A Framework for Measuring Accessibility as a Metric of Quality of Life in Polycentric Cities

by

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ABSTRACT

The concept of quality of life has been an ongoing subject of discussion—both theoretical and empirical—in the field of urban development. There is strong subjective (opinion-based) evidence suggesting the existence of a link between an individual's perception of their living environment and their quality of life. However, setting up an experimental framework for measuring quality of life is challenging since this type of investigation requires researchers to first answer the question of what factors could impact an individual's perception of quality of life, in particular those related to neighbourhood development and available services. It is important to note that, if appropriately chosen, factors affecting quality of life as it pertains to land development and land use can serve as metrics for urban developers and municipal planners in building attractive neighbourhoods. This, in turn, will lead to thriving cities/municipalities, and will promote sustainable social and economic development.

This thesis presents a methodology to measure the effect of neighbourhood development on the quality of urban life of residents, and assesses the impact of combining objective (quantitative) and subjective (qualitative) variables to evaluate quality of life in select neighbourhoods of a polycentric city (i.e., a city with more than one hub, or sub-centre, of services and activity). A case study that involves four neighbourhoods in Edmonton, Alberta, Canada, is used to demonstrate the effectiveness of the proposed methodology and illustrate its essential features.

PREFACE

This thesis is an original work by Mojgan Zarekani. No part of this thesis has been previously published.

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CHAPTER 1: INTRODUCTION

1.1 Introduction and Research Motivation

Quality of life is a broad term that incorporates economic wellbeing, as indicated by such metrics as income, as well as psychological wellbeing, which encompasses such aspects as positive relationships and personal growth (Sajeva et al. 2012). Yuan et al. (1999) have defined quality of life as a complex and multi-faceted concept that encompasses multiple variables from different theoretical perspectives. In recent years, quality of urban life has attracted attention among researchers, urban developers, and municipal planners since the investigation of quality of life in urban areas provides information regarding the improvement of living and working conditions and the promotion of sustainable social development.

From a research perspective, optimizing the quality of urban life is necessary due to the fact that the urban population has increased about ten-fold during the 20^{th} century (Satterthwaite 2007). This city growth has a direct effect on the living and working conditions of residents, resulting in a change in the quality of urban life. In fact, the phenomenon of rapid urbanization is one of several challenges faced in the 21^{st} century for land developers and municipal planners (International Federation of Surveyors 2010). This urban expansion, without an appropriate strategy, can lead to neighbourhood development which, though it meets housing needs, fails to uphold quality of life by meeting the needs of individuals, such as accessibility of amenities, public parks, and recreation facilities. Incidentally, a high quality of urban life is essential for 21st century cities due to the fact that more than 81% of Canadians are now living in the nation's major metropolitan areas (City of Edmonton 2010).

Generally speaking, regardless of one's occupation or income, city residents all hope to live in neighbourhoods which offer the highest possible quality of life in terms of safety and accessibility, which often is influenced by how long it takes to travel from home to where a given service is available. It is important to understand that neighbourhood safety is considered as the most important factor that affects neighbourhood selection and plays an important role within residents' lives including their daily physical activity (in the form of walking). In fact, neighbourhood walkability is today one of the criteria used by young people in choosing where to live (Beldon and Stewart 2011; Lachman and Brett 2011).

This research is based on the investigation of the quality of life in different neighbourhoods through the evaluation of objective and subjective variables in the context of a polycentric city, with Edmonton, Canada, as the case study. This research evaluates quality of life with regard to two main sociological factors: demographics, such as age, type of housing, and safety, and accessibility to services (either by walking or driving). Accessibility in this research refers to access to education, health facilities, transportation, recreation, green space, and general services (e.g., convenience stores, grocery stores/supermarkets, malls, and post offices). This investigation into demographics and accessibility for the purpose of the quantification of quality of life includes both objective and subjective variables. It is thereby possible to quantify quality of life within different neighbourhoods for the purpose of comparison, and, potentially, to examine "What if scenarios" at the design stage of future neighbourhoods.

In this research, two main variables are used for evaluating quality of life: objective and subjective variables. Objective variables are those drawn from official quantitative government statistics such as census data. This data can be referred to as an objective metric. Data pertaining to subjective variables, which can be referred to as subjective metrics, are gathered through the use of surveys or interviews. Rarely have subjective and objective variables of quality of life been integrated in a single, individual study. According to Schneider (1975), the singular use of objective variables for measuring the level of wellbeing does not entirely indicate quality of life, because objective variables assess the urban environment, and subjective variables evaluate an individual's experience.

Although the concept of combining objective and subjective variables is not new, there is no general consensus about the procedure for integrating all the various objective and subjective variables (Schneider 1975).This potential integration of objective and subjective variables can aid land developers and municipal planners to mitigate the issues faced with rapid urbanization. Therefore, it is critical for land developers and municipal planners to have a thorough understanding of the metrics used to quantify quality of life.

1.2 Research Objectives

The framework presented in this thesis is designed to evaluate quality of life in a polycentric city in order to optimize the quality of urban life and influence future development in a manner that will improve living and working conditions of residents. Both objective and subjective variables are used for evaluating the quality of life in select neighbourhoods in the case city—Edmonton, Canada. Expert opinion and neighbourhood development criteria (i.e., recommended neighbourhood structure and the LEED-ND guideline) are the standards used for comparing these variables. Within the context of these considerations, this research is built upon the following **hypothesis**:

"Determining the effect of neighbourhood planning and design on the quality of life of residents (from the perspective of accessibility) allows land developers and municipal planners to create user-centric analytical land development models to improve quality of life"

In order to verify this hypothesis, this research includes the following objectives:

- Define the objective and subjective variables related to land development and land use affecting quality of life for the two targeted categories of the comparison: (I) Demographics and (II) Accessibility.
- Develop an analytical model for quality of life which includes a systematic mathematical framework.
- Verify the proposed mathematical framework using a case study.

1.3 Thesis Organization

This thesis is organized into five chapters. Chapter 1 introduces the research. Chapter 2 (Literature Review) reviews the evolution and history of the neighbourhood concept since 1929, examines the theory of monocentric and polycentric models, and explores quality of life metrics used in the context of urban planning.

Chapter 3 (Methodology) discusses the methodology used in this research, including a summary of the historical expansion of the city of Edmonton in terms of both area and population, as well as a brief description of the select neighbourhoods used in the case study to assess quality of life. Based on objective and subjective variables, the select neighbourhoods are compared both with one another and with a hypothetical ideal neighbourhood, based on expert opinion and neighbourhood development criteria.

Chapter 4 (Results) provides the statistical results and data analysis for the quantification and assessment of quality of life through objective and subjective variables. The measured metrics of the select neighbourhood are then compared with the ideal neighbourhood based on neighbourhood development criteria and expert opinion in order to provide recommendations for future development.

Chapter 5 (Conclusion) provides a summary of the conclusions of this study, highlights the main contributions of the research, outlines the research limitations, and provides recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

2.1. Background and Literature Review

Prior to the formalization of the neighbourhood concept, a neighbourhood was simply defined as a place of living; no emphasis was placed on the social or economic wellbeing of individuals. For instance, Wang (1965) defined a neighbourhood as a place where people live together for an unspecified amount of time. By amalgamating social and economic wellbeing into the definition of a neighbourhood, urban developers and municipal planners began to account for the physical and psychological needs of individuals when designing communities.

In 1929, the neighbourhood was defined by Clarence Perry, considered the pioneer of the concept of neighbourhood in its classical form (Wang 1965), for the Regional Plan Association of New York, RPAA. He discussed the value of high quality urban design in developing the character of a neighbourhood, and created a typical neighbourhood plan. In this plan, a neighbourhood is surrounded by major roads and community facilities within 5-minute walking distances, with an elementary school and local community centre situated in the centre of the community. In addition, as illustrated in Figure 2-1, parks and playgrounds are distributed throughout the neighbourhood and are connected by pedestrian paths in order to provide easy walking access for all residents in the neighbourhood (Larice and Macdonald 2012).

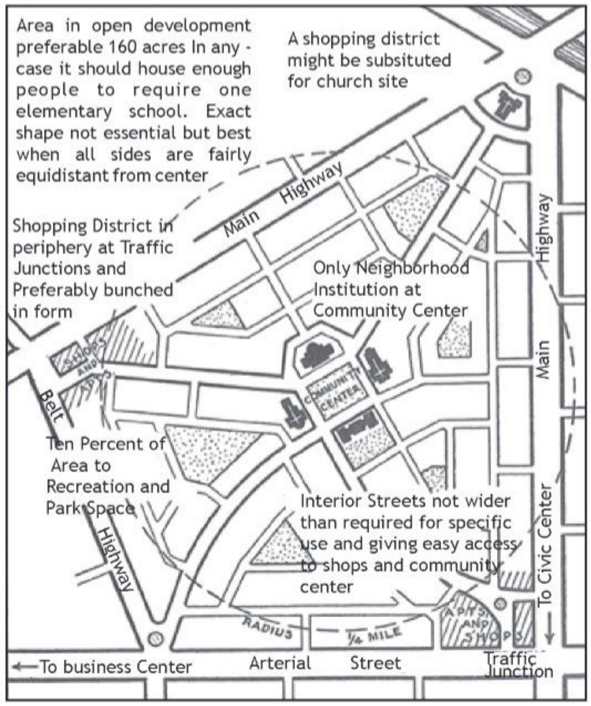


Figure 2-1: Perry's Neighbourhood Unit (Perry 1929)

Based on his definition, a neighbourhood is a component of a town, and is developed based on the standard of maintaining a 5-minute maximum walking distance to the local school (Perry 1929). Perry’s neighbourhood concept focuses upon the ability of all residents to walk to facilities, such as community centres, schools, and playgrounds (Walters and Brown 2004). Perry developed his neighbourhood unit theory with six aspects in mind: (I) Size, (II) Boundaries (formed by arterial roadways), (III) Open spaces, (IV) Institution sites, (V) Local shops and (VI) Internal street system (Perry 1939).

He believed that through proper planning of the aforementioned aspects, that a neighbourhood could be made more attractive and better promote wellness of residents. Furthermore, to Perry, the primary foundation of a neighbourhood is the local community centre, which provides face-to-face social interaction (Wang 1965).

2.1.1 Neighbourhood Design

Perry’s concept was carried forward with several modifications. For instance, Engelhardt proposed a general neighbourhood unit with different levels of school facilities. Based on his concept, the maximum walking distance to an elementary school should be 10 minutes or a radius of ½ mile from the centre of the neighbourhood, and a 5-minute maximum walking distance to playground and nursery school for all residents in the neighbourhood should be ensured (Meenakshi 2011) (see Figure 2-2).

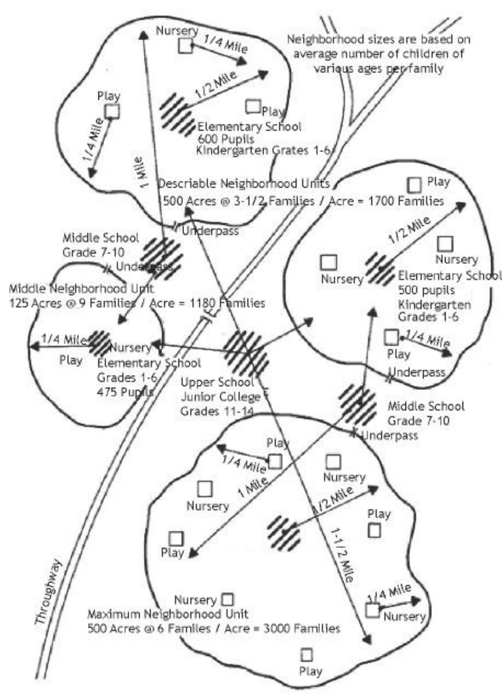


Figure 2-2: Engelhardt's Conception of the Neighbourhood (Meenakshi 2011)

As described by Meenakshi (2011), in 1942 Stein expanded the definition of neighbourhood by connecting neighbourhoods together in order to create towns, and placed an elementary school at the centre of each neighbourhood unit within ¼ mile radius of all residents. In his concept, a small shopping centre should be located close to the school at the centre of the neighbourhood, and residential streets should be structured as cul-de-sacs in order to reduce traffic. Stein's definition is illustrated in the figure below, where three neighbourhood units are connected together. These neighbourhoods are served by one senior high school and one or two local shopping centres. The radius for accessing these facilities by walking is 1 mile, or 20 minutes (Meenakshi 2011) (see Figure 2-3).

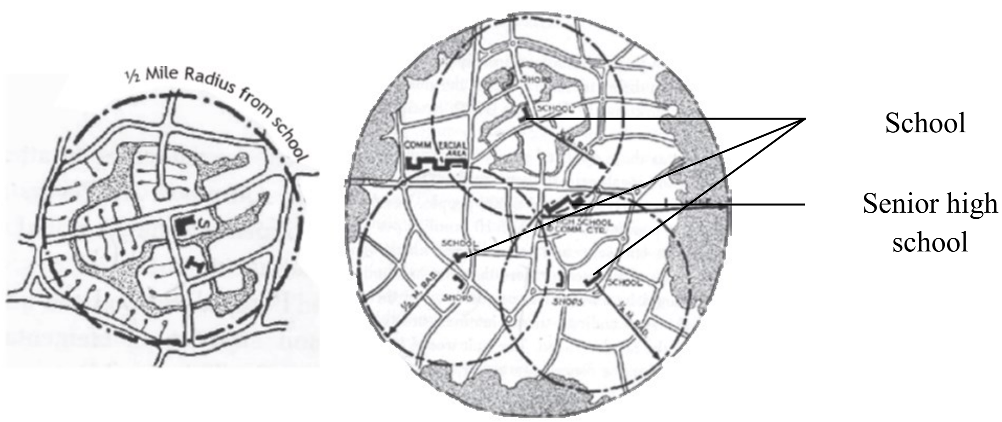


Figure 2-3: Stein's 1942 Diagram of Neighbourhoods (Meenakshi 2011)

In 1997, Duany and Plater-Zybrek developed an updated neighbourhood concept for the American Urban Condition, a small, government organization (Walters and Brown 2004). They proposed a similar neighbourhood size that was bounded by arterial roads and defined by a five-minute walking distance from the centre. In this contemporary concept, extensive commercial development is located along the arterial roads, and community institutions and some local shops are located beside a centrally-located public park. In their concept, schools are located along the outer boundaries of neighbourhood to create much larger space for activities and parking (Walters and Brown 2004).

2.2.2 Impact of Neighbourhood Design

In the past decade Perry’s principles have been endorsed by many planning and design organizations, having been implemented in neighbourhoods such as Radburn, New Jersey; Greenbelt, Maryland; and Greenhills, Ohio. As noted by Meenakshi, many cities embrace this updated neighbourhood concept as an ideal model; however, the model itself has also drawn criticisms from some scholars (see Figure 2-4).

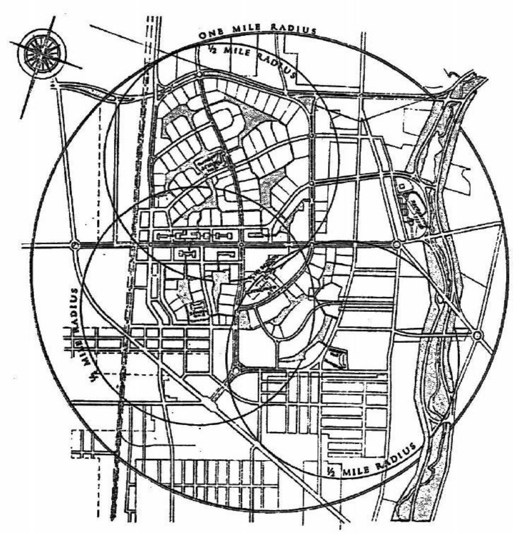


Figure 2-4: Neighbourhood in Radburn, New Jersey (Liu 1978)

One of the criticisms of the current neighbourhood concept, which has been influenced by Perry and others but has been modified over time, arises from the large size of neighbourhoods. For instance, when a neighbourhood is too large in area and the school is located at the centre of the neighbourhood, then walking accessibility is challenging for those residents who live far from the centre (Meenakshi 2011).

2.2.3 LEED Neighbourhood Development

Despite criticisms, the neighbourhood concept has been adopted by numerous organizations. The United States Green Building Council (USGBC), the Congress for the New Urbanism (CNU), and the Natural Resources Defense Council (NRDC) have collaborated to develop a rating system for neighbourhood planning and development, Leadership in Energy and Environmental Design for Neighbourhood Development (LEED-ND). This is based on the principles of smart growth (a paradigm in urban planning), new urbanism, and green infrastructure building, with the goal of establishing a national leadership standard for assessing and rewarding green and sustainable neighbourhood development (Congress for the New Urbanism et al. 2011). LEED-ND is a guideline and voluntary leadership standard for development that aids decision makers and developers by providing an incentive for better design and construction of new residential, commercial, and mixed-use developments, and which includes the following categories: (I) Smart Location and Linkage, (II) Neighbourhood Pattern and Design, and (III) Green Infrastructure and Building (Congress for the New Urbanism et al. 2011).

This guideline defines a neighbourhood as a place where people feel welcome, and which encourages social activity among residents. It includes a recognizable community centre that can provide outdoor public space for social and recreational activity. According to the LEED-ND guideline a neighbourhood is considered as a planning unit of a town or city, and its size is based on the comfortable walking distance from the centre of neighbourhood to its outer boundary (Congress for the New Urbanism et al. 2011). It is critical to note that while in Perry's conceptualization of neighbourhoods a ¼ mile distance from the centre (approximately a 5-minute walk) was used to define spatial parameters, the LEED guideline utilizes a 20-minute walk, which corresponds to approximately 1 mile (Congress for the New Urbanism et al. 2011).

In addition, even though Perry's model design suggests that a school, which can also have civic uses, is to be located at the centre of the neighbourhood, surrounded by parks, residential areas and retailers, this model does not address many features which are mentioned in the LEED-ND guideline, such as access to multimodal transportation options and choice in type of housing.

According to the LEED-ND guideline, most people are willing to walk approximately a ¼ mile to complete daily tasks, and for distances beyond a ¼ mile, individuals will prefer bicycling or driving (Congress for the New Urbanism et al. 2011). Additional research shows that people are often comfortable walking a ½ mile to reach a transit centres or shopping centre (Dittmar and Ohland 2004). The following list outlines the maximum walking distances to various amenities proposed by LEED-ND as prerequisites for designing a walkable and sustainable neighbourhood.

Transit:

- Transit stops are recommended to be located within a ¼ mile of the centre of the neighbourhood, which corresponds to a 5-minute walking distance.
- Transit centres are recommended to be locates within a ½ mile of the centre of the neighbourhood, which corresponds to a 10-minute walking distances.

Parks and recreation:

- Public spaces such as public squares, parks, and plazas are suggested to be located within a ¼ mile walking distance from the centre of the neighbourhood.
- Recreational / sports facilities are suggested to be located within a ½ mile walking distance from the centre of the neighbourhood, which corresponds to a 10-minute walking distance.

Schools or educational facilities:

- Elementary schools and junior high schools are proposed to be placed within a ½ mile distance, corresponding to a 10-minute walking distance.
- Senior high schools are proposed to be located within a 1-mile distance, which is equivalent to a 20-minute walking distance (Welch et al. 2011).

Figure 2-5 illustrates the findings of another study regarding maximum walking distances in Edmonton and six other municipalities in North America with regards to transit. According to (Ryus 2003), the maximum distance residents are comfortable walking in order to access transit varies among different cities and among different demographic groups. Nevertheless, as illustrated in the graph, a large proportion (75-80% on average) will not walk more than 400 m to reach a bus stop. This distance is about 800 m for rail transit, which indicates a 10-minute walking distance (Ryus 2003).

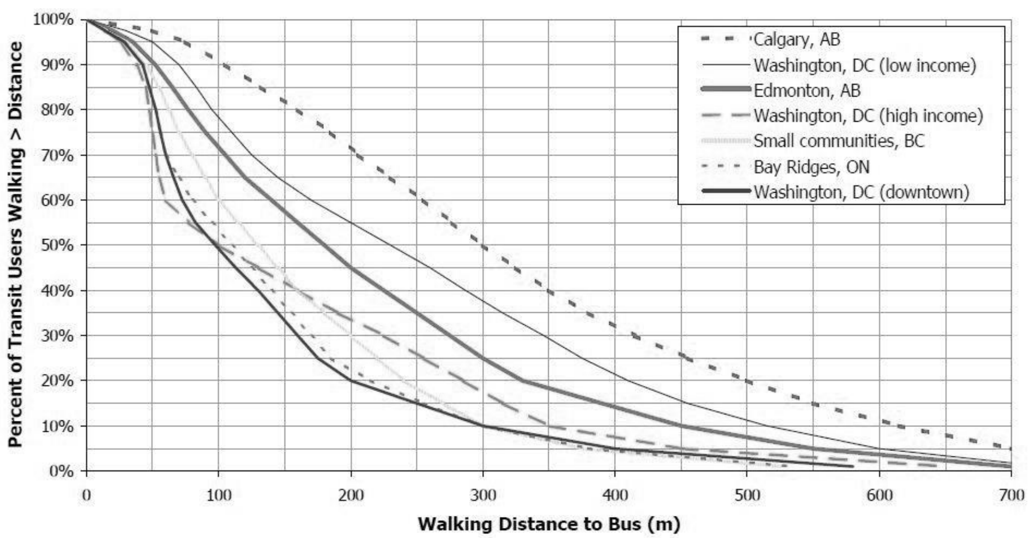


Figure 2-5: Comparison of Walking Distance to Bus Stop (Ryus 2003)

According to the above mentioned criteria, the following facilities and amenities in a neighbourhood require a ¼ mile to 1-mile maximum walking distance in order to satisfy the prerequisites of the LEED-ND guideline and recommendations in the literature:

- Daycare
- Pre-school
- Elementary school
- Junior high school
- Senior high school
- Public park / green space
- Recreation centre / sports facility
- Local community centre
- Transit centre / light rail station

It should be noted, in addition to the above considerations, the planning of a neighbourhood may be influenced by a number of factors such as natural topography, geographical features, and land ownership constraints. Therefore, it should be not be assumed that different neighbourhoods can be planned to be identical in every respect (City of Edmonton 2013). As an example, in a neighbourhood with a large size, promoting social and neighbourly behaviour becomes impractical (Meenakshi 2011).

Moreover, in order to improve the living standard of residents, a neighbourhood should be designed with characteristics such as:

- an outdoor activity centre in the heart of the community;
- a local community centre as the heart of the community and face-to-face social interaction;
- safe streets (i.e., low crime rate);

- easy accessibility to public parks/green space, schools, sports facilities, and transit centres; and
- definable boundaries.

2.2 Monocentric versus Polycentric Cities

According to researchers in the area of urban spatial structure, a city can be structured into one of two designs: monocentric or polycentric (Bertaud 2003; Ding 2007; Ingram 1997). The monocentric model was conceptualized by Alonso (1964), as the early phase in the evolution of urban development. In this model, cities have a unique centre, known as the Central Business District (CBD). As noted by Bertaud (2003), this model centralizes itself around one business district, making commercial establishments easy to find.

During the latter half of the 20th century, employment began to disperse within metropolitan cities from the CBD to the outskirts of the district, where employment opportunities were more plentiful (Meyer and Gómez-Ibáñez 1981). This diversification of the location of employment opportunities, also known as the decentralization of urban employment, became one of the reasons for the change in structure of many metropolitan areas in the monocentric model. Due to the expansion of daily trips over a wider range outside the original CBD, the structure of many cities changed from a monocentric spatial structure to a polycentric city model (Bertaud 2003).

2.2.1 Theory of Polycentric Model

As noted by Anas et al. (1998), the polycentric model tends to cluster several activity centres throughout urban cities, contrasting from the monocentric model which has one centralized activity district. New city development and planning tends to adhere to the polycentric model due its ability to coincide with 21st century demands, such as the decentralization of urban employment and the increased need for mobility and transportation over larger distances (Davoudi 2003).

Since the 1980s, researchers in the field of urban and regional planning have developed a number of theories and models for the concept of a polycentric city (Yue et al. 2010). In 1981, the concept of the multi-centered metropolis was proposed by Muller as a polycentric model. According to his concept, in the multi-centered metropolis some suburbs have changed to independent areas, or "sub-centres", emerging outside of the central core of the city. These sub-centres not only contain a portion of the population of the metropolis, but also accommodate a portion of major economic and social activities, employment, and educational and entertainment services. Hall (1999), alternatively, believed that polycentrism had mostly to do with the location of businesses. Bertaud (2003) traced the evolution from monocentric to polycentric, noting that, due to growing city size, the monocentric spatial structure of large metropolises tends to change into a polycentric spatial structure, and as result, the CBD diminishes in authority due to the generated cluster centres (Bertaud 2003).

2.2.2 Pattern of Urban Employment and Polycentric Cities

According to several researchers in the area of urban spatial structure, the relationship between the urban form and commuting patterns is indisputable, because the decentralization of urban employment has affected people's commuting patterns, trip duration, and distance (Ingram 1997).

In reality, in both monocentric and polycentric city residents commute from all over of the city, but the commuting patterns differ. In a monocentric city, employment is concentrated in the centre of city, and the suburbs have a high-flow computing pattern into the centre of the city. In a polycentric city, there are two types of commuting designs. In the first design, the city has several sub-centres of employment with similar scale, and each sub-centre generates trips, almost at random. In a second design, there are also several sub-centres, but some are more concentrated than others; therefore, the commuting flow in this model would be mix of both random and radial (Bertaud 2003, 2009; Ding 2007; Ingram 1997).

The study of how the decentralization of urban employment in polycentric metropolitan areas can affect the pattern of commuting within cities has caused a surge of interest in the area of urban planning in recent decades, leading to empirical studies of cities in North America, Europe, Oceania and Asia (Aguilera 2005; Alpkokin et al. 2008; Cervero and Landis 1991; Giuliano and Small 1993; Gordon and Richardson 1997; Gordon and Wong 1985; Guth et al. 2009; Naess and Sandberg 1996; Parolin 2005; Veneri 2010; Zhao et al. 2011). As noted by Lin et al. (2012), the decentralization of urban employment and polycentric development not only could improve commuting patterns by making travel time and distance shorter, but also could improve the management and strategic planning of cities to ensure that urban structure optimizes the aggregate travel behaviour of urban commuters. Other studies have demonstrated that the decentralization of urban employment and polycentric development in metropolitan areas can reduce commute time between home and workplace (Giuliano 1991; Giuliano and Small 1993). Giuliano used commute data from 1980s Los Angeles, a polycentric urban region, in order to support the idea that workers with jobs in Los Angeles's downtown have a longer commuting distance between home and workplace than workers with workplaces outside the downtown core (Giuliano 1991).

In addition, there are similar case studies in Europe and Asian cities that have shown the tendency of polycentric cities to be more travel-efficient in comparison to monocentric cities. According to a study in Germany based on 2007 data with regards to commuter flow, researchers found that the average distance of commute in the polycentric cities of Stuttgart (13.5 km) and Frankfurt (16.4 km) is lower than that found in the monocentric cities of Munich (19.0 km) and Hamburg (20.8 km) (Guth et al. 2009). Studies in China have drawn similar conclusions. In these studies researchers found that planned sub-centres and regional policies are beneficial to workers' commuting patterns since they can effectively reduce commute time and distance. According to a household survey conducted in Beijing in 2006, researchers found that decentralization of employment centres and polycentric development in Beijing would be beneficial to the relationship between jobs and housing (Zhao et al. 2011). Several researchers believe that employment dispersion would reduce urban congestion by providing the opportunity for residents and workers to change their housing or workplace location (Gordon et al. 1989, 1991). As noted by Veneri (2010) the formation of sub centres in a polycentric city would increase the probability of finding a job close to one's home. This, in turn, decreases commuting distance and travel time.

However, this contrasts with results of some empirical studies suggesting that employment dispersion and polycentric development can in fact increase commuting distance and travel time (Aguilera 2005; Cervero and Landis 1991; Cervero and Wu 1998; Levinson and Kumar 1994; Naess and Sandberg 1996). According to a study by the Metropolitan Washington Council of Governments examining how urban dispersion influences commuting patterns in U.S. metropolitan areas, researchers found that metropolitan Washington D.C.'s average work-to-home travel distance had increased from 10.6 km in 1968 to 13.2 km in 1988, with the city becoming increasingly polycentric during this time (Levinson and Kumar 1994). Hence, some scholars have argued that the phenomenon of scattering industry and services to the suburbs can increase commuting distance (Levinson and Kumar 1994). Other researchers have supported the idea that a monocentric urban structure does not increase commute time. Jun (2000) conducted a study in Seoul, Korea comparing the before-and after-effect of new development in the Seoul metropolitan area in order to identify differences in commuting patterns. According to the results of this study, the average commuting distances of workers living in new suburbs (or sub-centres) became significantly longer, increasing from 12% to 70% from 1990 to 1996. Giuliano (1991) and Dubin (1991) noted that suburbs or polycentric sub-centres could provide sufficient housing choices and jobs and as a result of shorter commuting distances for workers when socio-economic characteristics taken into account.

Other factors, such as mixed commercial and residential land use, residential densities, and transportation services can also influence commuting times (Cervero 1996). For instance, as a result of city growth and population dispersion, individuals situated in low-density suburban areas travel longer distances than people who live in high-density areas. As well, people living in high-density areas have greater access to public transportation services (Buchanan et al. 2006). However, a well-managed and planned polycentric urban structure, where urban growth is directed towards dispersed activity centres, can potentially address this challenge and reduce commuting trip distance and time in both developed and developing cities (Buliung and Kanaroglou 2006; Dieleman et al. 2002; Zhao et al. 2011).

2.3 Quality of Life

Quality of life is a general concept that can be defined and measured in various ways, as there does not exist a general consensus on its definition (Lötscher 1985; Mostafa 2012). Hancock (2000) defines quality of life as the degree to which an individual feels happiness and wellbeing. Swain (2002) describes quality of life as a feeling of wellbeing, or satisfaction resulting from factors in an individual’s life, such as income level, safety, and accessibility of amenities. Mostafa (2012) expresses quality of life as a global outcome that is highly valued by all individuals and a popular expression that defines an overall sense of wellbeing when applied to an individual or community.

In recent years, the study of quality of life has garnered considerable attention among researchers from a range of academic disciplines, as well as policy makers, planners, and others in the environmental design field (Marans 2011). According to Sajeva et al. (2012), quality of urban life research can be performed with respect to the international community, the national community, and the local community. For example, annual rankings for quality of urban life are produced by Mercer for use by multinational organization, government agencies and municipalities. These rankings are determined through the evaluation of 39 elements in 10 categories, such as schools, transportation, and recreation, for 460 cities across the world (Mercer 2012). As another example, Berger et al. (2003) evaluated the quality of urban life in 953 cities across Russia in order to identify the important elements that affect people's life in cities. In 2007 and 2010, surveys evaluating the quality of urban life were conducted in New Zealand for measuring residents' perceptions of their lifestyles ("Quality of Life Survey 2010 Eight Cities Report" 2012).

There are two variables used to evaluate quality of life: (1) objective variables, which use quantitative criteria including crime rate and income levels; and (2) subjective variables, which use qualitative metrics of accessibility of services, availability of activities, and sense of belonging (McCrea et al. 2005, 2011).

Objective variables can be measured using secondary data, which is available through official government statistics. One advantage of objective variables is that they are based on quantitative data, entailing that they can easily be used to compare various aspects of life through the use of a computer data analysis tools (Yuan et al. 1999). Using objective variables, various aspects of quality of life, such as crime rate and type of housing, can be compared between different social groups at various territorial levels (countries, regions, municipalities, cities, neighbourhoods) (Sajeva et al. 2012). Besides the advantages of the objective variables for evaluating quality of life, their main shortcoming is that official government data alone is not sufficient to evaluate an individual’s perception/experience of their own life (Veenhoven 2002). Quality of life studies have noted that residents can be subjectively happy or satisfied in an objectively poor situation, or conversely feel unhappy in an objectively good situation (Schneider 1975).

In order to accurately represent the qualitative aspect of an individual’s life, then, one must use subjective variables. With regard to subjective variables, data is collected at the individual level using social surveys (Sajeva et al. 2012). As noted by Rapley (2003), in the United States, to evaluate quality of life, subjective variables are utilized more frequently than objective variables. In 2000, Seik conducted a study evaluating the quality of life in Singapore and referenced 18 specific factors, including social life, family life, education, and wealth. Santos et al. (2007) conducted a study in Porto, Portugal, and identified 21 metrics, including culture, education, health, and services. Oktay et al. (2012) examined the role of neighbourhood attributes: attractiveness as a place to live, availability of activities, and accessibility to services, using the neighbourhood of Walled in Famagusta, Cyprus, as a case study.

Subjective variables measure an individual's satisfaction or overall well-being with the various aspects of urban living such as income and safety (Veenhoven 2007). As Saveja et al. (2012) noted, the most widely used metric for evaluating subjective quality of life is an individual's sense of satisfaction with life. In 1976, Campbell et al. argued that measuring an individual's life satisfaction subjectively is a more definable and plausible way to evaluate quality of life (cited in Marans and Stimson 2011). In subjective studies of quality of life, survey or interview participants are typically asked to respond to a question such as: "How satisfied are you with overall neighbourhood quality?" (Rustemli and Oktay 2010) or "Do you think of this neighbourhood as your home or just a place to live"? (Oktay et al. 2012). Although subjective variables may result in valuable measurements of quality of life, collecting subjective data is more time-consuming and costly compared to collecting objective data (Lotfi and Solaimani 2009).

According to Angur and Widery (2004), both objective and subjective metrics are needed for evaluating quality of urban life, as they complement one another. Although subjective variables are beneficial for evaluating quality of life, they cannot reflect the importance of different aspects of quality of urban life (McCrea et al. 2005). On the other hand, measuring objective variables alone is not sufficient for evaluating quality of life since it cannot capture individual perceptions, but when using subjective and objective variables together in order to evaluate individuals' lives, a cohesive conclusion can be achieved (Schneider 1975; Veenhoven 1990). Lotfi and Solaimani (2009) similarly noted that the combination of objective and subjective variables is the most appropriate way to measure quality of life, as the results are more realistic. However, the interconnection between these two types of variables has been either unclear or nonexistent in existing research methodologies (Lora and Powell 2011).

In this research, both objective and subjective variables are used for evaluating the quality of urban life, using Edmonton, Alberta, Canada, as a case study. The objective variables are collected from official government databases and Google Maps; subjective variables consist of expert opinion collected through surveys about preferred distances to neighbourhood facilities and amenities. The survey participants are urban planners and developers. The two main categories of metrics are demographics (objective variables) and accessibility (objective and subjective variables). Demographics metrics consist of overall neighbourhood metrics, transportation metrics, and safety metrics. Accessibility metrics consist of walking distances and driving distances.

2.3.1. Demographics

2.3.1.1 Neighbourhood Metrics

The neighbourhood metric is based on characteristics related to age range and type of housing, evaluation of which gives a better understanding of overall quality of life and, by extension, the needs of residents of a given neighbourhood (City of Edmonton 2013). In this regard, Toronto Public Health has argued that "healthy" cities respond to the diverse needs of residents through a diversity of housing types and convenient public transit (Perrotta et al. 2012). A review of studies in the areas of transportation and urban planning shows that people today, especially young adults, prefer to live in walkable neighbourhoods with a range of available modes of transportation (Davis and Dutzik 2012). This shift is due to changes in values, income level, growing environmental awareness, concerns about wellness, and a desire to avoid a time-consuming commute in congested traffic. Other studies reveal that offering a range of different types of housing in a neighbourhood not only could provide greater access and shorter travel times to workplaces, schools, and services, but also could provide more affordable housing (Perrotta et al. 2012).

Owen et al. (2007) have argued that ease of pedestrian access to destinations is correlated with having a range of different transportation options and, particularly, with neighbourhood walkability. They have also articulated that proximity and connectivity are the two key elements of a walkable neighbourhood, where proximity is associated with mixed land use and leads to shorter distances between origins and destinations such as amenities and workplaces, and connectivity is variation of routes to destination (Owen et al. 2007). According to Wang (1965), a neighbourhood should contain different types of people with different family sizes and incomes, and therefore requires various types of housing at varying degrees of affordability (e.g., single-detached homes, row housing), since a neighbourhood with a uniform housing style or size will become characterized by a particular social class (Wang 1965). Perrotta et al. (2012) have reported that approximately half of Toronto residents surveyed indicated a strong preference to live in a mixed housing neighbourhood with walkable access to shops and services.

2.3.1.1.1 Age Metrics

According to many studies in the area of urban planning, age is correlated to preferences with regard to mode of transportation. In a study by the University of Michigan Transportation Research Institute (2011), researchers found that the percentage of young adults without a driver's license or car has increased in recent years in developed countries such as Sweden, Norway, the United Kingdom, the United States, Canada (Sivak and Schoettle 2011). As noted by the United States Federal Highway Administration, young adults have values which differ from older generations and which influence driving and transportation trends. In particular, researchers have found that the attitude of young people toward sustainability has changed over time (van Heeswijk 2009). Recent studies in this area show that adults ages 18-34 years, and those over 65, prefer walking to driving (Davis and Dutzik 2012). As shown in the study by Davis and Dutzik, looking at the number of miles driven annually on America's roads, it can be concluded that from 1945 (i.e., post-World War II) to 2004, the number of miles driven increased steadily, and then, after 2004, the number began to plateau. For example, in 2011 the average American was driving 6% fewer miles per year compared to in 2004 (Davis and Dutzik 2012) (see Figure 2-6).

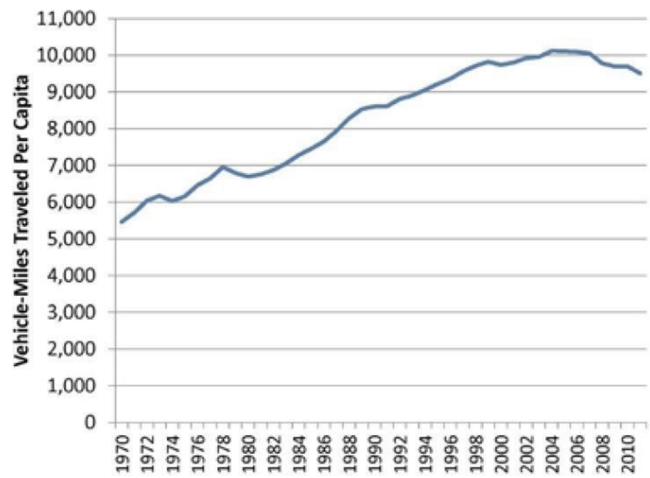


Figure 2-6: Vehicle-Miles Travelled Per Capita in the United States (Davis and Dutzik 2012)

Based on other U.S. studies carried out between 2001 and 2009, the average annual number of vehicle miles travelled by young adults is found to have dropped by 23%, suggesting that young adults prefer walking to driving (Federal Highway Administration 2011b). Also according to this research, in 2009 young adults ages 16-34 walked to destinations 16% more frequently than the same structure age, 16-34 years, in 2001 (Federal Highway Administration 2011b). A number of contributing factors to this trend over the past decade have been identified, such as higher gas prices, new licensing laws, improvements in technology that support alternative transportation, and a tendency to sustainability (Davis and Dutzik 2012). Indeed, according to a study by Steele (2010), many young Americans ages 18-34 prefer to live in places where they can easily walk, bike, or use public transportation instead of driving. The decrease in the amount of driving among young people is not limited to America, as it is generally observed in other developed countries such as Germany (Steele 2010) (see Figure 2-7).

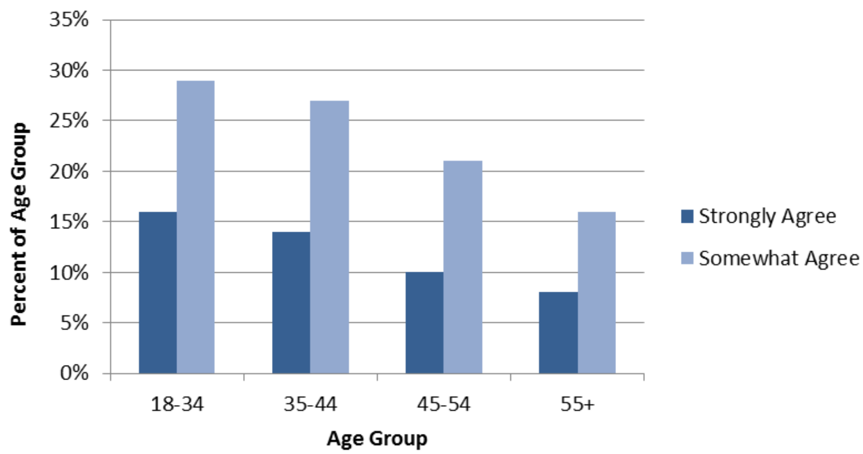


Figure 2-7: Commitment to a Conscious Effort to Reduce Driving—Survey Results by Age Cohort (Steele 2010)

Davis and Dutzik (2012) have simiarly asserted that most American young adults prefer to live in an area in which they can easily walk or take public transportation. According to a recent study conducted by the National Association for Realtors, young aldults have a stronger preference to live in areas which are close to shopping centres, restaurants, schools, and public transportation in comparison to other age groups (Beldon and Stewart 2011) (see Figure 2-8). A study carried out in Toronto, Canada indicated that the majority of Toronto residents prefer to live in a neighbourhood with easy walking access to a variety of services such as grocery stores and public transit (Perrotta et al. 2012).

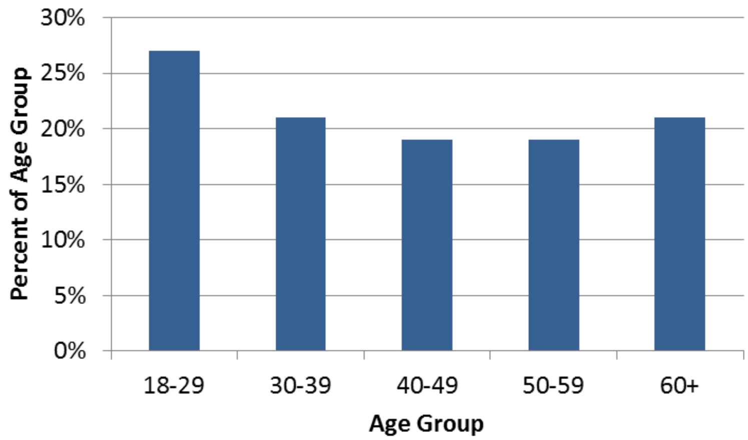


Figure 2-8: Young People between Ages 18-29—Importance of having amenities within Walking Distance (Beldon and Stewart 2011)

It has also been found that young people consciously reduce their driving due to an awareness that it causes air pollution and has a negative impact on the environment. For instance, according to a recent survey by KRC Research and Zipcar, 16% of young people between ages 18 to 34 said they had made a strong effort to replace driving with another transportation mode, whereas this proportion is approximately 6% for those age 55+ (Davis and Dutzik 2012) (see Figure 2-9).

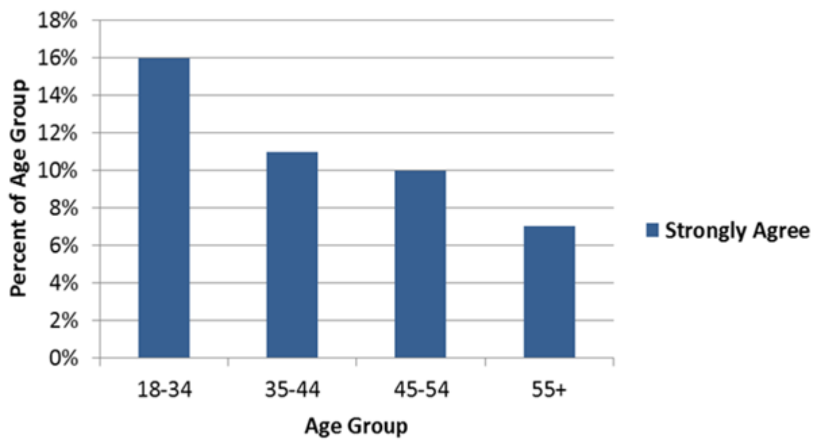


Figure 2-9: Interest in Reducing Driving Among Different Age Cohorts (Davis and Dutzik 2012)

According to the Federal Highway Administration the number of people ages 20-34 years old without driver's license has increased from 10.4% to 15.7% and for ages 19 and younger this proportion has increased from 52% to 56%, mainly due to increasing fuel prices and lower income making it difficult for that segment of the population to own automobiles (Federal Highway Administration 2011a) (see Figure 2-10).

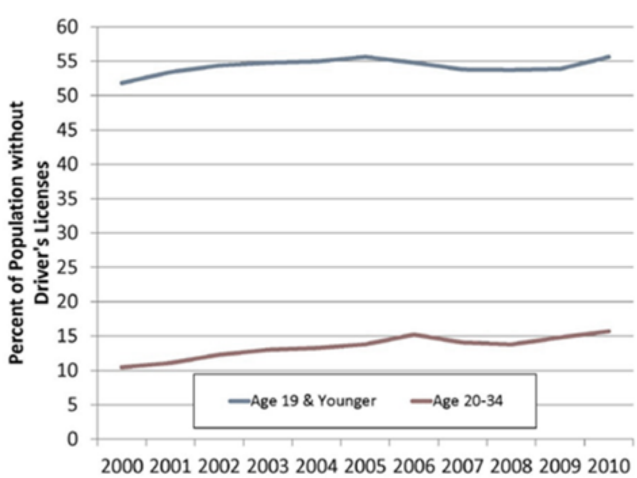


Figure 2-10: Share of Young People without Driver's License (Federal Highway Administration 2011a)

Meanwhile, in the U.S. from 2001 to 2009 the number of passengers between ages 16-34 years using public transportation has increased by approximately 40% (Bureau of Transportation Statistics 2012) (see Figure 2-11).

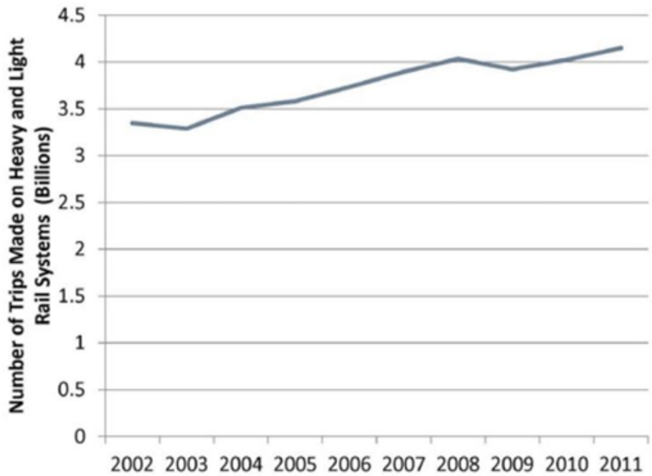


Figure 2-11: Light Rail Ridership in the United States (Bureau of Transportation Statistics 2012)

The above results illustrate the correlation between age and preferred mode of transportation, indicating an increasing preference, especially among young people, to walk as an alternative to driving. According in the present study walking accessibility is chosen as a factor by which to evaluate neighbourhood quality of life.

2.3.1.1.2 Type of Housing Metrics

According to the principles of smart growth (a paradigm in urban planning) and the LEED-ND guideline one aspect of a high quality of urban life is a wide range of housing options, which gives residents the opportunity to choose housing size and type based on their income level and preferences (International City/County

Management Association and U.S Environmental Protection Agency 2009; Welch et al. 2011).

Currently, developers, environmental organizations, and smart growth groups are working together to meet community needs and goals. One such goal is to provide affordable housing in communities for people of all income levels, so that they are not required to travel long home-to-work distances, which would lower their satisfaction level (International City/County Management Association and U.S Environmental Protection Agency 2009).

Results of a recent survey in Toronto, Canada, show that most residents are willing to live in a mixed housing neighbourhood with walkable access to facilities and amenities. According to this study, providing a wide range of housing types in a neighbourhood could increase walkability and social opportunities for all residents (Perrotta et al. 2012). By providing a wide range of housing types and prices within any given neighbourhood, residents have the option of choosing a housing option within a reasonable proximity to their place of work which accommodates their income and preferences. This can, in turn, lower household greenhouse gas emissions due to the available options to walk or utilize public transportation instead of driving.

In other words, offering different types and prices of housing not only provides a shorter distance between home and workplace, but also can support a diverse population including students, families, seniors, young singles, and couples (Welch et al. 2011).

2.3.1.2 Transportation Metrics

In this study, transportation is another objective metric used for evaluating quality of life. This metric is important since providing more choices of transportation is a key aim in urban planning and is associated with decreased household transportation costs, reduced greenhouse emissions, improved air quality, and improved public health (Mandeville 2014). Since residents utilize transportation services for their daily travel to work, school, shopping, and dining, availability of transportation services plays an important role in sustainable transportation and quality of life. Thus, the availability of transportation services must be taken into account by urban developers, municipal planners, and researchers in order to provide sustainable transportation to meet the needs of both present and future generations.

In this regard, Larsen et al. (2003) have argued that active transportation not only could reduce traffic congestion but also could improve personal health and quality of life. According to Perrotta et al. (2012), active public transit is a neighbourhood feature that not only is dependent on the neighbourhood design, but also can affect the level of physical activity of residents and thereby quality of life. The results of a survey conducted in Toronto, Canada, show that people in walkable neighbourhoods take transit more often and do more walking than those who are living in less walkable neighbourhoods (Perrotta et al. 2012). Besser and Dannenberg (2005) have asserted that almost one third of transit users walk at least 30 minutes per day to and from transit stops. As noted by Rustemli and Oktay (2010) in a study that surveyed 398 residents from 8 neighbourhoods in

Famagusta, Cyprus, satisfaction with public transportation was found to be associated with high quality of life. In this study, which explored quality of urban life, 49% of the residents indicated a preference to live in a community which has convenient public transportation services. 38% of respondents indicated a preference to live in a residential community with good driving access to services, amenities, and workplaces (Rustemli and Oktay 2010).

As mentioned, transportation infrastructure and urban design complement and support one another. Designing neighbourhoods or communities with easy access to public transportation can reduce the need for automobile travel. This approach to urban design allows people to live closer to their destinations, improves quality of urban life, encourages transit use, and minimizes a city's carbon and ecological footprint (City of Edmonton 2012b). According to a City of Edmonton report, Edmonton's average commute distance increased from 7.6 km to 7.8 between 1996 and 2006. This increasing vehicle dependency can be attributed to suburban development which is far from employment centres, light rail stations, and transit centres. In other words, a lack of access to public transportation and longer distances from home to work are associated with increased use of automobiles and longer daily commutes (City of Edmonton 2012b) (see Figure 2-12).

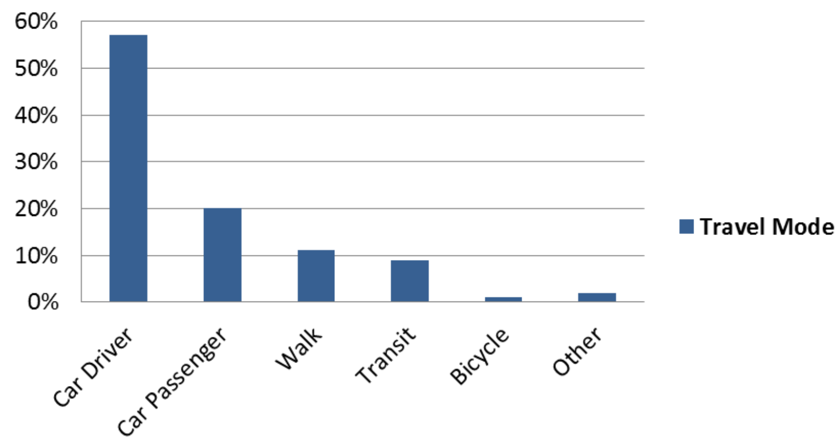


Figure 2-12: Modes of Transportation for Commuting in Edmonton (City of Edmonton 2012b)

It can thus be concluded that improved access to transportation choices in communities, such as increased number and broader distribution of light rail stations, transit centres, bus stops, and walkable streets, supports a healthy lifestyle, safety and security of transportation users, and generally increases quality of life.

2.3.1.3 Safety Metrics

Safety is another objective metric used for measuring quality of urban life. As noted by Sajeva et al. (2012) safety is associated with walkable streets, meaning walking in a neighbourhood without being concerned of becoming a victim of crime. Wasserman and Chua (1980) proposed that, logically, crime and walkability levels are linked to satisfaction with regards to personal safety. (Safety, within this study, is measured through crime rate.) By making communities safe and walkable, residents not only will able to become more engaged in the community, they will also feel a sense of belonging to the community (City of Edmonton 2013). However, finding a good and affordable home in a safe neighbourhood with easy access to facilities and services can be difficult, because homes in neighbourhoods with these characteristics are usually more expensive. People who cannot afford to live in these neighbourhoods often find themselves either moving far from their jobs or living in areas where they might not feel safe. Urban planners must thus seek to provide safe neighbourhoods with good public services for people with different incomes.

2.3.2 Accessibility

Increasing access to needed services and facilities is one aspect of quality of life in communities (International City/County Management Association and U.S Environmental Protection Agency (EPA) 2009). According to many studies related to quality of urban life, accessibility in a community improves the conditions for daily walking, public transit use, reduced automobile dependence, and social interaction for pedestrians (International City/County Management Association and U.S Environmnetal Protection Agency 2009; Perrotta et al. 2012). According to a City of Edmonton (2013) guideline for neighbourhood design, a neighbourhood should provide convenient access to all amenities for all residents, such as good connections between streets, multiple transportation choices for easy travel, and sidewalks for encouraging walkability (City of Edmonton 2013).

According to Kostritsky (1952), neighbourhoods should be designed based on a maximum walking distances from all points to the centre. According to the LEED-ND guideline, most people are willing to walk ¼ mile, which corresponds to approximately a 5-minute walking distance for daily errands; any distance beyond this radius will likely result in a resident using a car or a bicycle, unless the individual is walking to a transit centre or stop. In this case, the resident may be willing to walk as far as a ½ mile, or 10 minutes, to the transit centre or stop (Dittmar and Ohland 2004). As shown in Figure 2-13, Daniels & Mulley (2011) have shown that by increasing walking distance, an individual's willingness to walk will be reduced. In this study in order to explore level of accessibility in select neighbourhoods two types of access—walking and driving—are selected. The data is obtained from Google Maps and the City of Edmonton.

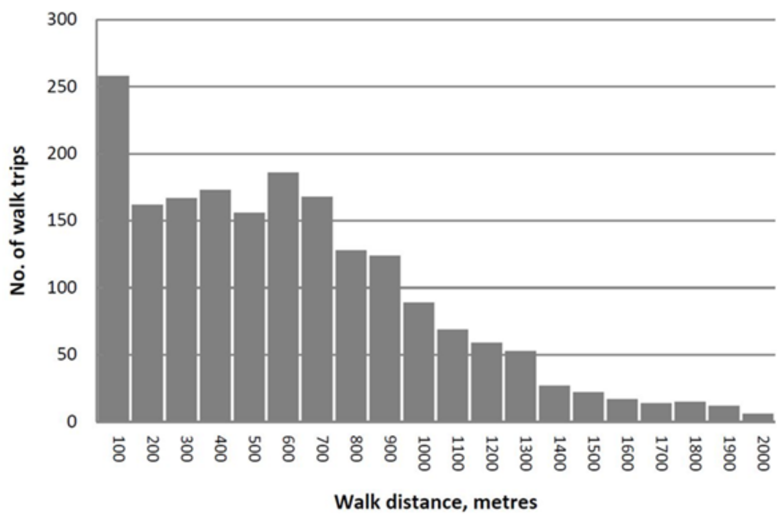


Figure 2-13: Frequency of Walking Distances from Home to Public Transit (Daniels and Mulley 2011)

2.3.2.1 Walking

Walkable neighbourhoods with relatively short walking distances are associated with a high level of resident satisfaction, which in turn influences quality of life. As noted by Elshater (2012), the theory of New Urbanism started as an effort to improve pedestrian movement in neighbourhoods. This theory influenced urban design, as well as aspects of urban planning, by advocating shorter walking distances (Elshater 2012). Other studies of walking as a mode of transportation have included those by Corpuz et al. 2005; Lee and Moudon 2006; Merom et al. 2010. According to these studies, there is a strong relationship between walking and public health (Daniels and Mulley 2011). Also, as noted by Larsen et al. (2003), increasing walkability in a community is correlated with reduced risks of obesity and other detrimental health conditions. According to a 2004 report, designing neighbourhoods based on reasonable walking distances not only upholds the health benefits of walking, but also enhances safety and a sense of community by encouraging more people to walk in the neighbourhood (Dover, Kohl & Partners Town Planning and Cheal, Cooper & Associates P.A. Architecture 2014).

2.3.2.2 Driving

As mentioned in previous sections, strong road network connections and diversity of housing types in a neighbourhood can result in easy access to all facilities and amenities with shorter trips for residents. Today people prefer to live in a neighbourhood with easy access to services, facilities, and workplace, thereby spending less time in traffic. In this regard, poor neighbourhood design and urban strategic planning are associated with greater travel times and fewer travel choices. Automobile travel is a mode of transportation that some urban residents choose for their daily travel, but several studies have shown that most residents who choose automobile travel do so because they are living in a neighbourhood with inconvenient public transit services and which is far from their workplace.

For example, a survey in Toronto, Canada, showed that those Toronto residents who are living in the least walkable neighbourhoods drive with their own vehicle four times as often and six times as far as those living in walkable and transit-oriented neighbourhoods (Perrotta et al. 2012). Another factor is the changing landscape of social interactions as a result of new technologies. For instance, one survey found that young adults in some cases prefer social networking over driving to spend time with friends in person (Davis and Dutzik 2012) (see Figure 2-14).

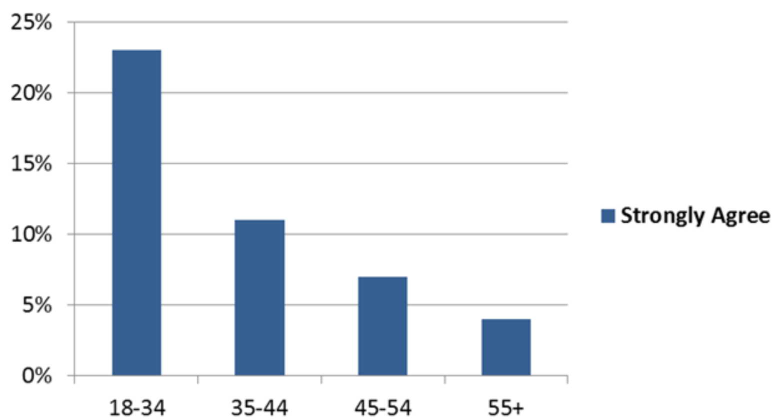


Figure 2-14: Interest in Social Networking in US (Davis and Dutzik 2012)

Based on the literature review and what has been argued above, a maximum distance that is desirable to walk is 5-10 minutes for accessing public transit, while for other services it ranges from 5-20 minutes. Based on the findings of the literature review, the following chapter describes the research methodology with respect to four neighbourhoods in the City of Edmonton, in consideration of Edmonton's population history. Four neighbourhoods with approximately the same population density are chosen: Riverdale, which is located in the central core; Lynnwood, in the mature core; Skyrattler, in the established core; and Ozerna, in the developed core.

CHAPTER 3: METHODOLOGY

3.1 Research Processes and Methodology

This chapter describes the research methodology used in this study for quantifying quality of urban life. As mentioned above, in order for quality of life to be quantified, one must first define the appropriate metrics; these metrics serve two objectives: (I) they are used as the basic building blocks (independent variables) for a quantitative model, and (II) they constitute an important source of information for planners, who can use these factors to improve the design of future neighbourhoods. In fact, adding a model of quality of life to the decision support toolbox used by land developers and municipal planners can help these professionals gain more insight into the relative importance of the factors that make neighbourhoods better living places.

Section one of this chapter provides an overview of the chapter and of the research methodology, which, as shown in Figure 3-1, comprises four components: (1) inputs, (2) criteria, (3) process, and (4) output. In section two, the history of the urban development of Edmonton, Canada, is reviewed. Section three describes the impacts of population growth in Edmonton. Section four outlines the four spatial strata in the City of Edmonton. Section five describes the location and history of the select neighbourhoods. The sixth section explains how these neighbourhoods are selected for this study. The defined metrics, their categories, and their calculations are explained in section seven. Finally, in section eight, the results of the select neighbourhoods are compared with one another based on the recommended weighted walking and driving distances to facilities and services.

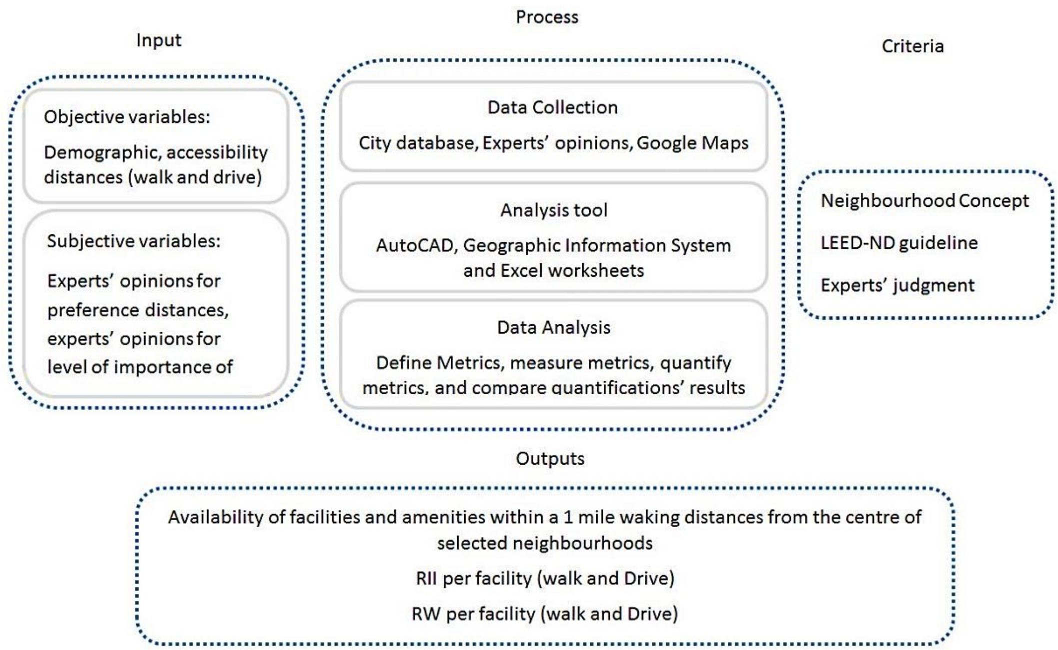


Figure 3-1: Research Methodology

3.2 Historical Growth Pattern of Edmonton

Edmonton, like many other cities in Canada, is a young, growing, and diverse city. This city was incorporated as a town in 1892, and then as a city in 1904. In recent decades, Edmonton has expanded considerably in both area and population. In 1901, Edmonton had a population of 2,626 and a total area of 23 km^2. According to the latest statistical data in 2012, Edmonton's population has increased to 817,498 over a total area of 684.4 km^2 (see Figure 3-3 for a graphic representation of this growth) (Stelfox et al. 2004).

As Stelfox et al. (2004) has noted Edmonton has absorbed several surrounding communities during its development: Jasper Place, Strathcona, Calder, and

Beverly, and added a series of annexations of surrounding rural lands, with the most recent occurring in 1982 (Stelfox et al. 2004). As can be observed in Figure 3-2, the most significant of these annexations occurred from 1980 to 1982, and amounted to approximately 396.5 km^2 of land added (City of Edmonton Department of Planning and Development 2012a) (see Appendix 4).

According to a report published by the City of Edmonton (2004) the average population growth of the city between the years 1954 and 2004 was approximately 2.6% per year, which generated continuous demand for housing (Stelfox et al. 2004). According to the Capital Region Population & Employment Projections Report, between 1976 and 1991 Edmonton had a steady population growth, and as a result of economic upturn in Alberta, Edmonton's population had reached 766,742 by 1996 (Alberta Capital Region 2009). As noted in another City of Edmonton report (2014a), there has been considerable population growth in Edmonton in recent decades, but the majority of this growth has been in developed and planned neighbourhoods and especially in the south side of the city (see Figure 3-4 and Figure 3-5). It is important to note that during this time of population increase, growth in mature and established areas has outpaced growth in the central core (City of Edmonton 2014a).

According to another report by the City of Edmonton (2014b), the last 40 years have also seen a shift with young adults accounting for the majority of the population gained. This report asserted that in comparison to other areas in the city, developing and planned neighbourhoods, which are more likely to accommodate young families with small children, have a higher average household size (2.87 in 2011), while the central core has the lowest average household size (1.62 in 2011). This report noted that the majority of people in mature and established neighbourhoods are over 50 years in age (City of Edmonton 2014b).

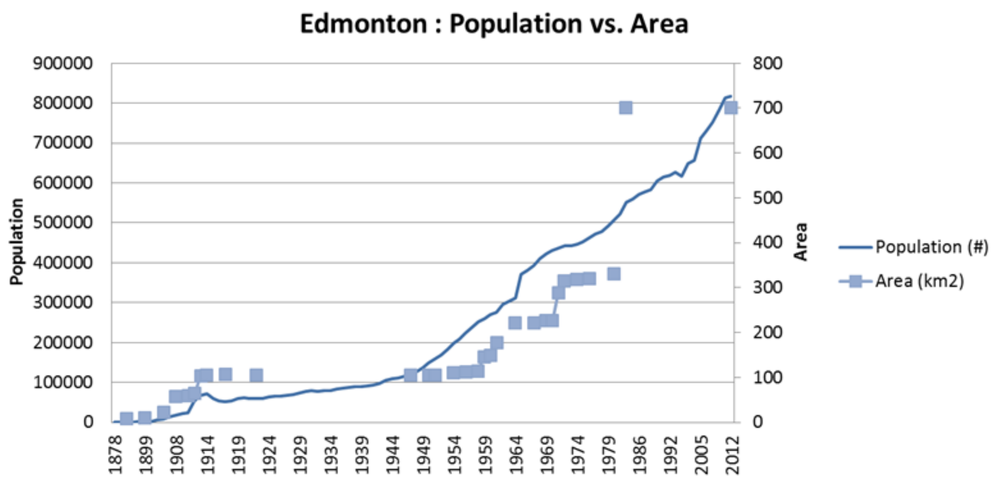


Figure 3-2: Edmonton Population Growth from 1878 to 2012 (City of Edmonton 2012a; City of Edmonton Department of Planning and Development 2012a)

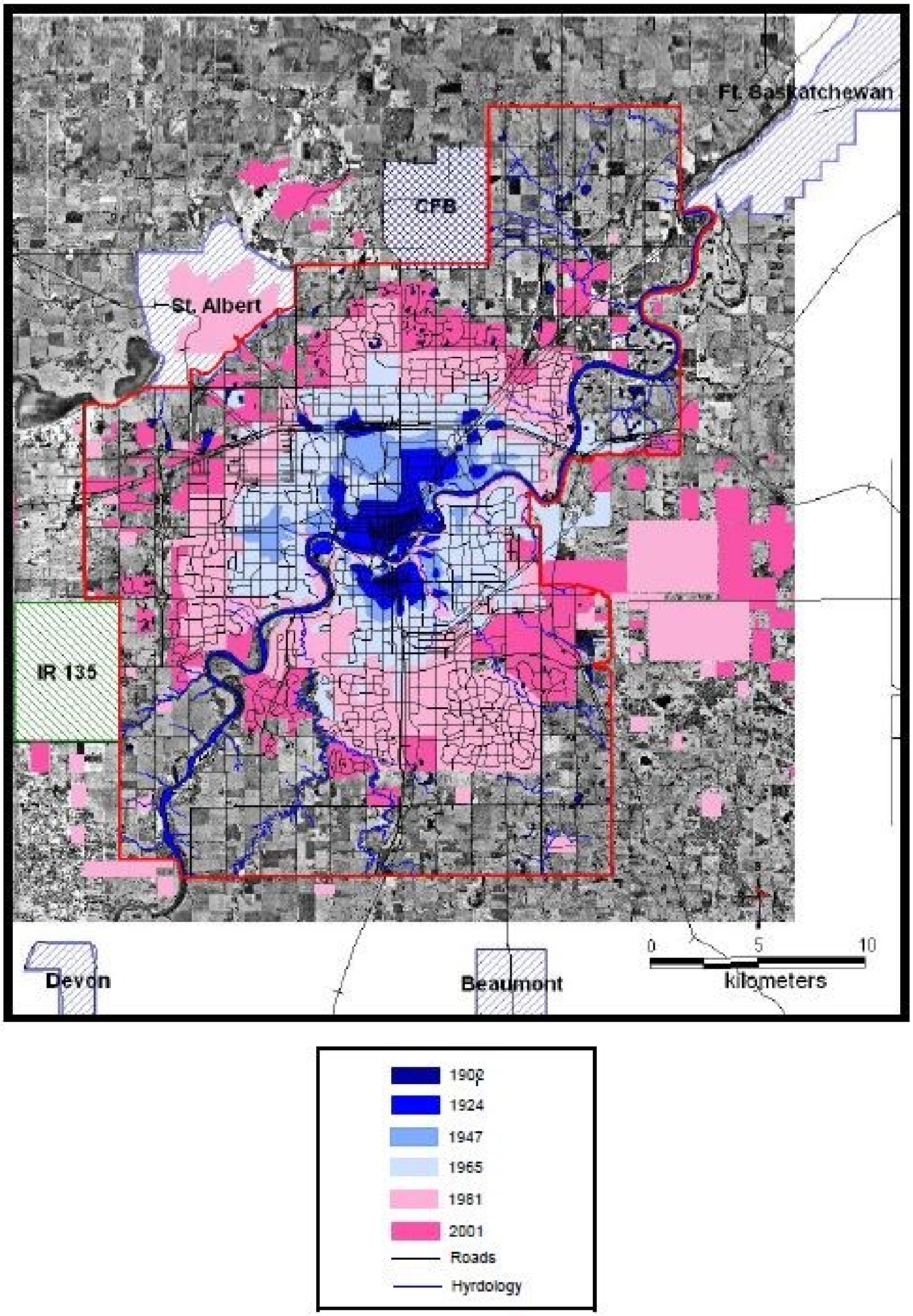


Figure 3-3: Historical Growth Pattern of the City of Edmonton from 1902 to 2004 (image superimposed on an aerial photo) (Stelfox et al. 2004)

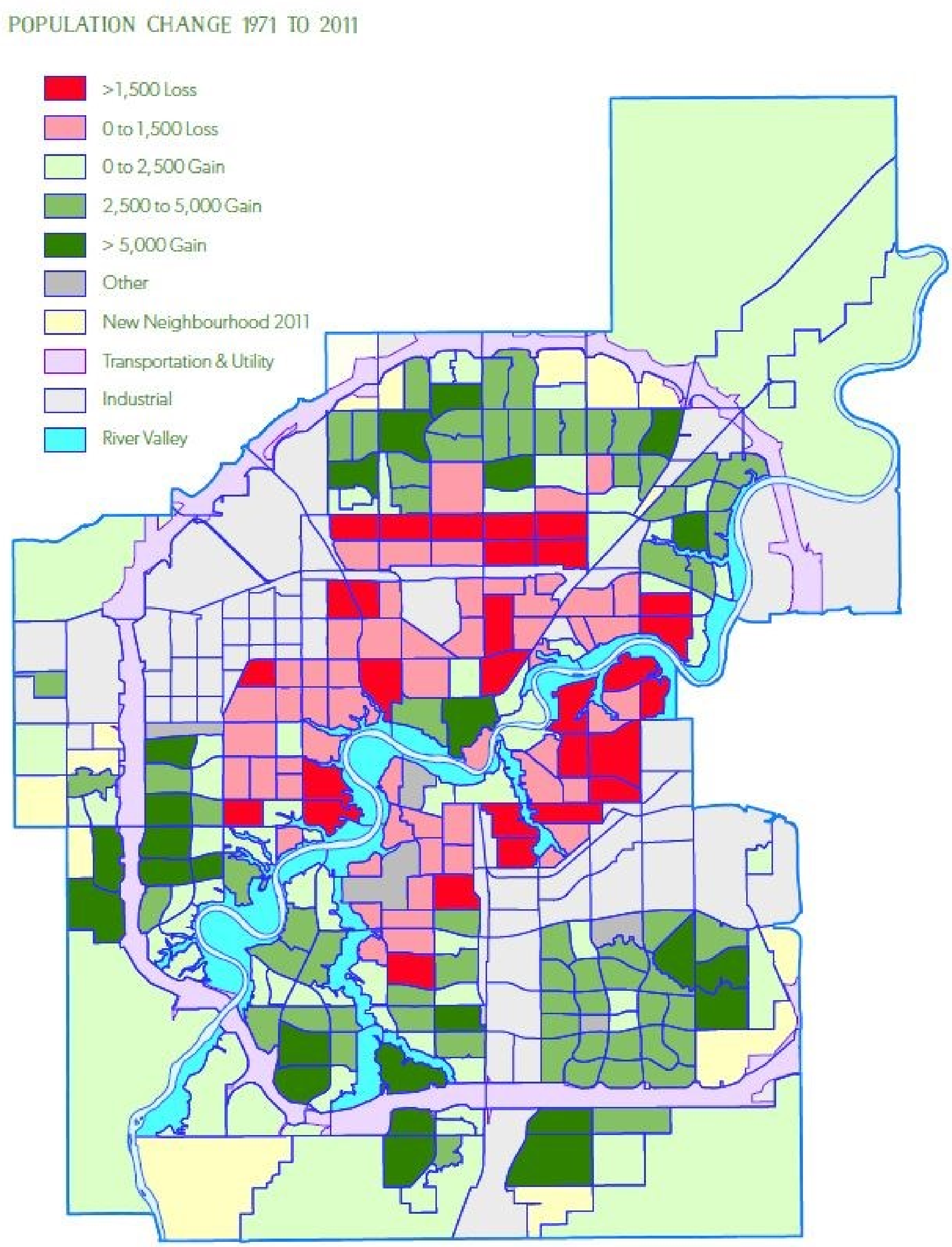


Figure 3-4: Population Growth by Residential Neighbourhood in the City of Edmonton from 1971 to 2011 (City of Edmonton 2014b)

Population Growth By Ward 2012 to 2014

Ward	2012	2014	Percent Gain
Ward 1	64,547	68,364	5.9%
Ward 2	68,558	72,534	5.8%
Ward 3	64,987	69,385	6.8%
Ward 4	70,849	75,578	6.7%
Ward 5	66,600	70,882	6.4%
Ward 6	72,281	76,136	5.3%
Ward 7	62,284	64,895	4.2%
Ward 8	66,999	68,857	2.8%
Ward 9	80,664	94,122	16.7%
Ward 10	60,475	61,796	2.2%
Ward 11	61,916	64,067	3.5%
Ward 12	77,338	91,310	18.1%
Total	817,498	877,926	7.4%

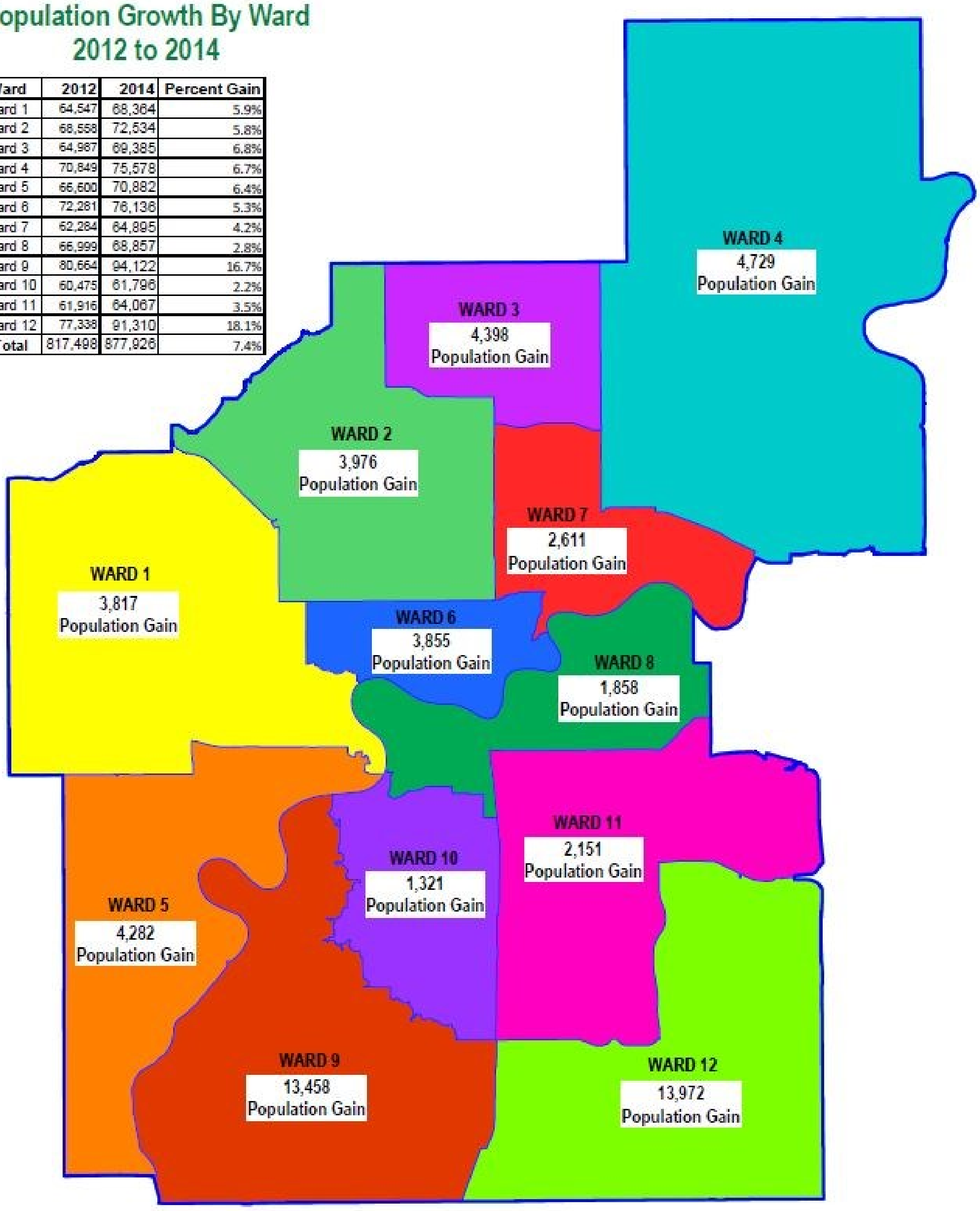


Figure 3-5: Population Growth by Ward in the City of Edmonton (City of Edmonton 2014a)

3.3 Impact of Population Growth

As shown in Figure 3-2 and Figure 3-3, growth was not only observed in the population but in the area as well. This kind of steady growth in population and area can influence quality of urban life in communities, especially when the city undergoes uncontrolled expansion, or when planners do not have a clear vision for future development. For instance, the increase of urban population requires the development of new housing, but the availability of services and amenities must also be considered when designing a neighbourhood (Stelfox et al. 2004). Thus, to uphold quality of urban life, a proper neighbourhood design is needed for new development or for redeveloping mature neighbourhoods. It is therefore essential to have a clear understanding of residents' needs and perceptions. Based on an understanding of residents' needs, urban developers and municipal planners can better determine what features are most essential and appropriate for neighbourhood design in order to meet everyday demands of residents.

3.4 City of Edmonton Neighbourhood Categories

As a point of reference for understanding neighbourhood design, in this research the historical area growth pattern of Edmonton from 1902 to 2004, and the existing urban footprint of Edmonton (2012) are investigated (Figure 3-6). As shown in the existing urban footprint map, Edmonton neighbourhoods can be categorized as follows:

- **Central core**: this consists of the downtown core and the 11 surrounding neighbourhoods: Boyle Street, McCauley, Central McDougal, Queen Mary Park, Oliver, University of Alberta, Garneau, Strathcona, Cloverdale, Riverdale, and Rossdale (Municipal Council of City of Edmonton 2010).

- **Mature neighbourhoods**: this includes those neighbourhoods that had been built out by 1970, and it is primarily residential (Municipal Council of City of Edmonton 2010).
- **Established neighbourhoods**: this is outside the Mature Neighbourhood Overlay and represents development between 1971 and 1995, offering convenient access to a wide range of services and amenities (Municipal Council of City of Edmonton 2010).
- **Planned or Developing neighbourhoods**: this includes the neighbourhoods with an approved Neighbourhood Structure Plan (NSP) and those ones that are within an approved Area Structure Plan or Servicing Concept Design Brief (City of Edmonton 2011).

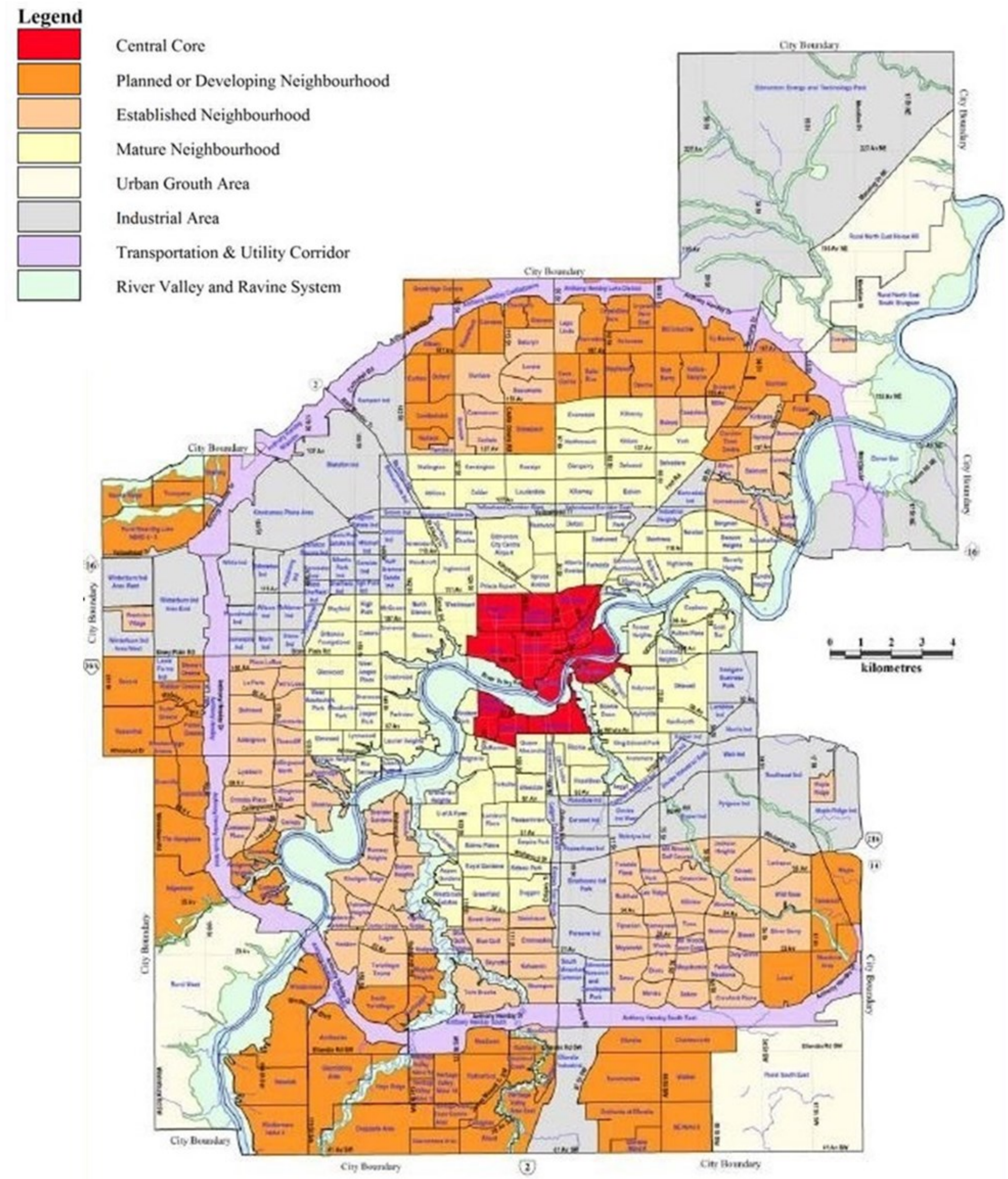


Figure 3-6: Existing Urban Footprint of Edmonton in 2012 (City of Edmonton Sustainable Development Department 2012)

According to the latest data from the City of Edmonton, Edmonton consists of 318 residential neighbourhoods distributed among the central core, mature neighbourhoods, established neighbourhoods, and developing and planned neighbourhoods. Given that the primary objective of this study is to quantify the quality of urban life in the context of polycentric cities, one neighbourhood from each category is selected for the purpose of comparison. The following neighbourhoods are selected due to their similar population densities (see Table 3-1):

Table 3-1: Area, Population, and Density of Select Neighbourhoods (City of Edmonton Department of Planning and Development 2013)

Neighbourhood	**Residential Area (ha)**	**Population in 2012**	**Density (Persons/ha)**
Riverdale, in the central core	30.96	1,980	64.00
Lynnwood, a mature neighbourhood	51.71	3,302	63.90
Skyrattler, an established neighbourhood	30.63	1,947	63.60
Ozerna, a developing neighbourhood	70.50	4,495	63.80

3. 5 Profiles of select neighbourhoods

Figure 3-7 shows the geographic locations of the four select neighbourhoods within the City of Edmonton. What follows is a brief description of each of the four neighbourhoods.

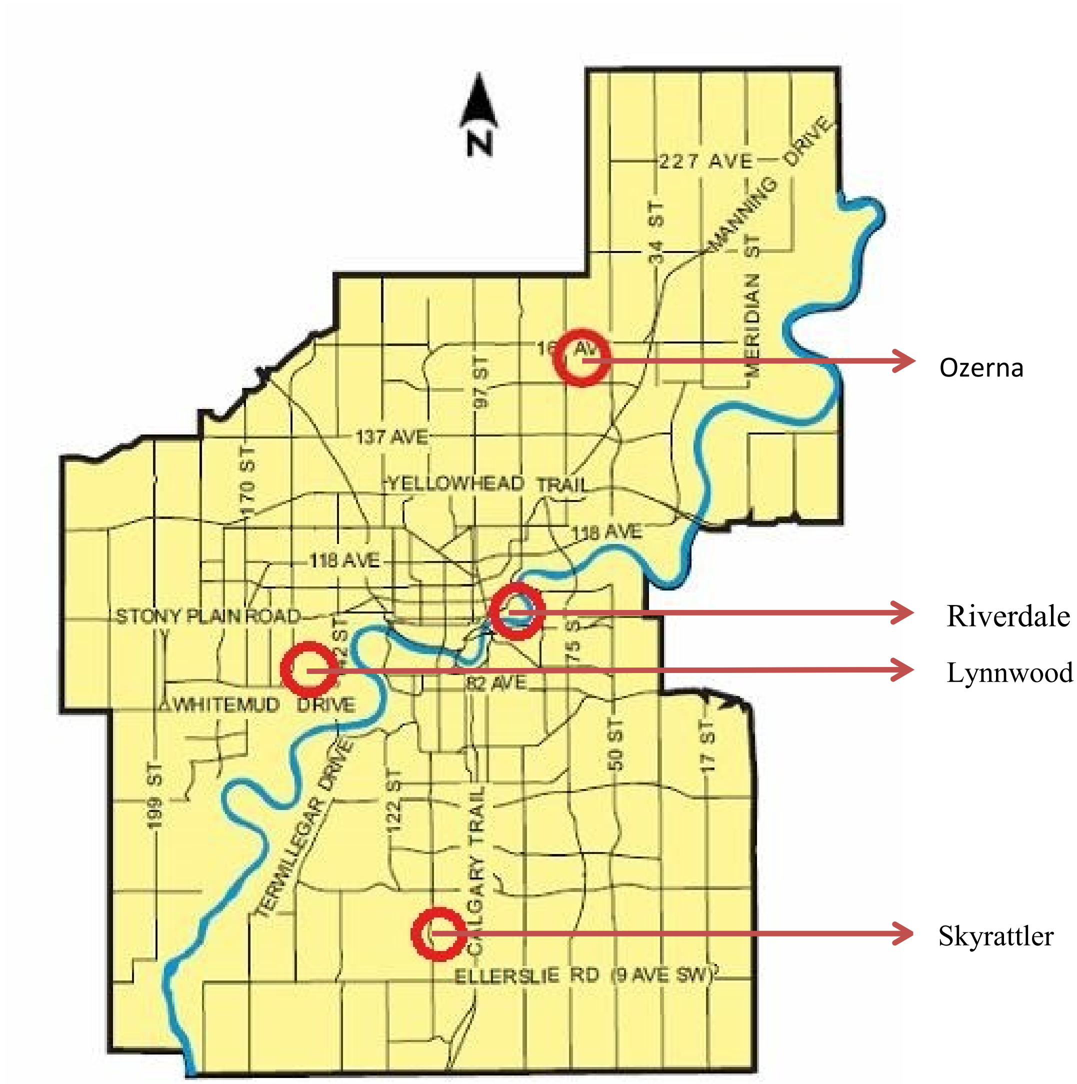


Figure 3-7: Locations of Select Neighbourhoods within Edmonton (City of Edmonton 2008a)

3.5.1 Riverdale

Riverdale neighbourhood is bounded on the south and east by the North Saskatchewan River and on the west and north by the river valley escarpment and Boyle Street neighbourhood (see Figure 3-6). This area was settled in the 1880s and quickly developed because of its accessibility to the river. The Dawson Mines across the river and near the Riverside Golf Course attracted a number of Riverdale residents in the time up to 1944. As of 2012, this neighbourhood has a population of 1,980, and the predominant type of housing was single-detached homes, accounting for about 36.4%. The second-most common housing type in this neighbourhood was the duplex/fourplex at 24.17% (City of Edmonton 2008a).

Figure 3-8: Riverdale Neighbourhood

3.5.2 Lynnwood

Lynnwood is a mature neighbourhood developed as part of the town of Jasper Place during the 1950s. Its period of development continued up to the early 1980s. Part of the North Saskatchewan River Valley system runs through the south central portion of the neighbourhood. This centrally located neighbourhood includes access to Whitemud Drive and to local commercial amenities and services along 149th Street. In 2012 the population of the neighbourhood was 3,293, and single-detached homes accounted for 55.97% of housing (City of Edmonton 2008b).

Figure 3-9: Lynnwood Neighbourhood

3.5.3 Skyrattler

Another neighbourhood chosen for this study is Skyrattler, which is located in an established part of Edmonton. This neighbourhood was annexed to the city in 1974, and most of its residential development occurred during the 1970s and 1980s. The housing mix of Skyrattler is dominated by row housing and low-rise apartments.

Figure 3-10: Skyrattler Neighbourhood

In this neighbourhood most row housing and apartments were built during the late 1970s; most single-detached homes were built during the 1980s. This neighbourhood has a small shopping plaza located at Saddleback Road and 23 Avenue, which is the only commercial property in this neighbourhood (City of Edmonton 2008c).

3.5.4 Ozerna

Ozerna is located within the Edmonton North Area Structure Plan (ASP), also known as the Lake District. Residential development in the neighbourhood began in the 1980s and continued until the early-2000s. The population of this neighbourhood was 4,495 in 2012 and 80.34% of housing was single-detached homes (City of Edmonton 2008d).

Figure 3-11: Ozerna Neighbourhood

3.6 Residential Density

As mentioned above, selection of these four neighbourhoods is based on their similar population densities, so as a first step in the selection the density of all residential neighbourhoods in Edmonton is calculated satisfying Equation (3.1):

$$N_d = {}^{P}/_{A} \qquad (3.1)$$

Where:

N_d= Neighbourhood residential density (ha)

P = Total number of residents in each neighbourhood in 2012

A = Net residential area for each neighbourhood

- The population of Edmonton was obtained from a 2012 census; however, residential area was only available for the year 2009. In this study residential development from 2009 to 2012 was considered minimal and therefore the 2009 value was regarded as sufficient.

Table 3-2: Select Neighbourhoods and their Respective Population Densities (City of Edmonton Department of Planning and Development 2013)

Neighbourhood	Residential Area (ha)	Population in 2012	Density (persons/ha)
Riverdale, in the central core	30.96	1,980	64.00
Lynnwood, a mature neighbourhood	51.71	3,302	63.90
Skyrattler, an established neighbourhood	30.63	1,947	63.60
Ozerna, a developing neighbourhood	70.50	4,495	63.80

3. 7 Defined Metrics

The next step for exploring metrics for quality of urban life is to define and compare specific metrics for different areas in the select neighbourhoods. These metrics are chosen based on the literature review and expert opinions of developers and planners (obtained by means of survey). The metrics fall into two main categories: demographics and accessibility of services. Each category is further sub-categorized. For instance, demographics which is one of the main categories for evaluating quality of life, includes neighbourhood metrics (age and type of housing), safety metrics, and transportation metrics (see Appendix 1). Accessibility can be divided into driving and walking access to amenities. The metrics defined for walking access differ from the metrics for driving access (see Appendix 1).

Finally, after collecting demographic information pertaining to objective variables, a comparison between the different neighbourhoods is conducted with respect to this category. With regard to accessibility of services (either by walking or driving), the obtained results for walking access (objective variables) are compared with the recommended maximum distances (based on the principles of neighbourhood design described in the literature, the LEED-ND guideline, and expert opinion) and the obtained results for driving access (objective variables) are compared with distances recommended by expert opinion (subjective variables) in order to assess quality of urban life in the chosen neighbourhoods.

The following objective metrics are defined for demographics in order to compare the quality of life between the chosen neighbourhoods:

- Neighbourhood metrics (i.e., age and housing type);
- Transportation metrics; and
- Safety metrics (i.e., crime rate)

3.7.1 Neighbourhood Metrics

Overall neighbourhood metrics include age and type of housing. Residents are categorized into five age cohorts as follows: (I) 0 to 14 years, (II) 15 to 34 years, (III) 35 to 44 years, (IV) 45 to 54 years, and (V) 55+ years. This study categorizes housing type as follows (City of Edmonton 2012a): (I) single-detached home, (II) duplex/fourplex, (III) row housing, (IV) low- or mid-rise apartment (1-4 storeys), and (V) high-rise apartment (5+ storeys). This study measures the mode of transportation in each neighbourhood and then compares them with each other based on the following categories: (I) car/truck/van (as driver or passenger), (II) transit, and (III) walking (City of Edmonton 2012a).

Safety is another objective metric used in this study. For this indictor, data on instances of crime by neighbourhood is obtained from the Edmonton Police Service, and includes the number of crimes in different categories reported to police in 2012. The reported data includes: (I) assault, (II) breaking and entering, (III) homicide, (IV) robbery, (V) sexual assault, (VI) theft from vehicle, (VII) theft of vehicle, and (VIII) theft over $5000 (Edmonton Police Service 2012). A sample of crime data by neighbourhood is shown in Figure 3-12.

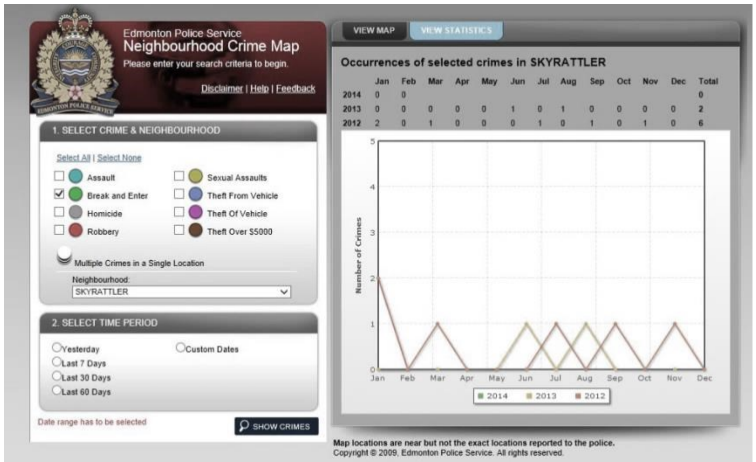


Figure 3-12: Sample of Crime Data for Skyrattler Neighbourhood from 2012 to 2014 (Edmonton Police Service 2012)

It should be noted that for the purpose of this study the overall crime rate is defined as reported crimes per thousand capita in 2012 (see Table 3-3 for an example).

Table 3-3: Incidence of Crime in Skyrattler Neighbourhood (Edmonton Police Service 2012)

Reported Crimes in Skyrattler (2012)	**Number of reported crimes**
Assault	3
Break and enter	6
Homicide	0
Robbery	1
Sexual assault	0
Theft from vehicle	9
Theft of vehicle	5
Theft over $5000	0
Total number of crimes	24

3.7.2 Accessibility

Within the scope of this research, accessibility is explored in terms of both walking and driving.

3.7.2.1 Walking

Based on the literature review, the following facilities/amenities are assessed in terms of walking accessibility, i.e., walking distance (see Table 3-4):

Table 3-4: Recommended Maximum Walking Distances to Facilities

Accessibility to Facilities	**Recommended Maximum Walking Distance***
Education Metrics	
Walking proximity to daycare	5 min
Walking proximity to pre-school	5 min
Walking proximity to elementary school	10 min
Walking proximity to junior high school	10 min
Walking proximity to senior high school	20 min
Greenery Metrics	
Walking proximity to public park / green space	5 min
Transportation Metrics	
Walking proximity to transit centre / light rail station	10 min
Recreation Metrics	
Walking proximity to recreation centre / sports facility	10 min
Services Metrics	
Walking proximity to local community centre	10 min
*Based on the principles of neighbourhood design described in the literature, LEED-ND guideline, and expert opinion	

Two different walking distances are considered in this research. The first walking distance is calculated in minutes for each facility—from the facility itself to the centre of the neighbourhood. The centre of each neighbourhood is derived from drawings/AutoCAD files received from the City of Edmonton and is located satisfying Equation (3.2) and then Google Maps is used for finding relative walking distances from the centre of the neighbourhood to a given facility.

$$N_c = \frac{\sum_{i=1}^{n} A_i \times xn_i}{\sum_{i=1}^{n} \mathrm{A}_i} \qquad (3.2)$$

Where:

N_C = Centre of neighbourhood

A_i = Area of each polygon

$xn_i = x$ Coordinate of polyline's centre

It should be mentioned that, for each type of facility, only the two available facilities nearest to the centre of each neighbourhood are chosen since, logically, people are likely to drive to the closest location where the service is available. A sample of the calculation for walking distance from the centre of Skyrattler to one of the closest daycares is shown in Table 3-5 and Figure 3-13.

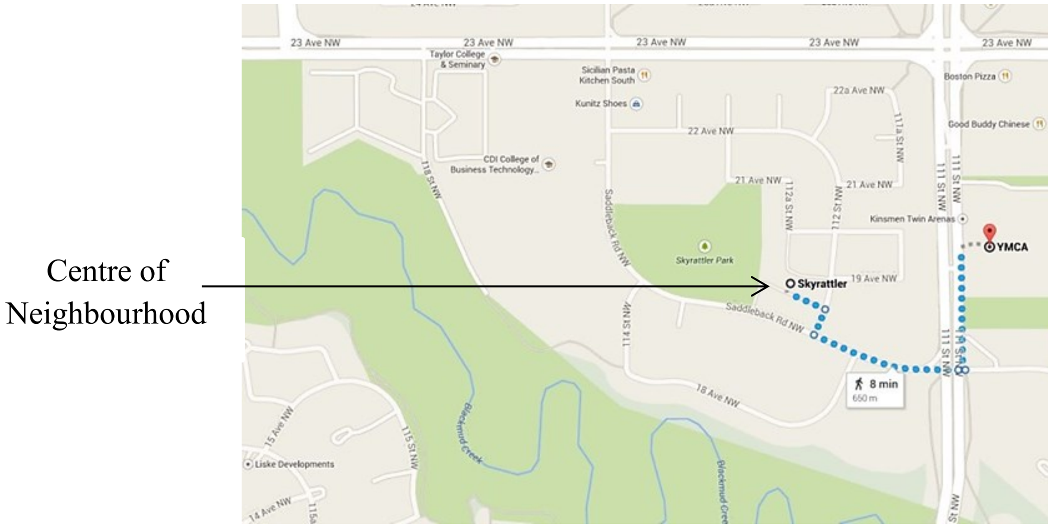


Figure 3-13: Walking Distance Calculation from Centre of Skyrattler to Daycare1 (“Google Maps” 2014)

Table 3-5: Walking Distances to Daycare Facilities in Skyrattler

Education Metrics	
Daycare (name and address)	Walking distance from centre of Skyrattler neighbourhood (minute/s)
YMCA 1975 111 St NW, T6J 7C6	8
YMCA 11350 25 Ave NW, T6J 5B1	14

For the second walking distance, the neighbourhood is divided into several defined areas based on the type of housing and access route(s). Specific distances from different defined areas of the neighbourhood are calculated in order to arrive at more accurate results for walking distances of residents. The defined areas are derived from drawings/AutoCAD files received from the City of Edmonton based on housing type (e.g., single-detached housing). Figure 3-14 and Table 3-6 show Skyrattler neighbourhood and the 21 defined areas it comprises.

Table 3-6: Housing Types in Skyrattler Neighbourhood

Type of housing	Defined area
Single-detached home	Defined areas 2 to 9
Duplex/fourplex	Defined area 1
Row housing	Defined areas 10 to 17
Low-/Mid-rise Apartment (1-4 storeys)	Defined areas 18 to 21
High-rise Apartment (5+ storeys)	None

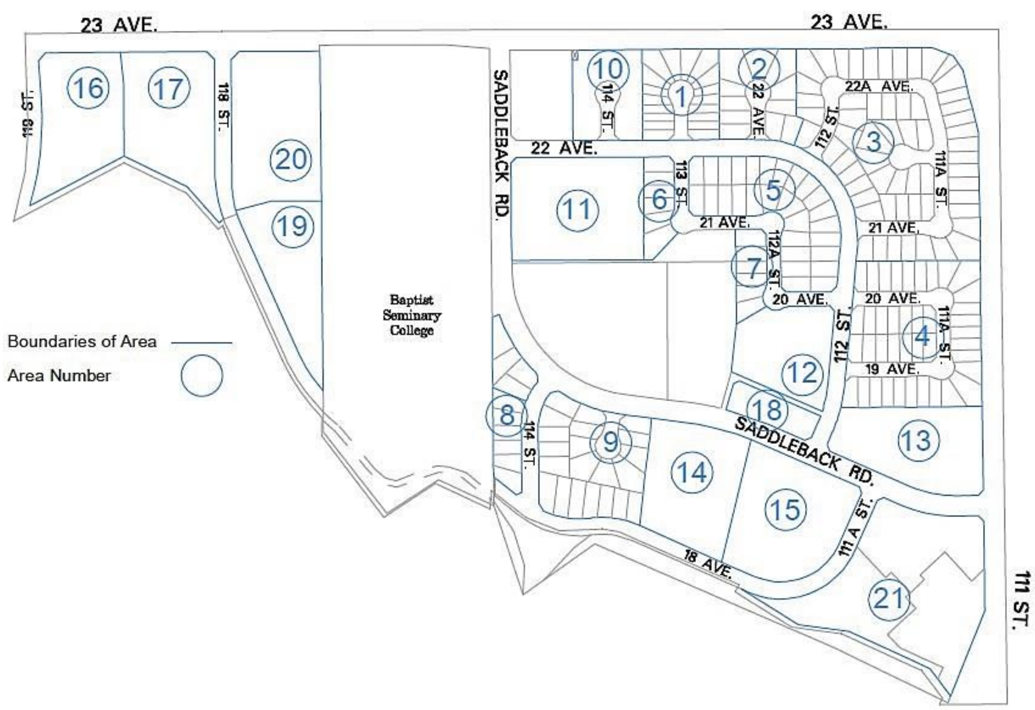


Figure 3-14: Defined areas of Skyrattler Neighbourhood (City of Edmonton Department of Planning 2012b)

After calculating the surface area of each defined area of the neighbourhood (A), the housing units in each defined area of are counted. The number of single-detached homes (N_u) is derived from the AutoCAD files received from the City of Edmonton. For other types of housing, the number of units (N_u) is determined by counting the number of units in the site. Table 3-7 shows a sample calculation of number of dwellings for defined areas 1 to 3 in the Skyrattler neighbourhood and the distances from these defined areas to the two closest daycares to this neighbourhood.

Table 3-7: Housing Type and Walking Distance in Defined Areas 1 to 3 in Skyrattler Neighbourhood

Defined Area	**Area 1**	**Area 2**	**Area 3**
Type of housing	Single-Detached Home	Single-Detached Home	Single-Detached Home
Education Metrics			
Day care			
YMCA 1975 111 St NW, T6J 7C6	11 min	10 min	22 min
YMCA 11350 25 Ave NW, T6J 5B1	10 min	11 min	40 min

After finding the number of housing units (N_u) for each defined area of the neighbourhood, the population must be estimated (P_A). For this purpose, it is first necessary to find the average size of a Canadian family in 2012. As shown in Table 3-8, Statistics Canada indicates the average size of Canadian family has been declining from 3.1 in 1986 to 3.0 in 2006, with a declining rate of 0.164% per year. Accordingly, the number of occupants per housing unit (P_{u1}) is estimated to be 3.0, based on Equation (3.3):

$$p_u = p_{u1} (1 + r)^n \qquad (3.3)$$

Where:

p_u = Forecast family size

p_{u1} = Current family size

r = Average growth rate

n= Year

Table 3-8: Average Size of a Canadian Family from 1971 to 2006 (Statistics Canada 2007)

	All families	
Year(s)	**Number (thousands)**	**Average size**
1971	5,042.60	3.7
1976	5,714.50	3.5
1981	6,309.20	3.3
1986	6,864.20	3.1
1991	7,482.10	3.1
1992	7,580.70	3.1
1993	7,679.30	3.1
1994	7,777.90	3.1
1995	7,876.40	3.1
1996	7,975.00	3.1
1997	8,076.30	3.0
1998	8,177.60	3.0
1999	8,278.80	3.0
2000	8,380.10	3.0
2001	8,481.40	3.0
2002	8,566.00	3.0
2003	8,629.00	3.0
2004	8,704.10	3.0
2005	8,779.40	3.0
2006	8,859.10	3.0
Source: Statistics Canada, Catalogue no. 91-213-X.		

Determining the number of units (N_u) and population per unit (P_u), the population of each defined area (P_A) is calculated satisfying Equation (3.4):

$$P_A = \sum_{type\ of\ units} N_u * P_u \qquad (3.4)$$

The density of each defined area (D_A) is calculated by dividing the population of each defined area of the neighbourhood (P_A) by the surface area (S_A) satisfying Equation (3.5):

$$D_A\left(\frac{ppl}{ha}\right) = {}^{P_A}/_{S_A} \qquad (3.5)$$

In the calculations of walking distance, if a defined area in the neighbourhood has more than one access route, then more than one starting point is considered for that defined area. Figure 3-15 and Table 3-9 show the three starting points considered for defined area 3 in Skyrattler neighbourhood.

Table 3-9: Walking Distances to Daycares in Skyrattler Neighbourhood

Defined Area	**Area 3-A**	**Area 3-B**	**Area 3-C**
Starting point address	2224 112 St NW	2128 111A St NW	11103 21 Ave NW
Education Metrics			
Day care	Walking distance (min)	Walking distance (min)	Walking distance (min)
YMCA 1975 111 St NW, T6J 7C6	7	7	8
YMCA 11350 25 Ave NW, T6J 5B1	12	15	13

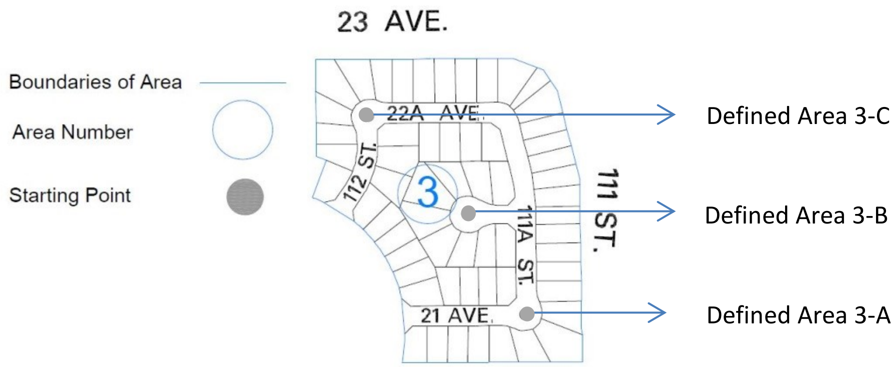


Figure 3-15: Starting Points for Access Routes to Facilities/Amenities in Skyrattler (City of Edmonton Department of Planning and Development 2012b)

Each facility has three access routes and corresponding starting points, which are used to find the distances from the defined area to the given facility. The average of these distances is considered to be representative of walking distance for that area. After calculating both the densities of the defined areas (D_A) and the walking distances from the defined areas to a facility, it is possible to find an average walking distance from a neighbourhood to a facility satisfying Equation (3.6):

$$WD_{NF}\,(min) = \frac{\sum\left(D_A\left(\frac{ppl}{ha}\right) * A(ha) * WD_{AF}(min)\right)}{D_N\left(\frac{ppl}{ha}\right) * A_N\,(ha)} \qquad (3.6)$$

Where:

WD_{NF} = Walking Distance from neighbourhood to facility (min)

D_A = Density of each defined area (persons/ha)

WD_{ANF}

$=$ Walking distance from each defined area in a neighbourhood to facility (min)

$D_N =$ Density of neighoubhood $\left(\frac{\text{persons}}{\text{ha}}\right)$

$A_N =$ Total residentail area in a neighbourhood (ha)

For each type of facility, the above calculations are completed for the two closest facilities to the centre of the neighbourhood, and the average of these two distances is considered to be representative of walking distance from neighbourhood to each type of facility satisfying Equation 3.7:

$$AVWD_{NF}\ (min) = \frac{WD_{NF1}\ (min) + WD_{NF2}\ \ (min)}{2} \qquad (3.7)$$

Where:

$AVWD_{NF} =$ Average Walking Distance from neighbourhood to facility

$WD_{NF1} = Walking\ Distance\ from\ neighbourhood\ to\ facility\ 1$

$WD_{NF2} = Walking\ Distance\ from\ neighbourhood\ to\ facility\ 2$

For instance, the average walking distance from neighbourhood to daycare was calculated as follows:

$$Average\ Walking\ distance\ from\ neighbourhood\ to\ daycare\ (min)$$
$$= 17\text{ min} + \ 20\text{ min} = 18.80 \sim 19\text{ min}$$

In the first method, the distances from the centre of the neighbourhood to selected facilities are calculated. In the second method, the distances from the defined areas in each neighbourhood to select facilities are calculated, and then weighted based on the importance of closeness of these facilities to the neighbourhood from the point of view of urban planners and developers. These opinions are obtained from a survey (see Appendix 3). Finally, the above calculations are carried out for all facilities, and the results of both methods and weighted recommended walking distances for each type of facility are compared.

3.7.2.2 Driving

In contrast to walking, where neighbourhood development criteria (based on the literature and the LEED-ND guideline) provide indications as to the distances that people would be willing to walk in order to access a given service, acceptable driving times have not been explored in previous guideline and studies (see Appendix 2). Accordingly, in order to gain insight into accessibility to services by means of driving, 20 planners and land developers are surveyed to establish expert opinion with respect to recommended maximum driving distances to select services. The following are the types of facilities that are chosen from the available literature and the survey conducted as part of this research, and are listed with the recommended maximum distances based on the survey in Table 3-10:

Table 3-10: Recommended Maximum Driving Distances to Facilities

Accessibility to Facilities	Recommended Maximum Driving Distance *
Education Metrics	
Driving proximity to postsecondary institution	30 min
Health Metrics	
Driving proximity to medical clinic	10 min
Driving proximity to medical laboratory (imaging, diagnostics, etc.)	30 min
Driving proximity to pharmacy	10 min
Driving proximity to hospital	20 min
Driving proximity to senior/long-term care facility	10 min
Service Metrics	
Driving proximity to convenience store	5 min
Driving proximity to grocery store/supermarket	10 min
Driving proximity to mall/shopping centre	20 min
Driving proximity to restaurant	20 min
Driving proximity to post office	10 min
Driving proximity to bank	10 min
Driving proximity to public library	10 min
Driving proximity to coffee shop	10 min
Driving proximity to hair salon	10 min
Driving proximity to cinema	20 min
*Based on expert opinion (survey)	

The calculations for finding driving distance are similar to those for walking distance. Both are derived from Google Maps. The only difference is that the driving distances in minutes are based on expert opinion while the walking distances are based on neighbourhood development criteria and expert opinion. Both described methods that have been applied for walking distances are also applied for driving and are used for each type of facility, and, similarly, only the two nearest facilities are considered in the calculations. As an example, the calculation of driving distance from Skyrattler to a medical laboratory is illustrated in Figure 3- 16.

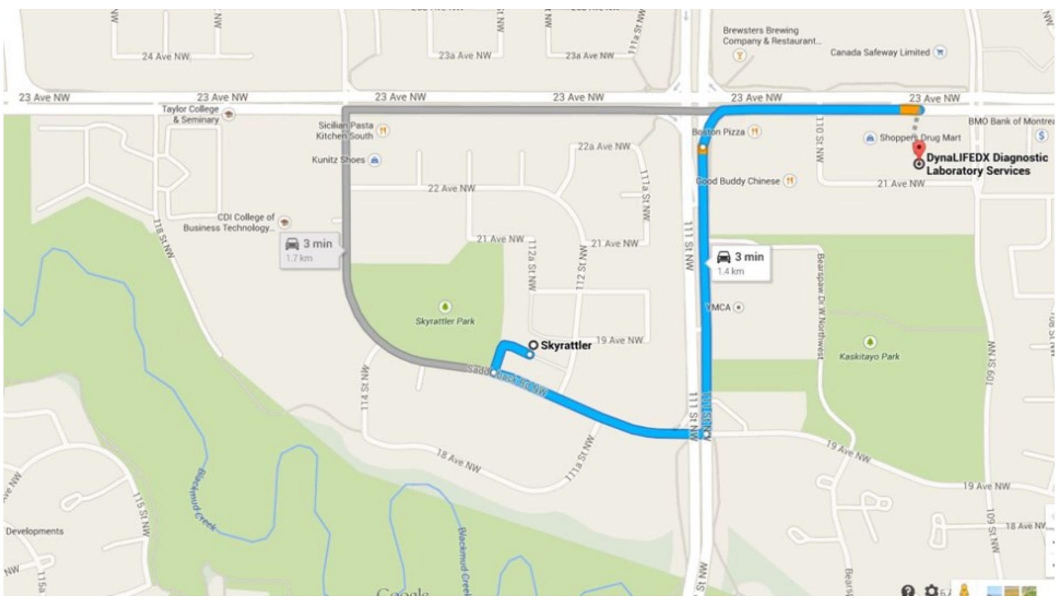


Figure 3- 16: Driving Distance Calculation from Skyrattler to Medical ("Google Maps" 2014)

3.8 Comparison of Neighbourhoods

Comparison of neighbourhoods is based on a consideration of several metrics. As mentioned earlier, some metrics are defined for walking distances and others for driving distances, since people are unlikely to walk beyond a certain distance in order to complete their daily errands. Table 3-4 and Table 3-10 contain the relevant metrics for comparison for walking and driving, respectively. The next step in the neighbourhood comparison is to identify the relative importance of metrics, referred to as metric weights. For this purpose, a survey is conducted and distributed among a group of experts comprising 10 developers and 10 planners. In the survey, importance level of metrics is identified by the experts. Importance scale is based on a 5-point scale as shown in Table 3-11.

Table 3-11: Importance Scale

Level of importance	**Importance scale**
Not important	1
Somewhat important	2
Moderate	3
Very important	4
Extremely important	5

After obtaining respondents' opinions about the importance of closeness of metrics to one's home, the results are used to calculate a Relative Importance Index. The index resulting from the importance scale is eventually used to assign relative weights and compare the select neighbourhoods with respect to neighbourhood development criteria and expert opinion. In this study, the Relative Importance Index (RII) of metrics is obtained satisfying Equation (3.7).

$$RII(\%) = \frac{n_1 + 2n_2 + 3n_3 + 4n_4 + 5n_5}{5(n_1 + n_2 + n_3 + n_4 + n_5)} \times 100 \qquad (3.7)$$

Where:

n_1, n_2, n_3, n_4, and n_5: The number of respondents who chose the respective levels of importance ranging from 'not important' to 'extremely important'.

Relative importance is often used for indicating practical significance (Tonidandel and LeBreton 2011), as is the case in this study. Relative importance index is a method that complements the overall output of management practice analysis, yielding a numerical value that denotes the overall rank of a given management practice among all management practices in the list (Aibinu and Jagboro 2002; Chan and Kumaraswamy 1997; Omar and Robinson Fayek 2013). In this study, the relative importance index of each metric is calculated using Equation 3.7 above. For example, the relative importance index for importance of closeness to daycare is calculated as follows:

$$Daycare\ RII\ (\%) = \frac{(1*7)+(2*1)+(3*2)+(4*5)+(5*4)}{5(7+1+2+5+4)} \times 100$$

$$= 57.89$$

Then, based on the relative importance index for each metric, the relative weight (RW_i) of a given metric, representing its importance, can be achieved satisfying Equation (3.8):

$$RW_i = \frac{RII_i}{\sum_1^n RII} \qquad (3.8)$$

Where:

RII_i = Relative importance index$_i$, which represents the importance of closeness of metric, i

$\sum_1^n RII = \sum_1^n \text{Relative importance index}$, which is the summation of the Relative Importance Indices for the given evaluation metric.

For instance, the weight of the daycare metric is calculated as follows:

$$Daycare\ Relative\ Weight = \frac{57.89}{605.25} = 0.10$$

Table 3-12 and Table 3-13 contain the results of the survey for selected facilities/amenities for both walking and driving.

Table 3-12: Metric Relative Importance and Relative Weight for Walking Distances

Metrics	**Walking**	
	RII	**RW**
Daycare	57.89	0.10
Pre-school	58.95	0.10
Elementary school	61.05	0.10
Junior high school	57.89	0.10
Senior high school	55.79	0.09
Public park / green space	86.32	0.14
Recreation centre / sports facility	77.89	0.13
Local community centre	71.58	0.12
Transit centre / light rail station	77.89	0.13
Total	**605.25**	**1.00**

Table 3-13: Metric Relative Importance Index and Relative Weight for Driving Distances

Metric	**Driving**	
	RII	**RW**
Postsecondary institution	59.00	0.06
Medical clinic	84.00	0.08
Medical laboratory (imaging, diagnostics, etc.)	69.00	0.07
Pharmacy	78.00	0.08
Hospital	79.00	0.08
Senior/long-term care facility	52.00	0.05
Convenience store	61.00	0.06
Grocery store/supermarket	79.00	0.08
Mall/shopping centre	61.00	0.06
Restaurant	59.00	0.06
Post office	54.00	0.05
Bank	69.00	0.07
Public library	61.00	0.06
Coffee shop	52.00	0.05
Hair salon	50.00	0.05
Cinema	51.00	0.05
Total	**1,018.00**	**1.00**

After collecting results from experts and assigning weights for defined metrics, these weights are applied to the results of each neighbourhood (for both the centre and from the defined areas). Recommended maximum distances based on the neighbourhood development criteria and expert opinion for both walking and driving are then considered in order to evaluate the accessibility of the select neighbourhoods. Therefore in this step the actual calculated distances (for both the centre and the defined areas) obtained from Google Maps needs to be multiplied by the weighting factors and added up for any neighbourhood, as shown in the following equations (Equations 3.9 and 3.10). The outcome is a number associated with each neighbourhood determining the weighted distances to all facilities for both walking and driving from both the centre and the defined areas.

$$WD_{CNF} = AVWD_{CNF} * RW_F \qquad (3.9)$$

Where:

$WD_{CNF} =$ Weighted distance from centre of neighbourhood to facility

$AVWD_{CNF}$

$=$ Average walking distance from centre of neighbourhood to facility

$RW_F =$ Relative weight for facility

$$TWWD_{CNF} = \sum WWD_{CNF} \qquad (3.10)$$

Where:

$TWWD_{FCN}$

$=$ Total weighted walking distance from centre of neighbourhood to facilities

$\sum WWD_{FCN} =$

$\sum$ weighted walking distances from centre of neighbourhood to facilities

As an example, Equation 3.9 shows the calculation of weighted walking distance to daycare from the centre of Skyrattler neighbourhood. (It is important to note that all these calculation are completed for driving as well.)

$$Weighted\ walking\ distance\ from\ centre\ of\ neighbourhood\ to\ daycare$$
$$= 11_{min} * 0.0849 = 0.9336 \quad (3.9)$$

Based on these calculations the best neighbourhood design would be the one with the lowest associated number. Table 3-14 shows the weighted metrics in relation to recommended maximum walking distances and the results for Skyrattler neighbourhood from centre and defined areas to select facilities.

Table 3-14: Weighted Metrics to Recommended Walking Distances and Results of Actual Distances from Centre and Defined Areas of Skyrattler Neighbourhood

Facilities	**Weighted recommended max. distance**	**From centre of Skyrattler**	**From defined areas of Skyrattler**
Daycare	0.48	1.05	1.05
Pre-school	0.49	1.85	3.12
Elementary school	1.01	1.61	2.72
Junior high school	0.96	5.45	8.80
Senior high school	1.84	4.52	6.64
Public park / green space	0.71	0.71	1.85
Recreation centre / sports facility	1.29	4.50	6.95
Local community centre	1.18	1.77	3.07
Transit centre / light rail station	1.29	1.93	3.09
Total	**9.24**	**23.41**	**37.30**

CHAPTER 4: RESULTS

4.1 Introduction

This study seeks to quantify quality of urban life in four neighbourhoods in Edmonton, Alberta. The following neighbourhoods, due to their similar population densities, were chosen as case studies in this research: Riverdale, in the Central Core; Lynnwood, a mature neighbourhood; Skyrattler, an established neighbourhood; and Ozerna, a developing neighbourhood. In this study, the quantification of quality of life within the select neighbourhoods is carried out by means of a three-step procedure: (I) determination of the appropriate demographics metrics; (II) evaluation of accessibility of facilities and amenities selected based on a 1-mile radius from the neighbourhood centre; and (III) comparison of the average walking distances to these facilities and amenities with those recommended in the neighbourhood development criteria and by expert opinion obtained in a survey. It is important to note that neighbourhood development criteria are limited in scope to walking distances whereas in this research we extend the concept of accessibility by considering driving as a means of accessibility. Furthermore, since some facilities may be perceived as having higher priorities than others, the calculated distances are weighted based on the opinions of 20 individuals with expertise in urban planning and land development.

4.2 Demographics

4.2.1 Age Structure and Mode of Transportation

In recent decades there has been increased awareness of the importance of a healthy lifestyle, which has made public health a central element around which urban planning decisions and policies are made. Given its health-related and other benefits, today neighbourhood walkability is becoming a selection factor, especially among young adults and young families, who are increasingly concerned with personal wellness and sustainability. As a result, it is instructive to begin by providing some descriptive statistics regarding the age distribution of the population in each of the select neighbourhoods, since this factor is known to have an impact on transportation habits.

As shown in Figure 4-1, two segments of the population stand out: (i) young adults (ages 15 to 34) and (ii) mature/elderly (ages 55+). It is important to note that even though these two populations represent two different generations, they share a common need for walking. For younger adults, this need might be characterized as “walking with purpose”, since this activity is sought to be included as part of their daily lives such as travelling to work, school, and daily errands. For the elderly, in addition to “walking with purpose”, walking activity can also be considered as “Walking for leisure” or “Walking for health” since many individuals at this age are retired and routinely walk as a light physical activity in the interest of health.

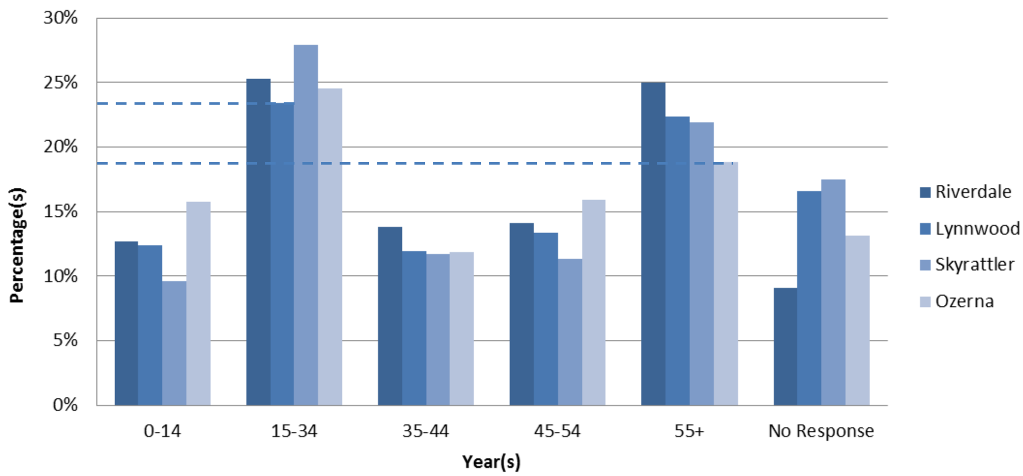


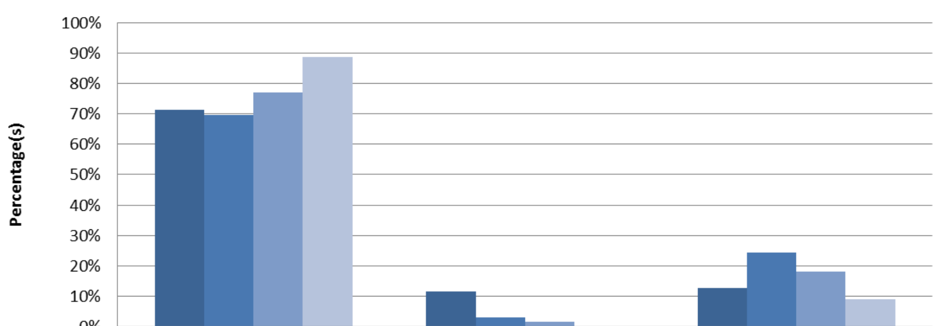
Figure 4-1: Age Structure in Select Neighbourhoods (City of Edmonton 2012a)

Table 4-1 highlights in detail the distributions of two of the age segments represented in Figure 4-1. It can be seen that the proportions of young adults whose ages range from 15 to 34 in the neighbourhoods under study are relatively close to one another (ranging from 23.5% to 28%). Also when the proportions of mature/elderly residents are compared, they are found to be lower in the newer developed neighbourhoods. For instance, Ozerna, which is located in a planned and developed neighbourhood, has the lowest proportion (18.84%) of mature/elderly residents among the four select neighbourhoods.

Table 4-1: Two Segments of Age Structure in Select Neighbourhoods (City of Edmonton 2012a)

Neighbourhood name and location	Age structure (%)	
	15-34 Years	55+ Years
Riverdale, in the central core	25.30	25.00
Lynnwood, a mature neighbourhood	23.50	22.41
Skyrattler, an established neighbourhood	27.94	21.93
Ozerna, a developing neighbourhood	24.52	18.84

In the next step, preferred mode of transportation for home to work is evaluated. As illustrated in Figure 4-2, the vast majority of residents in these neighbourhoods (70 to 90%) prefer driving. Public transit is ranked second with a proportion of 10 to 20%. Regarding walking as a mode of transportation for commuting to work, it is marginal at best in all neighbourhoods with the exception of Riverdale, where approximately 10% of residents have reported walking to work.



	Car/Truck/Van (as Driver, as passenger)	walk	Transit
Riverdale	71.37	11.69	12.77
Lynnwood	69.47	2.95	24.32
Skyrattler	77.12	1.66	18.01
Ozerna	88.60	0.05	8.93

Figure 4-2: Transportation Mode(s) in Select Neighbourhoods from Home to Work (City of Edmonton 2012a)

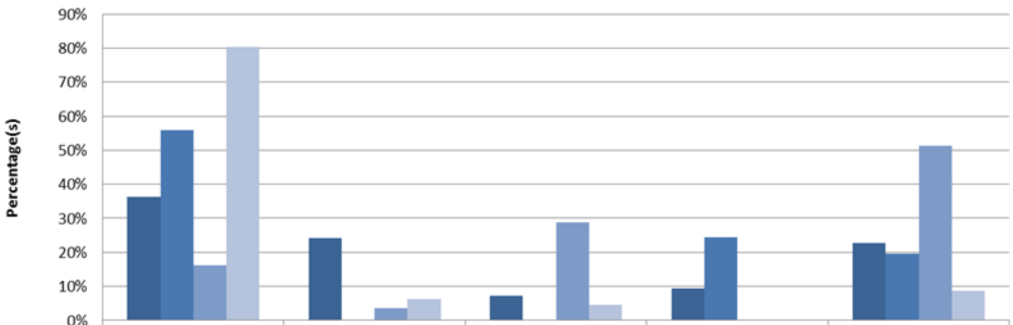
These numbers demonstrate that neighbourhoods situated in more recently developed areas and farther from the central business district (CBD) not only have a higher percentage of residents who use an automobile as their preferred mode of transportation from home to work, but also have lower percentage of residents who prefer to walk (see Figure 4-2). Moreover, the City of Edmonton study found that despite the large proportion of young adult residents in these neighbourhood (24-28%), there is still a strong preference for driving as a mode of transportation for commuting work. Furthermore, this study found this increasing vehicle dependency among the residents and decreasing the willingness to walk from home to work in these neighbourhoods can be associated with longer distances from home to work, which in turn can be associated with a particular neighbourhood design. Since when diversity of housing types exists in all neighbourhoods, residents with different incomes are able to live in a neighbourhood near their workplace. In other words, neighbourhood design, as well as neighbourhood preferences, will determine residents' travel choices.

The study also evaluates the percentage of residents who are taking public transit versus those who are driving or walking to work. It is found that not only is there little interest in walking as a mode of transportation for commuting to work, but also a considerable preference to take public transit is identified (see Figure 4-2). These results show that the Riverdale neighbourhood, which is located in the central core and close to the main CBD, has similar preferences for walking and taking public transit (about 12%). However, among the neighbourhoods studied, the further a neighbourhood is from the CBD, the lower the willingness is to walk or take public transit. This decreasing demand for both walking and public transit in a neighbourhood can be associated with the inconvenience of public transit. In this regard, Perrotta et al. (2012) have asserted that convenient public transit will result in a higher level of walking as a primary physical activity of residents, resulting in better public health of a neighbourhood. On the other hand, overwhelming preference to automobile use results in longer trips, more fuel consumption, greater emissions, and traffic congestion. This underscores the need to improve walkability in transit access in neighbourhoods further from the central core through appropriate urban planning.

4.2.2 Type of Housing

Diversity of housing types is another important component of urban planning and neighbourhood design that affects public health and quality of urban life. Diversity of housing types ensures a wide range of housing choices (size and price) and allows residents to live close to their workplaces in a preferred housing type. Hence, in this section variety of housing type in the select neighbourhoods is examined in order to determine which neighbourhood is likely to attract residents with varying level of incomes.

As illustrated in Figure 4-3, the study found that only Riverdale neighbourhood has a wide range of housing types, while other select neighbourhoods have low variety in housing type. In addition, this neighbourhood has the greatest proportion of residents walking from home to work. In this regard, Perrotta et al. (2012) argued that providing diversity of housing types in a neighbourhood could increase walkability. By providing a wide range of housing models and prices within any given neighbourhood, residents have the option of choosing a housing option within a reasonable proximity to their place of work which accommodates their income and preferences. Although Riverdale neighbourhood has the highest proportion of residents walking to work (11.69%) among the neighbourhoods studied, the proportion of those who prefer to drive (71.37%) is still much higher than the proportion who prefer walking. Figure 4-3 also demonstrates that there is no duplex/fourplex and row housing in Lynnwood neighbourhood, and no high-rise apartments (5+ storeys) in either Skyrattler or Ozerna neighbourhoods. This is likely the result of an urban development paradigm that offers a particular housing option to people with a specific range of income working in different places rather than a range of housing type options suited to different demographics and income levels, which entails an increase in automobile dependency. Therefore, in a polycentric city like Edmonton, offering a wide range of housing not only can encourage social activities and support the diverse population, but also can reduce the commute time by giving different choices to residents that allow them to live closer to their workplaces, thereby improving quality of life.



	Single Detached House	Duplex/Fourplex	Row House	Apartment (5+ stories)	Apartment (1-4 stories)
Riverdale	36.4	24.17	7.34	9.39	22.7
Lynnwood	55.97	0	0	24.39	19.57
Skyrattler	16.21	3.67	28.75	0	51.28
Ozerna	80.34	6.38	4.59	0	8.61

Figure 4-3: Types of Housing in Select Neighbourhoods (City of Edmonton 2012a)

4.2.3 Safety

Safety is one of the main factors affecting a resident's choice of neighbourhood. As mentioned in previous chapters, safety is also an important metric for quantifying quality of urban life, since it is associated with neighbourhood walkability (Perrotta et al. 2012; Sajeva et al. 2012). Hence, in this section neighbourhood safety in the context of crime is examined in select neighbourhoods by measuring the incidence of crime per capita in Edmonton in 2012. As shown in Figure 4-4, Lynnwood neighbourhood, which is located in the mature neighbourhood area, has the highest rate of crime per thousand capita (20), with the other neighbourhoods averaging 11 per thousand capita. Studies available in the literature have shown that the level of safety is proportional to the walkability of a neighbourhood, and consequently to the level of quality of life (Perrotta et al. 2012; Sajeva et al. 2012; Wasserman and Chua 1980).

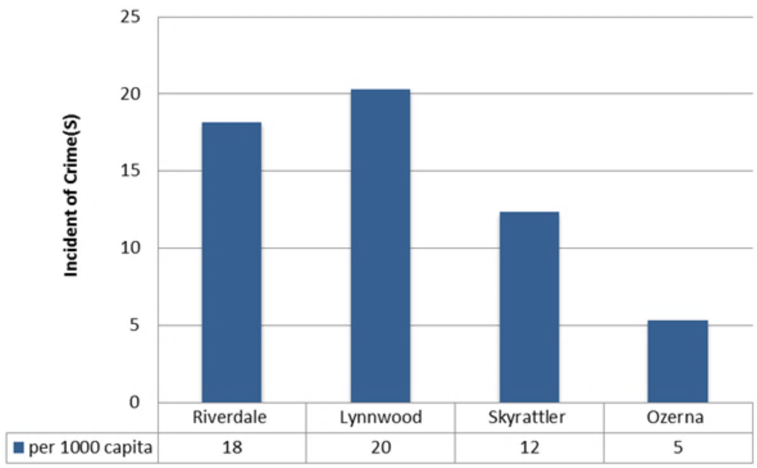


Figure 4-4: Incidence of Crime Per Thousand Capita in Select Neighbourhoods in 2012 (Edmonton Police Service 2012)

4.3 Accessibility

This section discusses the results found pertaining to walking and driving accessibility in the four select neighbourhoods, categorized in three steps. In step one, the availability of facilities and amenities within a 1 mile walking distance from the centre of the chosen neighbourhoods is examined and then compared to the recommended walking distances based on neighbourhood development criteria and expert opinion. Step two compares the Total Weighted Walking Distances (TWWDs) to the same facilities and amenities from both centre and defined areas of select neighbourhoods with TWWDs as recommended maximum walking distances. In the last step, the Total Weighted Driving Distances (TWDD) to select facilities and amenities from both the centre and the defined areas of select neighbourhoods are compared to TWDDs as recommended maximum driving distances in order to evaluate the driving accessibility of the neighbourhoods.

Measurement of walking distances from the centre of each neighbourhood is necessary for comparison with recommended maximum distances. In addition, distances from the different defined areas of a neighbourhood are calculated in order to reflect more precisely the transportation patterns of residents. It is important to note that the objective of assigning weights to distances is to aggregate expert opinion regarding the evaluation of the importance of closeness of different metrics into one value that represents neighbourhood walking and driving accessibility.

4.3.1 Availability of Services

Availability and number of facilities and amenities in the select neighbourhoods within 1 mile walking distance from the centre of a neighbourhood is examined and compared with the distances recommended in neighbourhood development criteria and expert opinion. As shown in Table 4-2, Table 4-3, and Table 4-4, Table 4-5 and Table 4-6), Lynnwood neighbourhood has more facilities and amenities (7 out of 9) located within 1 mile walking distance from its centre, while the other neighbourhoods have fewer (3 or 4 out of 9). It is also found when these findings are compared with one another that public park / green space in all select neighbourhoods is located in the centre or very close to the centre of the (i.e., within 5-minute walking distance). It is also found that all residents in the select neighbourhoods have access to bus stops within 3-minute walking distance. Consequently, in this research the availability and distances of bus stops are not considered.

Table 4-2: Facilities Accessible by Walking in Select Neighbourhoods

Neighbourhood	Number of available facilities and amenities	Name of available facilities and amenities
Riverdale, in the central core	4 out of 9	Daycare, pre-school, public park / green space, and local community centre
Lynnwood, a mature neighbourhood	7 out of 9	Daycare, pre-school, elementary school, junior high school, senior high school, public park / green space, and local community centre
Skyrattler, an established neighbourhood	3 out of 9	Daycare, public park / green space, and recreation centre / sports facility
Ozerna, a developing neighbourhood	3 out of 9	Pre-school, elementary school, and public park / green space

Table 4-3: Walking Accessibility of Facilities and Amenities from Riverdale

Walking accessibility of facilities and amenities from Riverdale	**Recommended maximum distance***	**Number of facilities/amenities**			
Education Metrics (Walking proximity)		**within 5 min**	**within 10 min**	**within 15 min**	**within 20 min**
To daycare	5 min	1	1		
To pre-school	5 min	1			1
To elementary school	10 min			2	
To junior high school	10 min			1	
To senior high school	20 min				
Greenery Metrics (Walking proximity)					
To public park / green space	5 min	1	1		
Transportation Metrics (Walking proximity)					
To transit centre / light rail station	10 min				
Recreation Metrics (Walking proximity)					
To recreation centre / sports facility	10 min				1
Services Metrics (Walking proximity)					
To local community centre	10 min	1			1
* Based on the principles of neighbourhood design described in the literature, LEED-ND guideline, and expert opinion					

Table 4-4: Walking Accessibility of Facilities and Amenities from Lynnwood

Walking accessibility of facilities and amenities from Lynnwood	**Recommended maximum distance***	**Number of facilities/amenities**			
Education Metrics (Walking proximity)		**within 5 min**	**within 10 min**	**within 15 min**	**within 20 min**
To daycare	5 min	1	1		
To pre-school	5 min	1		1	
To elementary school	10 min	1	1		
To junior high school	10 min		1		1
To senior high school	20 min				1
Greenery Metrics (Walking proximity)					
To public park / green space	5 min	2			
Transportation Metrics (Walking proximity)					
To transit centre / light rail station	10 min				
Recreation Metrics (Walking proximity)					
To recreation centre / sports facility	10 min				
Services Metrics (Walking proximity)					
To local community centre	10 min	1	1		
* Based on the principles of neighbourhood design described in the literature, LEED-ND guideline, and expert opinion					

Table 4-5: Walking Accessibility of Facilities and Amenities from Skyrattler

Walking accessibility of facilities and amenities from Skyrattler	**Recommended maximum distance***	**Number of facilities/amenities**			
Education Metrics (Walking proximity)		**within 5 min**	**within 10 min**	**within 15 min**	**within 20 min**
To daycare	5 min	1		1	
To pre-school	5 min			1	1
To elementary school	10 min			1	1
To junior high school	10 min				
To senior high school	20 min				
Greenery Metrics (Walking proximity)					
To public park / green space	5 min	1	1		
Transportation Metrics (Walking proximity)					
To transit centre / light rail station	10 min			1	
Recreation Metrics (Walking proximity)					
To recreation centre / sports facility	10 min	1			
Services Metrics (Walking proximity)					
To local community centre	10 min			2	
* Based on the principles of neighbourhood design described in the literature, LEED-ND guideline, and expert opinion					

Table 4-6: Walking Accessibility of Facilities and Amenities from Ozerna

Walking accessibility of facilities and amenities from Ozerna	**Recommended maximum distance***	**Number of facilities/amenities**			
Education Metrics (Walking proximity)		**within 5 min**	**within 10 min**	**within 15 min**	**within 20 min**
To daycare	5 min			1	1
To pre-school	5 min	1			1
To elementary school	10 min	1			1
To junior high school	10 min				
To senior high school	20 min				
Greenery Metrics (Walking proximity)					
To public park / green space	5 min	1			
Transportation Metrics (Walking proximity)					
To transit centre / light rail station	10 min				
Recreation Metrics					
To recreation centre / sports facility	10 min				
Services Metrics (Walking proximity)					
To local community centre	10 min				1
* Based on the principles of neighbourhood design described in the literature, LEED-ND guideline and expert opinion					

4.3.2 Comparison of Walking Distances from Centres and Defined Areas of Select Neighbourhoods

The TWWDs from both the centres and from defined areas of select neighbourhoods are compared with the recommended TWWDs. The purpose of this comparison is to determine which neighbourhood in the context of overall walkability has the best access to select facilities and amenities and can meet the standard established in neighbourhood development criteria and based on expert opinion. According to the findings, Lynnwood neighbourhood, with 19.09 $TWWD_{CNF}$, has the best access to all select facilities and amenities among the neighbourhoods studied, followed by Riverdale with 22.26 $TWWD_{FCN}$, Skyrattler with 23.41 09 $TWWD_{FCN}$, and Ozerna with 24.17 09 $TWWD_{CNF}$. However, as shown in Table 4-7, none of the select neighbourhoods meet the recommended TWWDs.

Table 4-7: Weighted Walking Distances from the Centres of Select Neighbourhoods to Select Facilities and Amenities

Walking distances to facilities from centres of select neighbourhoods	Weighted recommended max. distance	River-dale	Lynn-wood	Sky-rattler	Ozerna
Education Metrics (Walking proximity)					
To daycare	0.48	0.96	0.38	1.05	2.39
To pre-school	0.49	1.95	0.68	1.85	1.66
To elementary school	1.01	2.02	0.61	1.61	1.71
To junior high school	0.96	2.68	1.34	5.45	2.77
To senior high school	1.84	3.78	3.32	4.52	2.77
Greenery Metrics (Walking proximity)					
To public park / green space	0.71	1.43	0.71	0.71	0.14
Transportation Metrics (Walking proximity)					
To transit centre / light rail station	1.29	3.35	6.43	1.93	6.95
Recreation Metrics (Walking proximity)					
To recreation centre / sports facility	1.29	3.86	5.02	4.50	2.70
Services Metrics (Walking proximity)					
To local community centre	1.18	2.25	0.59	1.77	3.07
Total Weighted Walking Distance ($TWWD_{CNF}$)	**9.24**	**22.26**	**19.09**	**23.41**	**24.17**

The walking distances in the chosen neighbourhoods are evaluated from the defined areas in order to determine reasonable walking distances from the given neighbourhood to select facilities and amenities as well. As illustrated in Table 4-8, the results show that none of the neighbourhoods meet the recommended TWWDs based on walking distance calculations from defined areas, which matches the outcome for the calculation from centre of neighbourhood described above. According to the findings, Riverdale with a 32.28 TWWD from defined areas to facilities ($TWWD_{ANF}$) has the best access to select facilities and amenities based on distances from defined areas. Ozerna neighbourhood has the highest combined rate of TWWDs to facilities from both the centre and from defined areas.

When these two findings—walking distances from centre and from defined areas—are compared it is found that the neighbourhood with the lowest TWWDs from facility to neighbourhood centre is not necessarily the neighbourhood with the lowest TWWDs to facility from defined areas. This could be related not only to neighbourhood design but also to the shape and topography and location of facilities and amenities in the vicinity of the neighbourhood.

Table 4-8: Weighted Walking Distances from Defined Areas of Select Neighbourhoods to Select Facilities and Amenities

Walking distances to facilities from defined areas of select neighbourhoods	Weighted recommended max. distance	River-dale	Lynn-wood	Sky-rattler	Ozerna
Education Metrics (Walking proximity)					
To daycare	0.48	1.34	5.55	1.05	12.05
To pre-school	0.49	2.34	7.60	3.12	7.40
To elementary school	1.01	2.93	6.56	2.72	7.67
To junior high school	0.96	3.92	10.81	8.80	13.20
To senior high school	1.84	5.07	24.24	6.64	18.25
Greenery Metrics (Walking proximity)					
To public park / green space	0.71	2.42	3.71	1.85	4.99
Transportation Metrics (Walking proximity)					
To transit centre / light rail station	1.29	5.28	44.27	3.09	33.20
Recreation Metrics (Walking proximity)					
To recreation centre / sports facility	1.29	5.79	36.03	6.95	12.74
Services Metrics (Walking proximity)					
To local community centre	1.18	3.19	7.10	3.07	10.64
Total Weighted Walking Distance ($TWWD_{ANF}$)	**9.24**	**32.28**	**145.86**	**37.30**	**120.15**

4.3.3 Comparison of Driving Distances from Centres and Defined Areas of Select Neighbourhoods

TWDDs of select neighbourhoods from both the centres and defined areas are compared with the TWDDs recommended based on neighbourhood development criteria and expert opinion. According to the results (Table 4-9), all four neighbourhoods have TWDDs from centre to select facilities and amenities ($TWDD_{CNF}$) lower than the recommended 14.67. This indicates that all four neighbourhoods have good driving access based on calculations from centre of neighbourhood.

Table 4-9: Weighted Driving Distances from Centres of Select Neighbourhoods to Select Facilities and Amenities

Driving distances to facilities from centres of select neighbourhoods	**Weighted recommended max. distance**	**River-dale**	**Lynn-wood**	**Sky-rattler**	**Ozerna**
Education Metrics (Driving proximity)					
To postsecondary institution	1.74	0.52	0.93	0.64	0.87
Health Metrics (Driving proximity)					
To medical clinic	0.83	0.41	0.33	0.25	0.33
To medical laboratory (imaging, diagnostics, etc.)	2.03	0.47	0.14	0.27	0.75
To pharmacy	0.77	0.23	0.15	0.15	0.61
To hospital	1.55	0.70	0.78	0.78	0.70
To senior/long-term care facility	0.51	0.36	0.36	0.31	0.41
Service Metrics (Driving proximity)					
To convenience store	0.30	0.30	0.12	0.18	0.24
To grocery store/supermarket	0.78	0.31	0.16	0.31	0.47
To mall/shopping centre	1.20	0.42	0.48	0.48	0.48
To restaurant	1.16	0.17	0.12	0.12	0.12
To post office	0.53	0.27	0.16	0.21	0.27
To bank	0.68	0.27	0.14	0.20	0.34
To public library	0.60	0.36	0.30	0.54	0.48
To coffee shop	0.51	0.26	0.15	0.15	0.20
To hair salon	0.49	0.25	0.15	0.15	0.10
To cinema	1.00	0.15	0.50	0.35	0.40
Total Weighted Driving Distance ($TWDD_{CNF}$)	**14.67**	**5.44**	**4.95**	**5.08**	**6.75**

As shown in Table 4-10, the TWDDs from the defined areas in select neighbourhoods are also evaluated. According to the results, only Riverdale with $TWDD_{ANF}$ = 6.27 and Skyrattler with $TWDD_{ANF}$ = 7.43 meet the TWDDs as defined in the results of the survey of experts. Furthermore, when the results of TWDDs from both the centre and the defined areas in the chosen neighbourhoods are compared with one another it is found that the neighbourhood with the lowest rate of $TWDD_{CNF}$ is not necessarily the neighbourhood with the lowest rate of $TWDD_{ANF}$. A possible explanation of this result is the differences in configuration of neighbourhood and locations of facilities and amenities.

Table 4-10: Weighted Driving Distances from Defined Areas of Select Neighbourhoods to Select Facilities and Amenities

Driving distances to facilities from defined areas of select neighbourhoods	**Weighted recommended max. distance**	**River-dale**	**Lynn-wood**	**Sky-rattler**	**Ozerna**
Education Metrics (Driving Proximity)					
To postsecondary institution	1.74	2.38	5.45	0.70	4.17
Health Metrics (Driving Proximity)					
To medical clinic	0.83	0.33	1.73	0.33	1.57
To medical laboratory (imaging, diagnostics, etc.)	2.03	0.41	1.22	0.34	3.66
To pharmacy	0.77	0.23	1.30	0.23	2.30
To hospital	1.55	0.62	4.27	1.16	3.49
To senior/long-term care facility	0.51	0.31	2.55	0.51	1.94
Service Metrics (Driving Proximity)					
To convenience store	0.30	0.18	1.08	0.30	1.14
To grocery store/supermarket	0.78	0.23	2.25	0.47	2.33
To mall/shopping centre	1.20	0.30	2.82	0.78	2.22
To restaurant	1.16	0.17	1.10	0.17	0.70
To post office	0.53	0.21	1.27	0.27	1.11
To bank	0.68	0.20	1.15	0.34	1.56
To public library	0.60	0.30	2.10	0.84	2.16
To coffee shop	0.51	0.15	1.23	0.26	1.12
To hair salon	0.49	0.10	0.79	0.20	0.59
To cinema	1.00	0.15	3.11	0.55	2.05
Total Weighted Driving Distance ($TWDD_{ANF}$)	**14.67**	**6.27**	**33.41**	**7.43**	**32.11**

4.4 Future Development Priorities in Select Neighbourhoods

As discussed in previous sections, the walking distances in select neighbourhoods from both centre and defined areas fail to satisfy the recommended maximum distances. It can thus be concluded that the current designs of these neighbourhoods need improvement in terms of walkability. Therefore, in this study the three most critical metrics from each neighbourhood are identified and proposed for improved design and future development. More focus on the following metrics can enhance neighbourhood development and shorten walking distances, since these metrics have the highest weight and impact on the walking distances of residents. As shown in Table 4-11, the most critical walking distance metrics in these neighbourhoods are as follows: walking distance to senior high school and junior high school, walking distance to transit centre / light rail station, walking distance to recreation centre / sports facility, and walking distance to local community centre.

Table 4-11: Most Critical Walking Distance Metrics for Select Neighbourhoods

Critical metrics for walking distance	**Riverdale**		**Lynnwood**		**Skyrattler**		**Ozerna**	
	Centre	Defined Area	Centre	Defined Area	Centre	Defined Area	Centre	Defined Area
Senior high school	3.78	5.07	3.32	24.24	4.52	6.64	2.77	18.25
Transit centre / light rail station	3.35	5.28	**6.43**	**44.27**	-	-	**6.95**	**33.20**
Recreation centre / sports facility	**3.86**	**5.79**	5.02	36.03	4.50	6.95	-	-
Junior high school	**-**	**-**	-	-	**5.45**	**8.80**	-	13.20
Local community centre	-	-	-	-	-	-	3.07	-

As mentioned earlier, when driving distances for select neighbourhoods from both centre and defined areas are compared, it is found that Lynnwood neighbourhood with $TWDD_{ANF} = 33.41$, and Ozerna neighbourhood with $TWDD_{ANF} = 32.11$ fail to satisfy the TWDDs based on expert opinion. Table 4-12 shows the three most critical metrics influencing driving time in these neighbourhoods. As demonstrated in this table both Lynwood and Ozerna need better access routes or, as a second option, more convenient public transit in order to facilitate travel to postsecondary institutions. According to the results the next two critical metrics in Lynnwood that need to be considered by urban developers and municipal planners accessibility of hospital and cinema, and in Ozerna they are medical laboratory (imaging, diagnostics, etc.) and hospital.

Table 4-12: Most Critical Metrics for Driving in Select Neighbourhoods

Critical Metrics for Driving	**Riverdale**		**Lynnwood**		**Skyrattler**		**Ozerna**	
	Centre	Defined Area	Centre	Defined Area	Centre	Defined Area	Centre	Defined Area
Postsecondary institution	-	-	-	**5.45**	-	-	-	**4.17**
Hospital	-	-	-	4.27	-	-	-	3.49
Cinema	-	-	-	3.11	-	-	-	-
Medical laboratory (imaging, diagnostics, etc.)	-	-	-	-	-	-	-	3.66

It can be concluded that these findings not only provide better understanding of current neighbourhood design in the select neighbourhoods, but also aim to improve future design through understanding of the metrics used to quantify quality of life. Since urban expansion and neighbourhood development without an appropriate planning fails to meet the needs of individuals, such as accessibility to facilities and amenities, it will result in lower quality of life for individuals in any neighbourhood.

CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

This Chapter presents the contribution of this research work, limitations of the methodology, and gives recommendations for future work.

5.1 General Conclusion

This research presents a methodology to measure the effect of neighbourhood development on quality of life, and applies this methodology in four case studies in Edmonton, Alberta. The important metrics influencing quality of urban life are identified and defined, and a quantification process for the comparison of quality of life is designed based on neighbourhood development criteria, expert opinion, and importance of closeness of various facilities and amenities. Riverdale, in Edmonton's central core; Lynnwood, a mature neighbourhood, Skyrattler, an established neighbourhood; and Ozerna, a developing neighbourhood, are chosen as case studies and the proposed methodology is implemented. Quality of life is quantified based on analysis of data obtained from official government statistics, geographical maps, and drawings received by the City of Edmonton. This collected data is compared to previous transportation and urban planning studies available in the literature, neighbourhood development guideline (LEED-ND), and expert opinion.

This methodology is used to quantify quality of urban life in terms of accessibility (either walking or driving) to select facilities and amenities. It assists urban developers and municipal planners in optimizing quality of life by reducing commute time and improving the development of new communities.

5.2 Research Contributions

This research contributes to the field of urban planning and development through the quantification of quality of life. Specific contributions ae summarized below:

- Helping urban developers and municipal planners to have thorough understanding of the metrics used to quantify quality of life.
- Providing information regarding the quantification and evaluation of quality of urban life in existing neighbourhoods in order to determine redevelopment needs in a neighbourhood.
- Providing information based upon which urban developers/municipal planners can build attractive new neighbourhoods, utilizing user-centric analytical models to improve quality of life.

5.3 Research Limitations

The limitations of this research are presented as follows:

- The most recent Edmonton population data available is for 2012, whereas the most recent available residential area data is from 2009, and no residential data is available for 2012. It is thus assumed that residential area development (i.e., residential expansion) from 2009 to 2012 in the select neighbourhoods is minimal and thus negligible.
- The average size of a Canadian family is assumed to vary from one neighbourhood to another based on the total population of select neighbourhoods, but it is considered to be equal for all types of housing within a given neighbourhood.

- The total calculated defined residential area (ha) for a given neighbourhood is based on the AutoCAD file received from the City of Edmonton (2012) and it has at least 1% error compared to the total residential area (ha) file published by the City in 2009.
- The quantification of age structure categories with transportation mode and safety in select neighbourhoods is based only official government data, not the results of a household survey. Therefore, the young adults' ages are based on the Edmonton municipal census results and the age bracket 15-34 years, although a number of different age ranges are used in the literature.

5.4 Recommendation for Future Studies

The developed methodology can be a foundation for future studies in various fields of transportation and planning, such as the following:

- Incorporating more metrics in the quantification of quality of life, such as noise level, attractiveness, and perception of neighbourhood, by means of a household survey;
- Establishing a guideline for future development based on residents' needs; and
- Providing urban and transportation planning strategies to mitigate the issues faced with rapid urbanization and reduce commuting time by providing active transportation in the city.

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APPENDIX (1)

Metric	**Type of Data**
Demographic	
Neighbourhood Metrics	
Age	Statistic
Type of Housing	Statistic
Public Safety Metrics	
Assault	Statistic
Break and Enter	Statistic
Homicide	Statistic
Robbery	Statistic
Sexual Assault	Statistic
Theft From Vehicle	Statistic
Theft of Vehicle	Statistic
Theft Over $5000	Statistic
Transportation Metrics	
Mode of transportation	Statistic
Accessibility	
Transportation Metrics	
Walking proximity to transit centre / light rail station	Distance
Education Metrics	
Walking proximity to daycare	Distance
Walking proximity to pre-school	Distance
Walking proximity to elementary school	Distance
Walking proximity to junior high school	Distance
Walking proximity to senior high school	Distance

Health Metrics	
Walking proximity to pharmacy	Distance
Driving proximity to medical clinic	Distance
Driving proximity to medical laboratory (imaging, diagnostics, etc.)	Distance
Driving proximity to hospital	Distance
Driving proximity to senior/long-term care facility	Distance
Service Metrics	
Driving proximity to convenience store	Distance
Driving proximity to grocery store/supermarket	Distance
Driving proximity to mall/shopping centre	Distance
Driving proximity to post office	Distance
Driving proximity to bank	Distance
Driving proximity to public library	Distance
Driving proximity to restaurant	Distance
Driving proximity to coffee shop	Distance
Driving proximity to hair salon	Distance
Driving proximity to cinema	Distance
Greenery Metrics	
Walking proximity to public park / green space	Distance
Recreation Metrics	
Walking proximity to recreation centre / sports facility	Distance
Walking proximity to local community centre	Distance

APPENDIX (2)

Quality Of life Survey

Survey No. ____ **Date**: ____________________

We are conducting a survey of residents to find ways to improve the ***Quality of Life*** in neighbourhoods. It is our aim that the findings of this study be used to improve quality of life through improved urban planning. You can help us and help your neighbourhood by spending 2 minutes answering a few questions. All of your answers are completely confidential!

1. How long have you lived in your neighborhood?

☐ Less than 1 year ☐ 1 year to less than 3 years ☐ 3 years to less than 5 years ☐ 5 years or more

2. What is your Housing type?

☐ Single Family ☐ Duplex ☐ Row House ☐ Apartment (1-4 stories) ☐ Apartment (5+ stories)

3. Do you own or rent the place where you live?

☐ Rent ☐ Own/Bought

4. What is the maximum distance you would be willing to walk from your home to access the following services/amenities/facilities listed below? Please put only one check mark (√) for each business or facility.

	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	Don't know
Daycare	☐	☐	☐	☐	☐	☐
Pre-school	☐	☐	☐	☐	☐	☐
Elementary school	☐	☐	☐	☐	☐	☐
Junior high school	☐	☐	☐	☐	☐	☐
High school	☐	☐	☐	☐	☐	☐
University/postsecondary institution	☐	☐	☐	☐	☐	☐
Medical clinic	☐	☐	☐	☐	☐	☐
Medical laboratory (imaging, diagnostics, etc.)	☐	☐	☐	☐	☐	☐
Pharmacy	☐	☐	☐	☐	☐	☐
Hospital	☐	☐	☐	☐	☐	☐
Senior / long-term care facility	☐	☐	☐	☐	☐	☐

	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	Don't know
Convenience store	☐	☐	☐	☐	☐	☐
Grocery store / supermarket	☐	☐	☐	☐	☐	☐
Mall / shopping centre	☐	☐	☐	☐	☐	☐
Post office	☐	☐	☐	☐	☐	☐
Bank	☐	☐	☐	☐	☐	☐
Public library	☐	☐	☐	☐	☐	☐
Coffee shop	☐	☐	☐	☐	☐	☐
Hair salon	☐	☐	☐	☐	☐	☐
Cinema	☐	☐	☐	☐	☐	☐
Public Park / green space	☐	☐	☐	☐	☐	☐
Recreation centre / sports facility	☐	☐	☐	☐	☐	☐
Community centre	☐	☐	☐	☐	☐	☐
Transit centre /LRT station	☐	☐	☐	☐	☐	☐

5. What is the maximum distance you would be willing to drive from your home to access the following services/amenities/facilities listed below? Please put only one check mark (√) for each business or facility.

	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	Don't know
Daycare	☐	☐	☐	☐	☐	☐
Pre-school	☐	☐	☐	☐	☐	☐
Elementary school	☐	☐	☐	☐	☐	☐
Junior high school	☐	☐	☐	☐	☐	☐
High school	☐	☐	☐	☐	☐	☐
University/postsecondary institution	☐	☐	☐	☐	☐	☐
Medical clinic	☐	☐	☐	☐	☐	☐
Medical laboratory (imaging, diagnostics, etc.)	☐	☐	☐	☐	☐	☐

APPENDIX (3)

Quality of Life Survey

Survey No. ____ **Date:** ____________________

We are conducting a survey of residents to find ways to improve the ***Quality of Life*** in neighbourhoods. It is our aim that the findings of this study be used to improve quality of life through improved urban planning. You can help us and help your neighbourhood by spending 2 minutes answering a few questions. All of your answers are completely confidential!

1. Please rank the importance of closeness of the following facilities to your home if you want to walk to get them? For each of the services/amenities/facilities listed; use a checkmark (✓) to select one of the options.

(1= Slightly important, 2= Somewhat important, 3= Moderate, 4= Very important, 5= Extremely important)

	1	2	3	4	5
Daycare	☐	☐	☐	☐	☐
Pre-school	☐	☐	☐	☐	☐
Elementary school	☐	☐	☐	☐	☐
Junior high school	☐	☐	☐	☐	☐
Senior high school	☐	☐	☐	☐	☐
Pharmacy	☐	☐	☐	☐	☐
Public park/green spaces	☐	☐	☐	☐	☐
Recreation Centre/sport facilities	☐	☐	☐	☐	☐
Local community	☐	☐	☐	☐	☐
Transit centre/ LRT station	☐	☐	☐	☐	☐

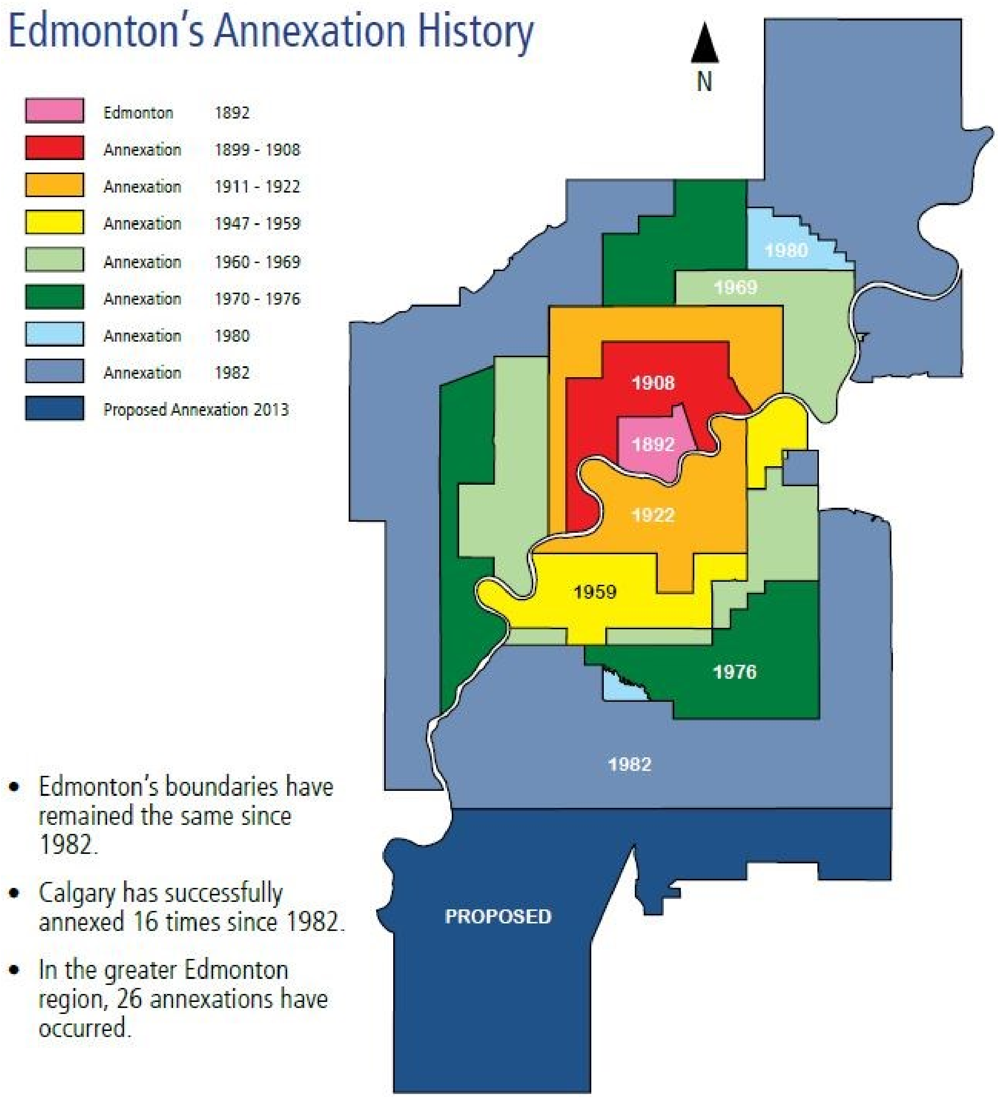
2. Please rank the importance of closeness of the following facilities to your home if you want to drive to get them? For each of the services/amenities/facilities listed; use a checkmark (✓) to select one of the options.

(1= Slightly important, 2= Somewhat important, 3= Moderate, 4= Very important, 5= Extremely important)

	1	2	3	4	5
University/postsecondary institution	☐	☐	☐	☐	☐
Medical clinic	☐	☐	☐	☐	☐
Medical laboratory (imaging, diagnostics, etc.)	☐	☐	☐	☐	☐
Pharmacy	☐	☐	☐	☐	☐
Hospital	☐	☐	☐	☐	☐
Senior/long-term care facility	☐	☐	☐	☐	☐
Convenience store	☐	☐	☐	☐	☐
Grocery store/ supermarket	☐	☐	☐	☐	☐
Mall/ shopping centre	☐	☐	☐	☐	☐
Restaurant	☐	☐	☐	☐	☐
Post office	☐	☐	☐	☐	☐
Bank	☐	☐	☐	☐	☐
Public Library	☐	☐	☐	☐	☐
Coffee shop	☐	☐	☐	☐	☐
Hair salon	☐	☐	☐	☐	☐
Cinema	☐	☐	☐	☐	☐

Thank you for your cooperation in completing this survey.

APPENDIX (4)



Edmonton's Annexation History (City of Edmonton 2014b)