabulation between mode choice and travel times for all of the amenities (combined) survey respondents were asked to consider, completed in SPSS.

Table 6A

All Amenities		**Travel Time**					
		Under 5 min	*5-9 min*	*10-14 min*	*15-20 min*	*Over 20 min*	Total
Travel Mode	*Automobile*	28	103	109	50	24	**314**
	Public Transit	3	7	12	12	16	**50**
	Bicycle	5	10	8	2	1	**26**
	Walking	90	71	51	24	1	**237**
Total		**126**	**191**	**180**	**88**	**42**	**627**

Table 6B

Chi-Square Tests	*Value*	*df*	*Asymp. Sig. (2-sided)*
Pearson Chi-Square	1.465E2	12	.000
Likelihood Ratio	133.995	12	.000
N of Valid Cases	**627**		

a. 3 cells (15.0%) have expected count less than 5. The minimum expected count is 1.74.